INFLATION, INFLATION UNCERTAINTY AND ECONOMIC GROWTH NEXUS: AN IMPACT STUDY OF SOUTH AFRICA

by

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DECLARATION

I, **Shelton Masimba Tafadzwa Mandeya** (student number: **67142826**), hereby declare that this thesis, entitled "**Inflation, Inflation Uncertainty and Economic Growth Nexus: An Impact Study of South Africa**", is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part thereof, for examination at Unisa for another qualification or at any other higher education institution.

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Date: **MARCH 25, 2021**

ABSTRACT

This study empirically examines the inflation, inflation uncertainty and economic growth nexus in South Africa using quarterly data for the period 1961Q1-2019Q4. The study employed the Autoregressive Distributed Lag (ARDL) bounds-testing approach. Literature has recorded a number of studies on the relationship between inflation and economic growth which yielded different conclusions. Studies on the South African economy omit the joint impact of inflation and inflation uncertainty on economic growth. This study enhances literature by bridging this gap.

The empirical findings from the study illustrate that, in South Africa, inflation harms economic growth in both the short- and long-run. Inflation uncertainty is negatively related to economic growth in the short-run but lacks any significant relationship with economic growth in the long-run, which is an indication that inflation uncertainty is a short-run phenomenon in South Africa. Accordingly, the study recommends that the South African Reserve Bank maintains policies that promote price stability, such as inflation targeting, to provide a conducive environment for growth. It should also be stressed that price stability is a necessary but not sufficient condition for growth, hence the need for government to engage macroeconomic policies to promote economic growth.

KEYWORDS:

Inflation, inflation uncertainty, economic growth, price stability, inflation-targeting, South Africa, ARDL bounds testing approach, co-integration.

DEDICATION

To my son, Seth, may this work be an encouragement to you in the future.

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- and lastly to all who directly and indirectly lent their hand in this journey.

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ACRONYMS

Key Acronyms	Meaning
ADF	Augmented Dickey-Fuller
ARCH	Auto-Regressive Conditional Heteroskedastic
ARDL	Autoregressive Distributed Lag
BGP-LM	Breusch-Pagan-Godfrey Lagrange Multiplier
CMA	Common Monetary Area
CPI	Consumer Price Index
CUSUM	Cumulative Sum of Recursive Residual
CUSUMQ	Cumulative Sum of Squares of Recursive Residual
DF-GLS	Dickey-Fuller Generalised Least Squares
ECM	Error Correction Model
GDP	Gross Domestic Product
GDE	Gross Domestic Expenditure
LCB	Lower Critical Bound
LM	Lagrange Multiplier
INF	Inflation rate
PP	Phillips-Perron
R	Nominal Interest Rates
RDP	Reconstruction and Development Programme
SACU	Southern African Customs Union
SARB	South African Reserve Bank
SIC	Schwarz Information Criterion
StatsSA	Statistics South Africa

UCB	Upper Critical Bound
VOL	Inflation Uncertainty
Y	Economic Growth

CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 Background to the study

The impact of inflation and inflation uncertainty on economic growth has been the subject of macroeconomic research and debates for quite a long time. Despite the debates, however, there is consensus among different studies that inflation and inflation uncertainty affect savings and investment, which in turn influences the rate of capital formation and ultimately economic growth (see Mundell, 1963, 1965; Tobin, 1965; Cooley and Hansen, 1989; Datta and Kumar, 2011; Barro, 2013). The bone of contention, specifically, hovers on the debate on whether inflation and uncertainty about inflation impacts economic growth negatively, or positively.

In theory, some economists hold the view that high inflation and inflation uncertainty accommodates economic growth. For instance, Mundell (1963) predicts that high inflation forces economic participants to reduce their money balances and acquire real assets, which stimulates capital formation and ultimately economic growth. In the same vein, Tobin (1965) posits that inflation uncertainty induces households to hold more real capital assets than non-interest-bearing assets, which promotes capital formation and, in turn, economic growth. The propositions by Mundell (1963) and Tobin (1965) concur with the Keynesians' view that inflation is positively correlated to economic growth in the long run. This guided monetary policies during the decades preceding the 1970s.

The focus, however, changed in the 1970s due to the emergence of a stagflation - an empirical phenomenon of the 1970s which presented a contrasting view on the world economies. A stagflation ensued – inflation was high but with stunted economic growth. This drew the attention of many theoretical studies, such as those of Okun (1971), Friedman (1977), Stockman (1981) and Ball (1992), which postulate the existence of a negative relationship between inflation and economic growth. The differences and lack of consensus in the theoretical underpinnings on the relationship then sustained the debate on whether inflation and inflation uncertainty harms or benefits economic growth.

The existing empirical literature is also not different from the theoretical literature. At one extreme, there is a body of empirical literature that finds a negative relationship between either inflation or inflation uncertainty or both, and economic growth (see among others, Judson and Orphanides, 1999; Grier and Perry, 2000; Grier, Henry, Olekalns and Shields, 2004; Rother, 2004; Apergis, 2005; Munyeka, 2014). In contrast, Coulson and Robins (1985), Jansen (1989), Bredin, Elder and Fountas (2009), and Fountas (2010) document a positive relationship among the variables. The empirical results also differ between and within industrialised countries and emerging economies.

The choice of South Africa, an emerging economy, in this study was motivated by two reasons. First, the South African financial sector is one of the largest and most sophisticated and has an expanding presence in Africa, according to the International Monetary Fund (IMF) (2014). Any changes in macroeconomic variables, such as inflation in this instance, disturbs the financial sector, the effects of which are transmitted to other economies in Africa marked by the presence of South African financial institutions. Second, South Africa is a member of the Common Monetary Area[1] (CMA) which is a *de facto* monetary union where member's currencies are pegged one-for-one to the South African Rand. Furthermore, South Africa's monetary policy is adopted by the member states. This places South Africa in an influential role within Southern Africa and exposes members of the CMA to South African monetary policy and changes in macroeconomic variables.

Since the 1970s, South Africa has been characterised by price instabilities (Akinboade, Siebrits and Niedermeier, 2004). Structural factors such as economic embargoes on the South African government, poor performance of monetary policies and interventionist policies are cited as some of the reasons behind the price instabilities before the 1990s (Akinboade, *et. al,* 2004). In a quest to achieve price stability, while addressing the concerns against interventionist policies, in 2000 South Africa adopted the inflation targeting framework (South African National Treasury (Treasury), 2000). Inflation targeting is supported by a body of theory by scholars such as Mishkin (2001), Mishkin and Schmidt-Hebbel (2007) and Bernanke, Laubach,

[1] The Common Monetary Area is allied to the Southern African Customs Union, and it links South Africa, Namibia, eSwatini (formerly Swaziland) and Lesotho to a monetary union.

Mishkin and Posen (1999) that regards price stability as a pre-requisite for economic growth and employment creation. This notion of price stability as a prerequisite for economic growth has not, however, been spared from criticism. Stiglitz (2008) argues informally that inflation in developing economies is mainly caused by soaring prices of food and oil which represents a larger share of household budget than in developed economies, thereby disconnecting price stability as a prerequisite for economic growth. In South Africa, considerable criticism on the view of a negative impact of inflation and inflation uncertainty on economic growth was brought forward by the Congress of South African Trade Unions (COSATU). COSATU proposes that the SARB should allow inflation to increase in order to accommodate output growth, employment creation and a stable exchange rate (Munyeka, 2014).

Empirical evidence on the South African economy also offers conflicting conclusions on the nature of the relationship that inflation and inflation uncertainty have with economic growth. For instance, Weeks (1999) and Hodge (2006) find that South Africa can make use of higher rates of inflation to accommodate economic growth. In contrast, Nell (2000), Niyimbanira (2013), Munyeka (2014) and Kumo (2015) find that high inflation harms economic growth. Therefore, no conclusive relationship has been established, bringing with it a host of challenges for policy adoption and implementation as far as inflation and inflation uncertainty is concerned. It is against this background that this study aims to revisit this relationship.

1.2 Statement of the problem

The literature on the impact of inflation and inflation uncertainty on economic growth has been widely researched, as discussed in Section 1.1. Both the theoretical underpinnings and empirical findings, however, yield inconclusive results, thereby perpetuating the debate. Theoretically, the debate finds different conclusions from within the different economic schools of thought, to various underpinnings by different scholars. Empirical findings also point to different conclusions. In South Africa, no conclusive empirical results have been obtained to date, making the choice of monetary policy a harder exercise.

Under the premise that price stability promotes economic growth in the long-run, the South African Reserve Bank (SARB) adopted the inflation targeting policy in 2000, with the target range of 3% to 6% (Marcus, 2014; Vermeulen, 2015). While inflation has generally been kept within the target bands of 3% and 6% and stable, economic growth has been sluggish, defying the premise of a positive relationship between price stability and economic growth in the long-run. This has reignited the debate on the impact that inflation and inflation uncertainty have on economic growth in South Africa.

It is against this backdrop that this study revisits and examines the inflation, inflation uncertainty and economic growth nexus in South Africa using the Autoregressive Distributed Lag (ARDL) bounds testing approach. This study notably includes inflation uncertainty in its analyses, thereby examining the joint impact of inflation and inflation uncertainty on economic growth. This enriches the insight into the ongoing debate while circumventing the possibilities of errors in conclusions in the previous studies due to the omission of inflation uncertainty in the studies.

1.3 Objectives and hypotheses of the study

1.3.1 Objectives of the study

The main objective of this study is to empirically examine the inflation, inflation uncertainty and economic growth nexus in South Africa. Given this, the specific objectives of this study are, to:

(i) explore the dynamics of inflation, inflation uncertainty and economic growth in South Africa, from 1960 to 2019,
(ii) review and analyse the theoretical and empirical literature on the inflation, inflation uncertainty and economic growth nexus,
(iii) examine the short- and long-run impact of inflation and inflation uncertainty on economic growth in South Africa and
(iv) compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting.

1.3.2 Hypotheses of the study

In respect of the objectives above, this study has the following empirically testable hypotheses:

(i) Inflation and inflation uncertainty nurtures a significant long-run negative relationship with economic growth in South Africa;
(ii) Inflation and inflation uncertainty nurtures a significant short-run negative relationship with economic growth in South Africa; and
(iii) The coefficients of inflation and inflation uncertainty are higher under the pre-inflation targeting era compared with the coefficients of inflation and inflation uncertainty under the inflation targeting period.

1.4 Significance of the study

By examining the impact of inflation and inflation uncertainty on economic growth in South Africa, this study enriches the literature in various ways. Firstly, although studies on the impact of inflation on economic growth in South Africa have been conducted, however, to the best of the researcher's knowledge, this study is a pioneer study in exploring the joint impact of inflation and inflation uncertainty on economic growth in South Africa. Previous studies such as Nell (2000), Hodge (2006) and Niyimbanira (2013), among others, omitted inflation uncertainty. Judson and Orphanides (1999) point out that the omission of inflation uncertainty may lead to a failure to capture the impact of inflation on growth. To this effect, this study addresses this shortcoming.

Secondly, although studies have been done on the impact of inflation on economic growth in South Africa, this study is unique in that it provides a comparison of the impact of inflation and inflation uncertainty on growth in South Africa before and after the adoption of an inflation targeting framework. Given the changing behaviour of variables over time, this assists in pointing out the existing relationship among variables under study given the current conditions and the monetary policy regime in effect.

Thirdly, this study uses a longer timespan stretching from 1961Q1 to 2019Q4. This increased the sample size, which increased the statistical power in hypothesis testing,

thereby increasing the reliability and validity of the study's results (Kim and Park, 2019). Not only does this study use a longer time span, covering four decades, but it also uses quarterly data which sets it apart from previous studies that either focused on short time frames or used less frequent data, such as annual data.

Fourthly, the impact of inflation and inflation uncertainty on economic growth remains a debatable issue given different theoretical underpinnings as well as empirical findings. South African empirical studies also derive ambiguous results with Nell (2000), Hodge (2006) and Adusei (2012) finding a positive relationship between inflation and economic growth in the short-run, while Vermeulen (2015), Manamperi (2013) and Munyeka (2014) find conflicting results. Given this ongoing debate on the impact of inflation on economic growth, this study will also add further insight to the debate.

Finally, Phiri (2018) blames the differences in the empirical conclusions on the differences in the estimation techniques and data used. The significance of this study also lies in its use of the Autoregressive Distributed Lag (ARDL) estimation techniques in examining the short- and long-run impact of inflation and inflation uncertainty on economic growth in South Africa, thereby contributing an existing but different estimation technique to the ongoing debate.

1.5 Organisation of the study

The study is divided into six chapters. Chapter Two presents the dynamics of inflation, inflation uncertainty and growth in South Africa. Chapter Three reviews both theoretical and empirical literature on the inflation, inflation uncertainty and growth nexus. Chapter Four outlines the methodology of the study, displaying how time-series techniques are used to analyse the inflation, inflation uncertainty and economic growth nexus in South Africa. Chapter Five discusses the econometric analyses and the empirical findings from the study. Thereafter, Chapter Six as the final chapter concludes the study with a discussion of major findings, policy implications as well as areas for further research on the subject.

CHAPTER 2

THE DYNAMICS OF INFLATION, INFLATION UNCERTAINTY AND ECONOMIC GROWTH IN SOUTH AFRICA (1960 – 2019)

2.1 Introduction

This chapter provides episodes of inflation, inflation uncertainty and economic growth for South Africa for a period of 60 years stretching from 1960 to 2019. The chapter also presents trends, as well as analyses of the trends, thereby providing insight into the inflation, inflation uncertainty and growth nexus argument. The chapter is structured into five sections. Section two presents a chronology of inflation and inflation uncertainty dynamics before adoption of inflation targeting and during inflation targeting, in isolation from economic growth dynamics. Section three presents economic growth dynamics before adoption of inflation targeting and during inflation targeting and is also analysed in isolation from inflation and inflation uncertainty. The fourth section provides joint analyses and trends of inflation, inflation uncertainty and economic growth from the pre-inflation targeting era up to 2019. Finally, section five provides concluding remarks.

2.2 Episodes of inflation and inflation uncertainty in South Africa: From pre-inflation targeting era to inflation targeting era

Inflation is defined as a considerable rise in the general price level. Different proxies are used to measure the general price level. The proxies range from explicit indicators such as the Consumer Price Index (CPI) and the Producer Price Index (PPI), to implicit indicators such as the Gross Domestic Product (GDP) deflator and the Gross Domestic Expenditure (GDE) deflator. The widely used proxy is the CPI, which is also used in South Africa (StatsSA, 2020a). For reporting purposes, StatsSA publishes the inflation rate as the change in CPI in a given month compared to the CPI of the same month in the previous year, expressed as a percentage. StatsSA also computes quarterly inflation at an annualised rate, as well as annual rates of inflation.

Grier and Perry (1998) define inflation uncertainty as unpredictable volatility in general prices. Given that inflation uncertainty is an unobserved variable, many different

measures have been proposed in the literature. Iyke and Ho (2019) group these measures as either ex-post or ex-ante. Inflation uncertainty can be measured ex-ante, that is, before the period of inflation has passed; or ex-post, which is measured after the inflation period has occurred.

South Africa's monetary policy regimes have, since 1960, evolved through five broad frameworks. The monetary policy framework was in the 1960s and 1970s characterised with direct intervention where authorities would impose certain quantitative restrictions on the extension of bank credits (Van Der Merwe, 1997). Over time, however, the policies evolved towards a market-oriented approach where policymakers created incentives for financial institutions to react in the desired manner. This section is further divided into two sub-sections. The first section presents the inflation and inflation uncertainty dynamics during the monetary policy regimes that were adopted before inflation targeting. The second sub-section explains the dynamics after the adoption of inflation targeting.

2.2.1 Inflation and inflation uncertainty dynamics: Before inflation targeting (1960 – 1999)

The monetary frameworks in South Africa preceding 1960 were mainly influenced by the rise of conservative Keynesianism with some monetarist elements, to a limited extent (Mollentze, 2000). These frameworks fell after questions were raised on the presence of unique properties in money as a financial asset that would make changes in the money supply, these being the decisive factor in the determination of economic events (Mollentze, 2000).

The monetary regimes that followed involved direct intervention by the central bank. However, the regimes gradually evolved towards market-oriented policies. Understanding of these monetary policy regimes is crucial in understanding the inflation and inflation uncertainty dynamics since their main objectives were to achieve price stability. Inflation uncertainty and inflation episodes will be explained in line with these monetary policy frameworks. Table 2.1 provides a summary of monetary policy regimes pursued before inflation targeting, from 1960 to 1999.

Table 2.1: South Africa's monetary policy frameworks: 1960 - 1999

Period	Monetary Policy Framework
1960 - 1981	Liquid asset ratio-based system with quantitative controls over interest rates and credit
1981 - 1985	Mixed system during transition
1986 - 1998	Cost of cash reserves-based system with pre-announced monetary targets (M3[2])
1998 - 1999	*Daily tenders of liquidity through repurchase transactions (repo-system) plus, pre-announced M3 targets and informal targets for core inflation*

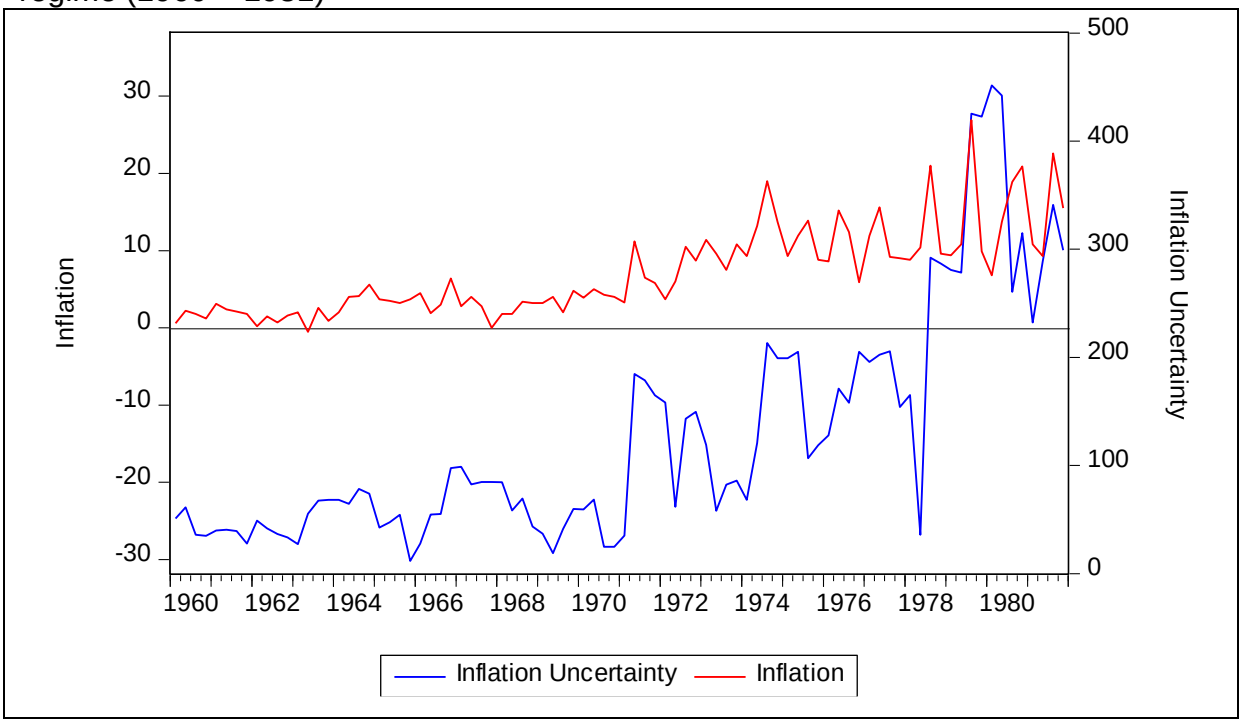
Source: Casteleijn (2001)

2.2.1.1 The dynamics of inflation and inflation uncertainty during the liquid asset ratio-based regime (1960 – 1981)

In 1960, the South African Reserve Bank (SARB) introduced the *liquid asset ratio-based system* with quantitative controls on interest rates and credit. This operated until the early 1980s (Aron and Muellbauer, 2006). Interest rates did not play a major role as a corrective measure since liquid asset requirements were prioritised. Direct intervention measures such as credit ceilings, direct consumer credit control and exchange rate controls were employed to slow down the growth of money supply, bank lending and inflationary pressures (Casteleijn, 2001). Figure 2.1 below shows the inflation and inflation uncertainty trends from 1960 to 1981 when South Africa was under the liquid asset ratio-based monetary regime.

[2] M3, in South Africa, is the most comprehensive measure of money regarded as the best measure of developments in the monetary sector. It comprises of currency in circulation, demand deposits, quasi-money, and all long-term deposits with a maturity longer than six months.

Figure 2.1: Inflation and inflation uncertainty trends during the liquid asset ratio-based regime (1960 – 1981)



Source: Author's output with data from SARB (2020)

The rate of inflation was largely stable between 1960 and 1970, with a maximum rate of inflation of 6.4%. Furthermore, the rate of inflation uncertainty as measured by the annualised standard deviation of quarterly inflation never exceeded 100% during this period.

In the early 1970s, food prices rose sharply to 7.1%, owing to rises in prices for vegetables as well as housing prices (SARB, 1972). This resulted in substantial accelerations in inflation from the 1970s through to the 1980s. Furthermore, South Africa's inflation problems were exacerbated by the rise in oil prices in 1973, due to the Arabian oil embargo to the United States and Netherlands (Wakeford, 2006). Oil prices rose substantially. The year that followed, in 1973, ushered another oil shock which spurred a rise in oil prices by a factor of nearly 4, from about $3 per barrel to around $11.50 per barrel (Van Der Merwe and Meijer, 1990). These were repercussions from the collusion by the Organisation of Petroleum Exporting Countries (OPEC) members to restrict production volumes while increasing the prices of oil (Van Der Merwe and Meijer, 1990). Inflation uncertainty rose throughout this period,

consistent with Friedman's (1977) hypothesis that high inflation stimulates inflation uncertainty.

Inflation remained rampantly high through to the early 1980s, with inflation uncertainty recording substantial increases, as shown in Figure 2.1. Further to international oil price woes, the apartheid[3] government suffered embargoes on oil imports, with Iran joining Arabian states in halting oil exports to South Africa in 1979 (Crawford and Klotz, 1999). This strained the supply of oil, which further increased inflation in the early 1980s, with the inflation rate exceeding 20% in 1979 as depicted in Figure 2.1. The level of inflation remained high through to 1981 when South Africa adopted a hybrid regime that transitioned to a cash-reserve regime, from the liquid asset ratio-based regime.

2.2.1.2 The dynamics of inflation and inflation uncertainty during the transition period (1981 – 1985)

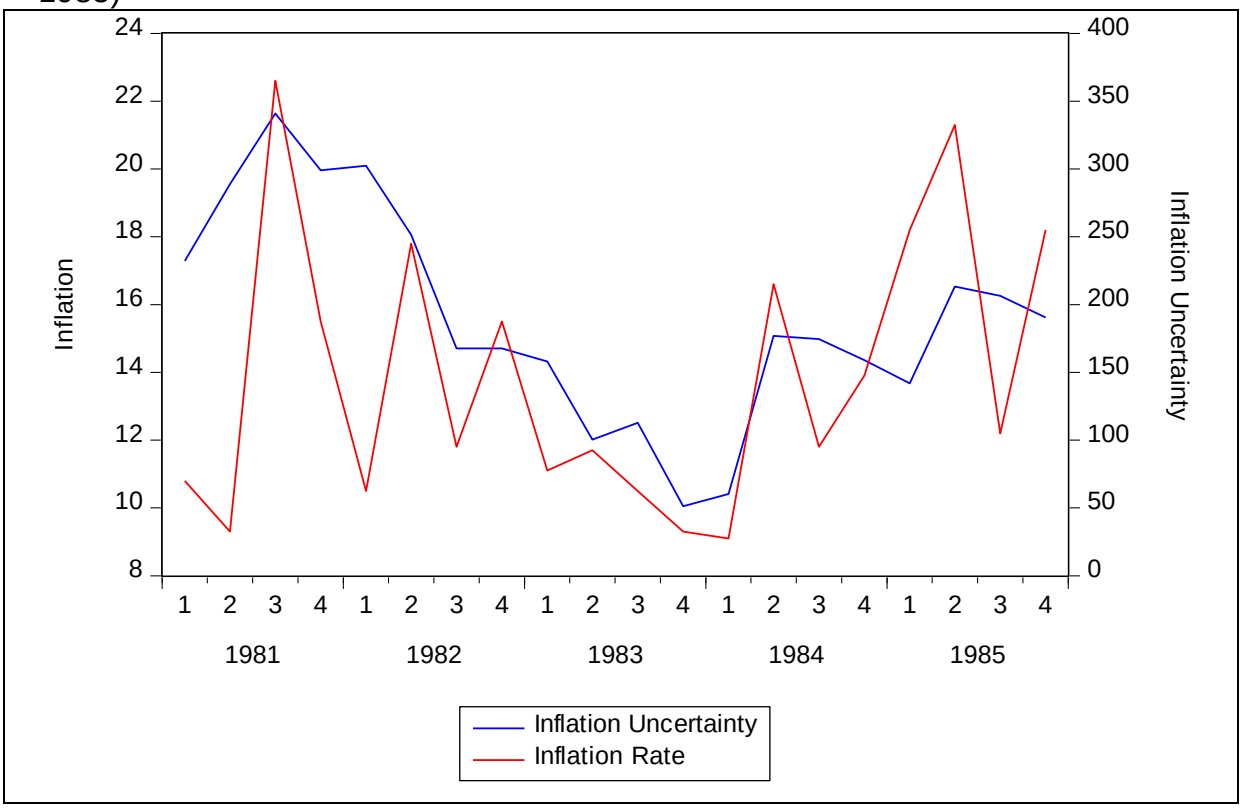
After experiencing continuous rises in inflation, the SARB sought to reform its monetary policy, transitioning from persistently direct intervention techniques to predominantly market-driven monetary mechanisms (Mollentze, 2000). Financial liberalisation was initiated with influence from the De Kock Commission Reports (De Kock 1978, 1985). The commission reiterated that well-developed and efficient markets are a prerequisite for growth and general soundness of the economy, and recommended market-related interest rates while arguing against direct or non-market-oriented policy measures. Following this, the SARB reduced interventions in the market, and eased financial regulations in domestic financial markets while moving towards financial liberalisation from 1981 (Moolman and Du Toit, 2004).

The SARB did not only reduce financial regulations in domestic markets, but also engaged in liberalisation of international capital markets, thereby facilitating ease of transferring capital in and out of the country (Odhiambo, 2011). Financial openness subsequently rose. Concurrently, South Africa also eased factor movements of labour, increasing freedom to work domestically or outside of South Africa.

[3]Apartheid was a system of institutionalised racial segregation by the white-minority government against the majority, non-white citizens in South Africa and Namibia. It was legislated in 1948 but dismantled in 1994 when South Africa attained its freedom.

Between 1981 and 1985, South Africa therefore, underwent through a transition from interventionist policies to market-oriented monetary regimes. The SARB introduced the cash reserves system where the discount rate influenced the cost of overnight collateralised lending, indirectly affecting market interest rates. Open market operations were employed to influence the supply of credit while linking commercial bank rates with the discount rate, which was set at a high rate. The reasoning was that this action would control the growth of money supply in the economy, thereby taming the rate of inflation, by an estimated lag exceeding 12 months (Aron and Muellbauer, 2006). However, despite these measures, inflation remained high, and predominantly double digit. Figure 2.2 shows the inflation and inflation uncertainty trends from 1981 to 1985 when South Africa was under a transition process from direct intervention policies to market oriented monetary regimes.

Figure 2.2: Inflation and inflation uncertainty trends during the transition period (1981 - 1985)



Source: Author's output with data from SARB (2020)

Although inflation had been predominantly high, inflation uncertainty improved over the period. One of the major reasons for the rise in inflation during this period was the imposition of economic sanctions on South Africa, which pushed production costs up. Chicheke (2009) argues that inflation remained high and volatile during this period due to the neglect of the corrective effect of interest rates by the policymakers and the poor performance of monetary policy when the SARB was under the helm of Gerhard De Kock.

2.2.1.3 The dynamics of inflation and inflation uncertainty during the monetary targeting regime (1986 – 1999)

As part of implementing the recommendations from the De Kock Commission Report (De Kock, 1985), the SARB introduced the monetary targeting regime in the mid-1980s (Stals, 1997). The most comprehensive definition of money, M3, was used as the nominal anchor for monetary policy. Growth of money supply was employed as an intermediate objective based on the premise that it would exert some influence on the extension and creation of bank credits, thereby ultimately protecting the value of the rand (Aron and Muellbauer, 2006).

There was no provision, however, that coerced the SARB to hold itself accountable to the public on the processes followed in choosing the inflation target nor update on the remedial process should they miss the targeted inflation (Aron and Muellbauer, 2006).

Monetary targeting is based on the quantity theory of money which assumes that inflation results from the difference between the growth in money supply and economic growth. The success of monetary targeting depends entirely on the presence of a stable relationship between money stock, which affects nominal income, and the goal variable such as inflation (Mishkin, 2001). Monetary targeting failed in South Africa because there was no empirical evidence of a direct relationship between money supply and inflation. Velocity of money in South Africa is also unstable, rendering the relationship between the goal and target variables weak. These were the main reasons for the abandonment of monetary targeting. Furthermore, structural changes during the transition period in the South African financial system altered the transmission mechanism (Casteleijn, 2001). Table 2.2 illustrates the growth in money supply against the set guidelines, and the inflation rate between 1986 and 1999.

Of the 14 years when South Africa pursued the monetary targeting regime, actual growth of money supply was within the targeted bands in only five years. The SARB barely achieved the monetary targets in the late 1980s, mainly due to capital inflows, which increased the growth of money supply after easing of sanctions on the South African economy (Casteleijn, 2001). Table 2.2 shows that from 1994 onwards, growth of money supply overshot and breached the targets throughout.

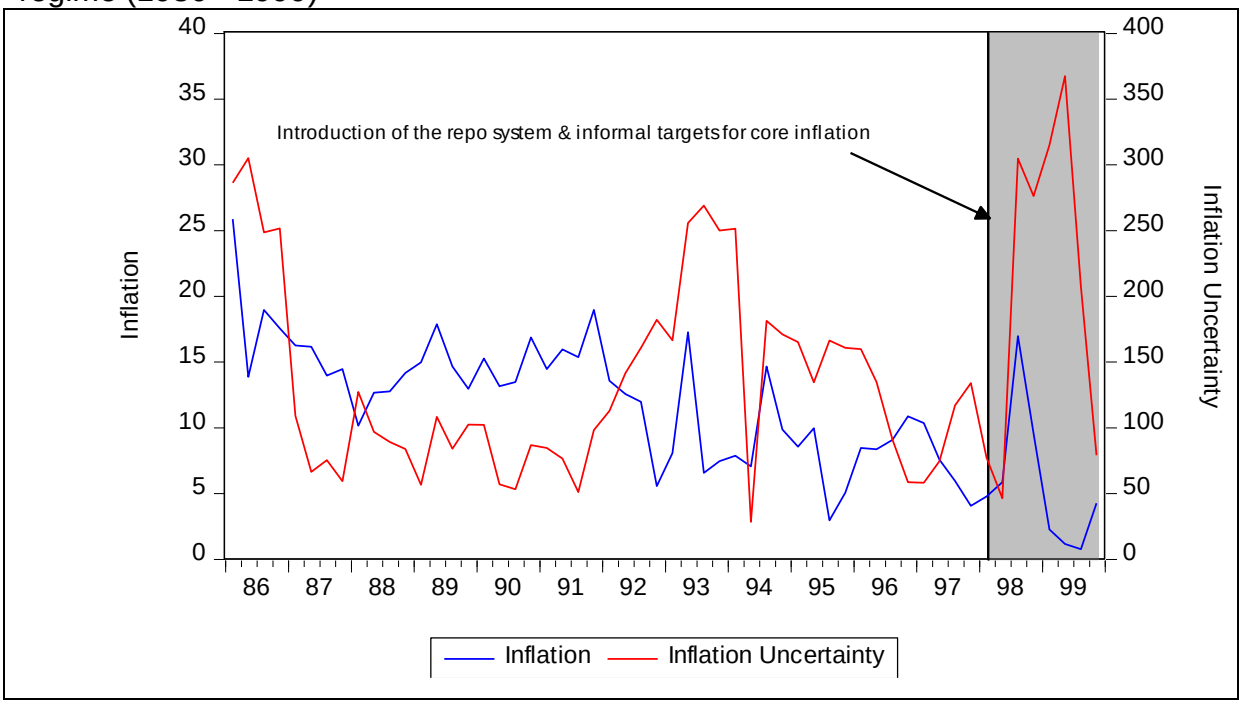
Table 2.2: Targeted money supply growth in comparison with actual money supply growth and inflation outcomes from 1986 to 1999

Year	Money Growth Targets %	Money Growth Actual %	Inflation (CPI) %
1986	16 – 20	9.3	18.6
1987	14 – 18	17.6	16.1
1988	12 – 16	27.3	12.9
1989	14 – 18	22.3	14.7
1990	11 – 15	12.0	14.4
1991	8 – 12	12.3	15.3
1992	7 – 10	8.0	13.9
1993	6 – 9	7.0	9.7
1994	6 – 9	15.7	9.0
1995	6 – 10	15.2	8.7
1996	6 – 10	13.6	7.4
1997	6 – 10	17.2	8.6
1998	6 – 10	14.6	6.9
1999	6 – 10	10.2	5.2

Source: South African Reserve Bank Quarterly Bulletin (2000)

Figure 2.3 further illustrates the inflation and inflation uncertainty trends in South Africa between 1986 and 1999, when monetary targeting was in use.

Figure 2.3: Inflation and inflation uncertainty trends during the monetary targeting regime (1986 - 1999)



Source: Author's output with data from SARB (2020)

Inflation remained relatively high between 1986 and 1990, despite a steady decline in South Africa's main trading partners' rates of inflation (Fourie and Burger, 2015). Fourie and Burger (2015) argue that inflation remained high during this period due to a weak monetary stance by the South African Reserve Bank. Van Der Merwe (1997) and Moll (1999) corroborate on the account that lifting of sanctions on South Africa and integration of South Africa into the world economy in the late 1980s to early 1990s caused an increase in the general price level. This is pinned on the increase in demand for domestic products by the international market, which caused demand-pull inflation in South Africa.

South Africa experienced a downward trend in inflation between 1992 and 1999, although inflation uncertainty remained high. This decline in inflation is accredited to the informal inflation targeting that was implicitly applied between 1992 and 1999 after the formulation of an eclectic monetary policy approach (Van Der Merwe, 2004).

2.2.2 The dynamics of inflation and inflation uncertainty during the inflation targeting regime (2000 – 2019)

The failure of the monetary targeting approach to harness inflation prompted the adoption of formal inflation targeting by the SARB in 2000. In the budget speech on the 23rd of February 2000, the then Finance Minister, Trevor Manuel, formally announced the adoption of the inflation targeting of 3% to 6%, which was to be achieved by the year 2002 (South African National Treasury (Treasury), 2000). However, the 2001 Medium-Term Budget Policy Statement introduced an escape clause that allowed the SARB to publicly define the target as temporarily non-binding under special circumstances, such as supply shocks (Treasury, 2001). Price stability remained the primary mandate of the South African Reserve Bank.

Inflation targeting is characterised by a number of elements, such as public announcement of numerical inflation targets and price stability as the primary goal of monetary policy (see Mishkin, 2000). This is often cited as the backbone that limits the time inconsistency problem. South Africa adopted inflation targeting based on the premise that price stability is a prerequisite for economic growth. Price stability, which is defined as low and stable inflation, is crucial to achieve due mainly to two reasons.

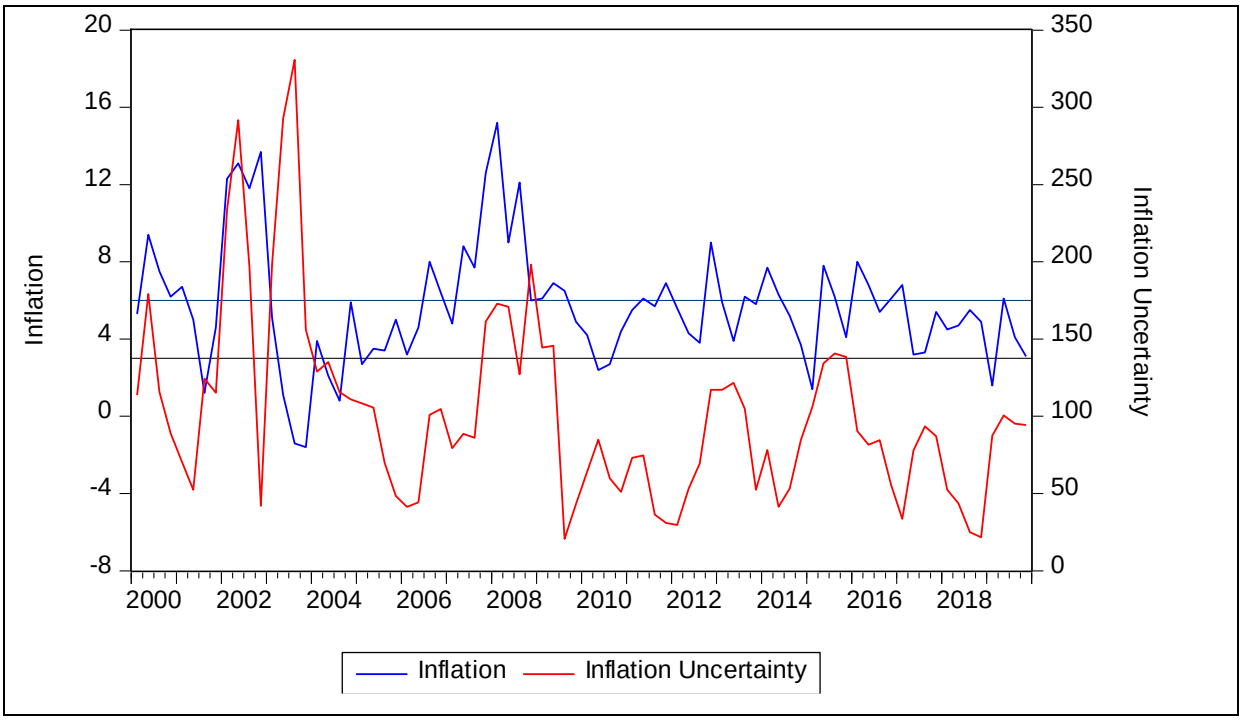
Firstly, inflation erodes purchasing power and standards of living. Although salaries can be adjusted in line with inflation, while investments and savings may outgrow inflation, it is impossible for the poor to protect themselves against inflation. They rely mainly on nominal earnings such as grants and pensions, which cannot be hedged against inflationary increases. StatsSA (2016) states that a volatile inflation hurts the poorest in South Africa.

Secondly, Treasury (2000) reasons that stability in the value of money enhances growth prospects. Inflation targeting is suggested to anchor inflationary expectations which reduces uncertainty, while boosting transparency as far as central bank's policy intentions are concerned. Through anchored expectations, central bank's credibility in managing and combating inflation increases sets a conducive environment for sustainable long-term economic growth (Vermeulen, 2020). South Africa, therefore, adopted the inflation targeting framework to prioritise price stability with the objective of counteracting the erosion of incomes and living standards due to price instability

whilst also safeguarding investment and savings decisions. Ultimately, long term growth would be attained.

Figure 2.4 below illustrates the trends in inflation and inflation uncertainty from 2000, when inflation targeting was adopted, until 2019.

Figure 2.4: Inflation and inflation uncertainty trends under the inflation targeting regime (2000 - 2019)



Source: Author's output with data from SARB (2020)

Inflation targeting has largely been credited as more effective in achieving price stability in South Africa, as compared to its predecessor policies (Makuvaza, Nyambe and Sheefeni, 2019). Although inflation has generally been tied within the 3% to 6% target, it breached the targets in some of the instances. The first breach was experienced in 2002, when inflation reached double digit figures, which posed the first threat to the credibility of inflation targeting since 2002 was set as the target to achieve the stipulated band (StatsSA, 2016). Akinboade, Siebrits and Niedermeier (2004) argue that inflation breached the 6% band due to factors exogenous to the South African Reserve Bank. The main reasons cited for the increase in inflation were sharp

increases in the world price of crude oil, increase in cost of imported products, a rise in food prices due to adverse weather conditions, as well as depreciation of the Rand.

The second breach was experienced between 2007 and 2009 where inflation stayed predominantly above the 6% band. This was mainly due to the 2007/8 global financial crisis, increases in food prices and electricity costs as well as global prices of crude oil (SARB, 2008). Inflation also exceeded 6% in 2013, as well as in 2016.

Inflation uncertainty has been decreasing since the inception of the inflation targeting framework, thereby tying down inflationary expectations. This decreases speculation, while increasing investor confidence.

2.3 Episodes of economic growth in South Africa: From pre-inflation targeting era to inflation targeting

South Africa is revered as the engine of growth in Africa (Arora and Vamvakidis, 2005). It is an upper-middle income economy that is often classified as an emerging economy and is the only African member of the G20[4]. Since 1960, the economy of South Africa has experienced two major eras, with the first one being the time it was under the apartheid governance, and the second one after the attainment of freedom and dismantling of apartheid in 1994. However, for the purpose of this study, a contrast of economic growth will be given between the pre-inflation targeting era and the inflation targeting period. This section is therefore further divided into three subsections accordingly. The first subsection gives an overview of the structure and outlook of the South African economy. The second subsection then details the economic growth trends from 1960 to 1999, which is the period before adoption of inflation targeting. The third subsection narrates the economic growth trends from 2000 until 2019, the period when South Africa was under the inflation targeting framework.

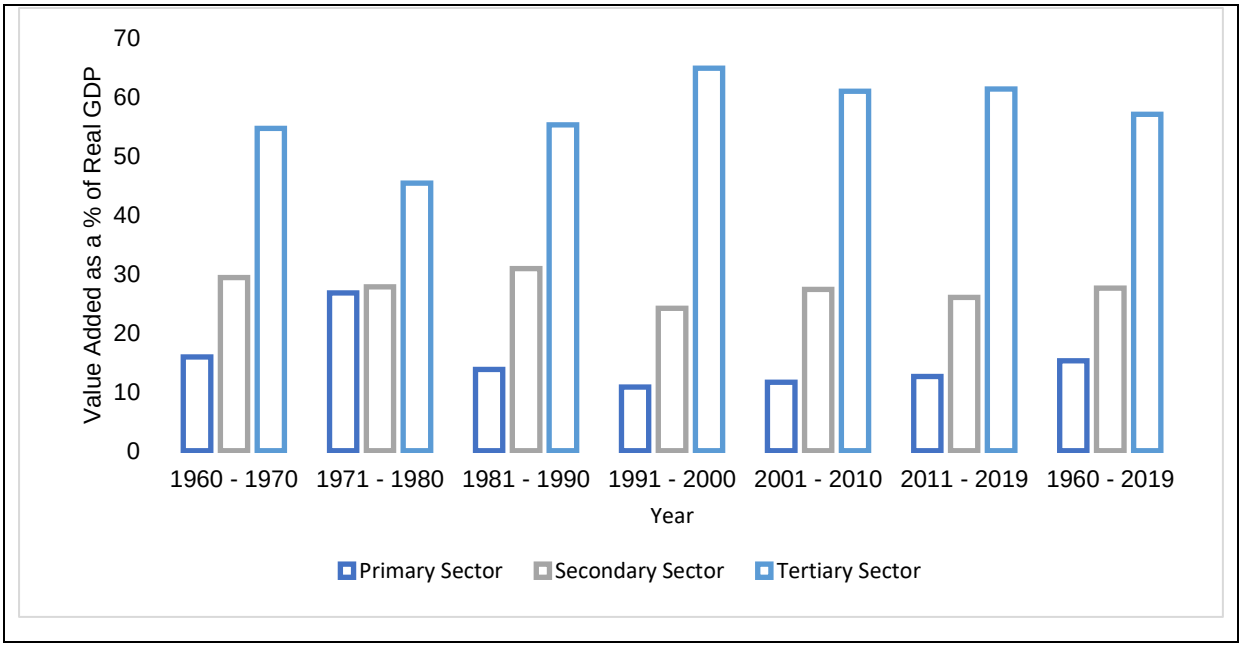
2.3.1 Structure and outlook of the South African economy

The South African economy has been characterised since 1960 as a service-driven economy dominated by the tertiary sector. The tertiary sector contributes more than

[4] G20, in full – Group of 20, is an international forum for global economic and financial cooperation formed in 1999; made up of 19 countries and the European Union. The cumulative GDP of its members exceed 80% of world GDP, constitutes three-quarters of global trade and more than two-thirds of the global population (G20, 2020).

60% to the Gross Domestic Product, with the biggest contributor being the finance, insurance, real estate and business services (SARB, 2010). Figure 2.5 illustrates the value added by different sectors as a percentage of South Africa's real GDP at constant 2010 prices.

Figure 2.5: Composition of Real GDP in South Africa: 1960 - 2019



Source: Author's output with data from SARB (2010) & World Bank (2020)

The primary sector has been declining since the 1960s, from 28.6% to 12.6% in 2019, while the secondary sector marked a slight increase from 23% in the 1950s to 26% in 2019. The services sector rose from 55% contribution to GDP in the 1960s to more than 60% since 2000, marking South Africa as a services-driven economy.

The key macroeconomic variables that drive economic growth in South Africa are explained by accumulation of physical capital, human capital development, international trade, price stability, government spending and exchange rate movements (Chirwa and Odhiambo, 2016). Policies adopted after attainment of freedom in 1994 reveal a deep contrast from the policies that were instituted during the apartheid era, resulting in large differences in the direction of these key macroeconomic variables. The South African economy suffers from high inequality, with the World Bank (2020) estimating a Gini index of 63.0, making it one of the most

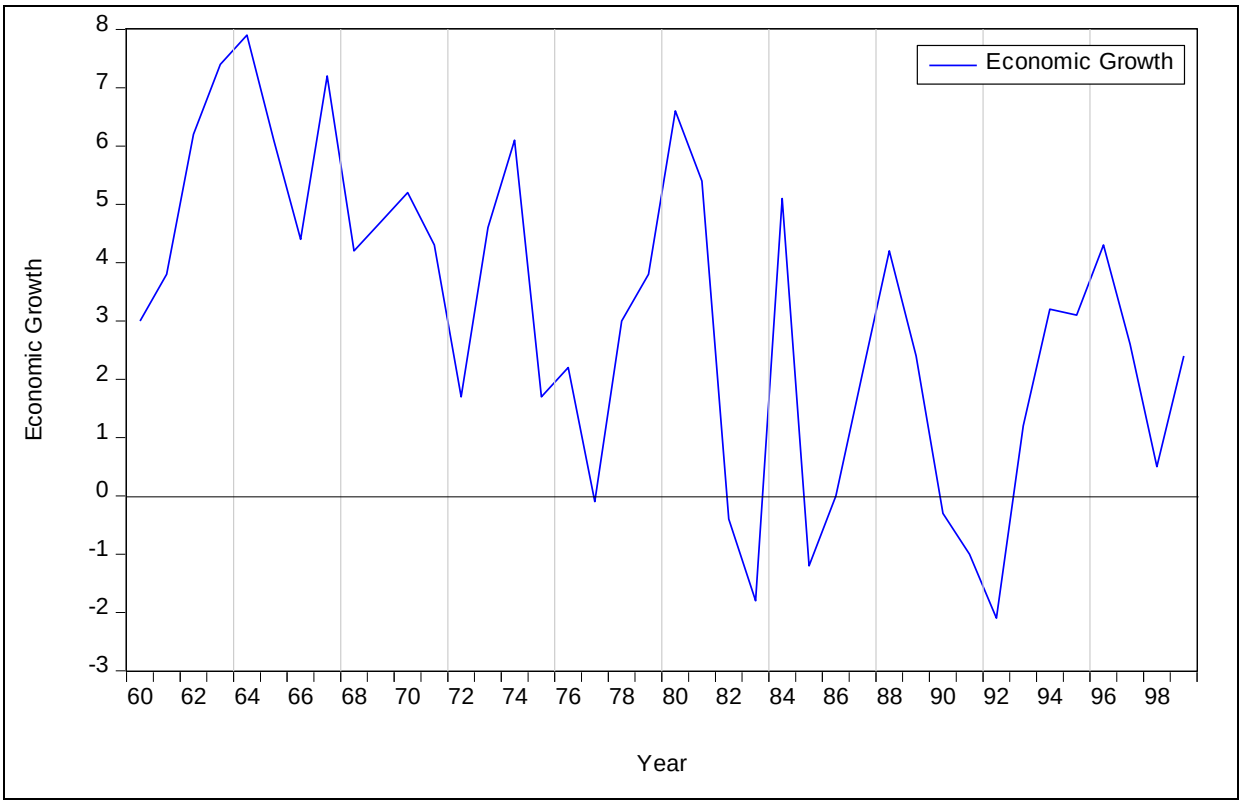
unequal societies in the world. Inequality is widely known to be the key driver of poverty, as documented by Todaro and Smith (2012), hence the high levels of poverty in South Africa. Poverty is also exacerbated by the ever-rising levels of unemployment.

The section that follows explains the trends in economic growth in chronological order, in line with macroeconomic policies that were applied by the different regimes.

2.3.2 Economic growth dynamics: Before inflation targeting (1960 – 1999)

Two political regimes existed between 1960 and 1999 – the apartheid regime that started in 1948 and ended in 1993, and the democratic transition covering the period 1994 – 1999. South Africa's real Gross Domestic Product (GDP) was US$79.1 billion in 1960 and it grew to US$256.2 billion at 2010 constant prices in 1999 (World Bank, 2020), indicating an average growth rate of 3.1% per annum. Figure 2.5 presents the trends in real GDP growth for South Africa from 1960 to 1999.

Figure 2.6: Economic growth trends before adoption of inflation targeting (1960 - 1999)



Source: Author's output with data from SARB (2020)

The economic set-up of the South African economy between 1960 and 1999 is explained by the events starting from 1948, which triggered the adoption and implementation of the apartheid policies. Industrialisation and mining activities in urban areas resulted in an influx of the working-class population to urban areas in the 1940s. Levy (1999) narrates that there was an exodus of cheap labour from farms to urban areas, resulting in an urban population of 46.6% in the 1940s. This resulted in shortages of cheap labour on farms whilst simultaneously increased the demand for commodities in the urban areas, hence rising costs of commodity prices, job competition and housing shortages. Consequently, wages decreased. Chirwa and Odhiambo (2016) posit that the success of the South African economy relied heavily on cheap labour.

In response to the problems emanating from the migration of labour from farms to urban areas, the Sauer Commission was set up in 1948 (Moll, 1991). The commission recommended reversing the growing urbanisation through strict control of migration in and out of urban areas while also reducing dependence on domestic labour. The recommendations made by the Sauer Commission in 1948 became the cornerstone of apartheid. Among other terms, the commission recommended racial categorisation where each race was given economic activities to carry out, with natives being accorded the worst of the activities (Apartheid Museum, 2006).

Moreover, the then government also passed the Bantu Education Act of 1953 which educated the native blacks only as unskilled labour (Lowenberg, 1997; Levy, 1999). These mercantilist policies created an acute shortage of skilled labour while creating an unequal society – problems of which are still being felt in the South Africa of today.

In response to this, in August 1963 the United Nations (UN) General Assembly imposed a voluntary arms embargo on South Africa (Crawford and Klotz, 1999), which was not effective as it was voluntary and so only a few states enforced it. The rate of economic growth decreased in 1964, as shown in Figure 2.6, and this can be pinned partly to the ban on direct investment in South Africa by the Japanese government in 1964. Moreover, in 1973, the Organisation of Petroleum Exporting Countries (OPEC), imposed an oil embargo on South Africa which resulted in acute fuel shortages and stifled economic growth (Becker, 1988).

After failure of the August 1963 voluntary arms embargo, the United Nations, in 1977, imposed a mandatory arms embargo on South Africa. This objective was foiled since the apartheid government responded to this through resorting to local production of military equipment (Moll, 1991). The economy, in contrast to the intended objective of the sanctions, instead experienced growth, as shown in Figure 2.6.

Between 1981 and 1986, the Unites States, Japan, the United Kingdom, the United Nations and the European Community imposed a number of sanctions on the apartheid regime that were in the form of disinvestment and divestment (Becker, 1988). Disinvestment initiated restrictions on new foreign capital investments in South Africa. Divestment, on the other hand, led to international boycott by nations, institutions and individuals from doing business with South Africa (Levy, 1999). As a result, South Africa experienced balance of payment deficits as well as capital flights, which explains the contraction of the economy in the early 1980s, as shown in Figure 2.6.

Apart from economic embargoes that were attracted by the apartheid regime, the apartheid policies themselves negatively distorted a number of key macroeconomic variables, thereby stifling growth. Investment decreased due to capital flights while racial discrimination and human capital discrimination suppressed human capital development. Poor policies by the central bank led to an increase in inflation to double digits between 1973 and 1992, a situation made worse by the oil embargoes. In the late 1970s, the government instituted intervention policies on the exchange rate, thereby imposing a dual exchange rate system and exchange controls on debt repayment which ushered in exchange rate misalignment and instabilities (Levy, 1999).

Sanctions of South Africa were relaxed in 1993 owing to the promise of freedom that was then attained in 1994, and the abolishment of apartheid. This may explain the improvement in South Africa's rate of economic growth from 1993, as shown in Figure 2.6. A shortage of skilled labour still continued, however, in the midst of poverty, inequality and limited basic public services. The newly elected government of Nelson Mandela proposed the Reconstruction and Development Programme (RDP) that aimed to alleviate poverty through the attainment of economic growth and development (Republic of South Africa, 1994).

The RDP borrowed its concepts largely from the new growth theory (NGT) by Romer (1986) which argues that inclusion of government in the economy would 'crowd-in' the private sector as opposed to the classical and neoclassical beliefs of government 'crowding-out' the private sector. While crowding-in the private sector, the RDP was also meant to untap the potential from the previously suppressed human capital, while addressing the socio-economic issues of inequality and poverty.

In 1996, South Africa embarked on the new economic blueprint named Growth, Employment and Redistribution (GEAR) which aimed at creating 400 000 new jobs each year while achieving 6% p.a economic growth within four years (Republic of South Africa, 1996). The intermediate objectives were achievement of price stability, stabilisation of the exchange rate, a focus towards promotion of non-gold exports, human capital development and attraction of domestic and international investment. The economy picked up in 1997, which could have been a response to the policy. Price stability, however, was not achieved during this period, leading to the adoption of inflation targeting. The next section discusses the trends in economic growth under the inflation targeting framework.

2.3.3 Economic growth dynamics under inflation targeting (2000 – 2019)

Faced with price instabilities which distorted investment decisions, the central bank adopted inflation targeting in 2000. Inflation targeting worked in tandem with the GEAR economic policy from the Ministry of Finance. Although the GEAR economic policy had achieved one of its objectives of reducing government budget deficits, growth in the real wages deferred the achievement of employment creation (Mahadea and Simson, 2010).

Failure by the GEAR policy to achieve its intended objectives triggered the migration to a new blueprint called the Accelerated Shared Growth Initiative for South Africa (ASGISA) in 2006 (Republic of South Africa, 2006). The government revised the economic growth rate target from 6% targeted in GEAR to 4.5% per annum between 2005 and 2009 and reverted to the 6% target between 2010 and 2014 (Mahadea and Simson, 2010). Figure 2.7 illustrates the trends in economic growth from 2000 to 2019.

Furthermore, Figure 2.7 demonstrates that the ASGISA policy met the target between 2005 and 2007 when economic growth reached a maximum of 5.6% p.a. South Africa experienced a decline in economic growth, however, followed by negative economic

growth in 2009 due to the global financial crisis. The World Bank (2020) posits that the 2007/8 global financial crisis affected mainly economies that are highly dependent on the tertiary sector, of which the services sector contributed more than 60% to South Africa's GDP during the period.

Figure 2.7: Economic growth trends from 2000 - 2019

Source: Author's output with data from SARB (2020)

Upon realising the vulnerability of reliance on the services sector, the government of South African proposed the New Growth Path (NGP) in 2010 with the aim of reinvigorating the primary and secondary sectors of the economy with a target of reducing unemployment to 15% by 2020 through public infrastructure programmes (Republic of South Africa, 2010). The NGP placed more emphasis on job creation and reduction of income inequality, with an ambitious economic growth rate target band of 4% to 7%. The policy therefore aimed to increase the intensity of employment growth. The target, however, was not met throughout the entire life of the NGP policy.

In 2013, the government of South Africa transitioned from the NGP policy to the National Development Plan (NDP) which placed more emphasis on long term plans to deal with unemployment, inequality, poverty and redistribution (Republic of South Africa, 2013). The policy never achieved any of its targets, with economic growth rates

declining from 2013 to 2016. Unemployment kept on rising, reaching an all-time high of 30.1% in the first quarter of 2020, before improving to 23.3% in the second quarter of 2020 (StatsSA, 2020b). After the negative effects of Covid-19 on economic activities, the government introduced the South African Economic Reconstruction and Recovery Plan as a supplement to the NDP plan in 2020. Economic growth has, however, been very low since 2017, not exceeding 2% per annum.

2.4 Inflation, inflation uncertainty and economic growth: An analysis of the trends (1960 – 2019)

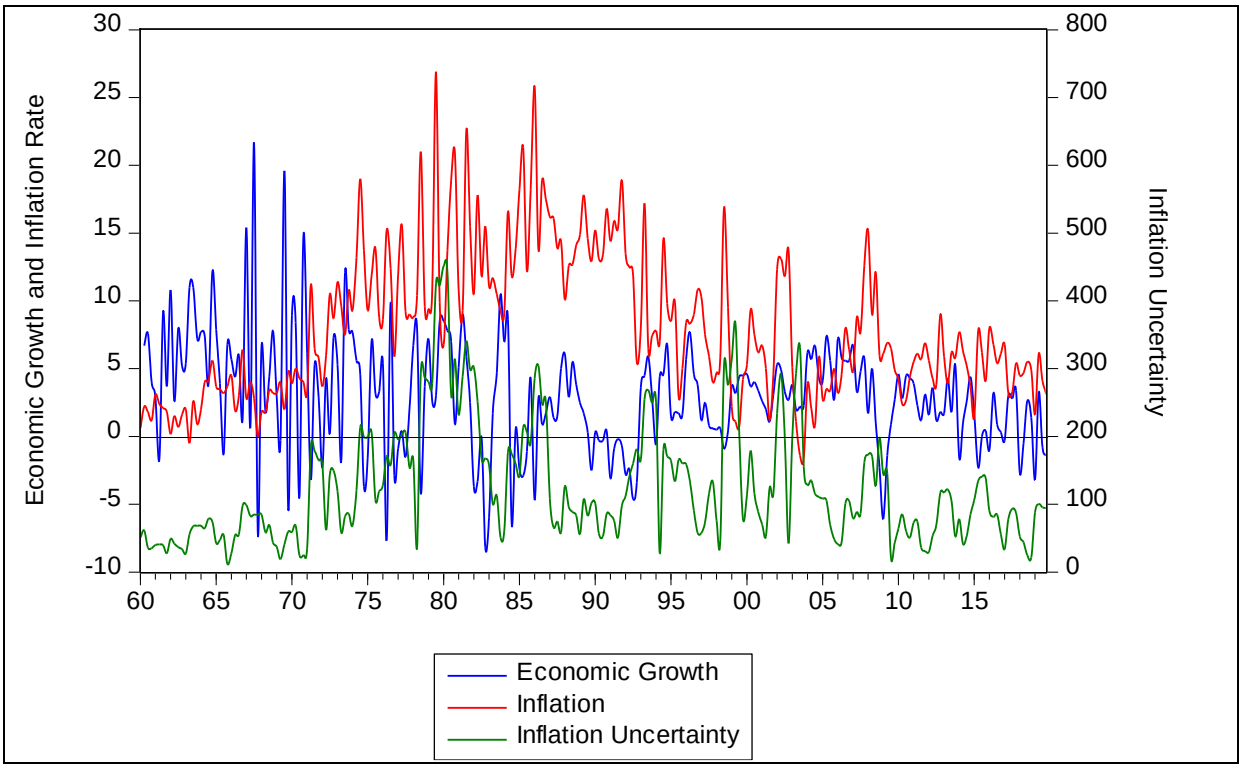
Slow economic growth, coupled with unemployment and rising levels of poverty and inequality are the major macroeconomic issues currently grappling the South African economy. This is, however, despite ambitious policies, such as the NDP policy, being instituted by government. The government of South Africa has been trying, mainly, to steer the economy from the demand side through proposing public works programmes in its economic blueprints. Scholars such as Kantor (2018) argue that the problem is mainly on the supply-side rather than the demand-side, hence the government is providing an incorrect solution to the problem at hand.

The lack of consensus on the causes of economic contraction and rising levels of unemployment has directed some quarters of economists, policymakers and pressure groups to turn their focus to the conduct of the monetary policy. Attention has been drawn on the appropriateness of inflation targeting by the central bank during times when the economy is experiencing stifled growth.

The Congress of South African Trade Unions (2019), Economic Freedom Fighters (EFF) (2019) and University of Johannesburg's Centre for Competition, Regulation and Economic Development (2019), among others, push for abandonment of inflation targeting by the South African Reserve Bank arguing that the policy is too conservative during periods of low economic growth. This is despite documented benefits of inflation targeting by scholars such as Mishkin (2000), further backed by empirical evidence on the South African economy by scholars such as Makuvaza, Nyambe and Sheefeni (2019) and Vermeulen (2020), which supports the role of inflation targeting in anchoring inflation expectations down, hence maintaining price stability and promotion of investment spending.

Figure 2.8 below illustrates the trends of inflation, inflation uncertainty and economic growth in South Africa from 1960 to 2019.

Figure 2.8: Inflation, inflation uncertainty and economic growth trends (1960 - 2019)



Source: Author's output with data from SARB (2020)

Figure 2.8 shows that during the 1960s South Africa recorded high levels of economic growth while the rate of inflation was low. Inflation uncertainty was also low. Periods when inflation was very high, between 1975 and 1999, the levels of economic growth were low. During this same period, inflation uncertainty was also turbulent. Inflation became more stable after adoption of inflation targeting in 2000, as evidenced by the low levels of inflation uncertainty. Economic growth was, however, low. It can also be noted that during periods of high inflation, economic growth has been low, for instance around 2002 when inflation was high, economic growth was declining.

From the trends shown in Figure 2.8, while it can be noted that the rate of inflation decreased coupled with falling levels of uncertainty about inflation (providing price stability) after the adoption of inflation targeting, the rate of economic growth was,

however, low. It is unclear whether the low levels of economic growth are due to strict monetary policy measures or other exogenous measures.

2.5 Concluding remarks

This chapter discusses the dynamics of inflation, inflation uncertainty and economic growth in South Africa for the period covering 1960 to 2019. The chronology of inflation episodes and inflation uncertainty dynamics before adoption of inflation targeting and during inflation targeting, in isolation from economic growth dynamics, was presented in section two. From 1960 on, South Africa transitioned through five broad frameworks that evolved from direct intervention measures to market-oriented policies. Inflation was high and unstable in the 1970s and 1980s, mainly due to high prices of crude oil, rising food prices, sanctions and poor monetary policy measures.

Section three presented economic growth dynamics before adoption of inflation targeting as well as during inflation targeting, in isolation from inflation and inflation uncertainty. The period stretching from 1960 to 1993 was under the apartheid rule, a period where discrimination was nurtured at the expense of skills-shortages. Upon attaining freedom in 1994, South Africa adopted the Reconstruction and Development Programme (RDP) with the objective of engaging in public works and infrastructure as a way of crowding-in private investment. The policy was succeeded with the Growth, Employment and Redistribution (GEAR) policy in 1996 that aimed at spurring economic growth, which would create employment opportunities while concurrently engaging in income redistribution policies. Inflation targeting was introduced in 2000 and worked concurrently with GEAR during its inception years. GEAR managed to decrease budget deficits, but unemployment remained high due to jobless growth. In 2006, South Africa moved onto the Accelerated Shared Growth Initiative for South Africa (ASGISA) which relied heavily on stimulating private sector growth. The policy faced challenges from the 2007/8 global financial recession which required intensive government intervention. The policy was then succeeded with the New Growth Path in 2010, which was later abandoned for the National Development Plan in 2013. The economic growth trend has declined during the periods of these two policies.

The fourth section provides joint analyses and trends of inflation, inflation uncertainty and economic growth from the pre-inflation targeting era up to 2019. Inflation was high

and unstable during the pre-inflation targeting era, with output fluctuations. After the adoption of inflation targeting in 2000, price stability was achieved. Economic growth was, however, low during this period.

CHAPTER 3

THEORETICAL AND EMPIRICAL LITERATURE REVIEW

3.1 Introduction

The impact of inflation and inflation uncertainty on economic growth remains an important macroeconomic issue for policy makers. While inflation and inflation uncertainty are known to alter spending patterns by the economic participants, its impact on economic growth, however, remains a debatable issue.

This chapter reviews the previous work and studies on the impact of inflation and inflation uncertainty on economic growth in South Africa and abroad. Knowledge of the impact these variables have on economic growth will ascertain the worthiness of fighting inflation and inflation uncertainty, and for South Africa in particular, rests the argument about whether to continue or abandon the South African Reserve Bank's price stability mandate. As such, this chapter considers theoretical and empirical literature surrounding the relationship that inflation and inflation uncertainty have with economic growth.

The chapter is organised as follows: Section 3.2 reviews theoretical literature while Section 3.3 reviews empirical studies that have been conducted on the relationship that inflation and inflation uncertainty have on economic growth. The section will focus on empirical studies done in the rest of the world, as well as particular focus on South Africa. Section 3.4 concludes the chapter.

3.2 Inflation, inflation uncertainty and economic growth nexus: Theoretical framework

This section reviews the theoretical literature that explains the relationship that inflation and inflation uncertainty have with economic growth. The relationship that these variables have is explained through different schools of thought ranging from the Classical School of Thought to the New Keynesians. The differences in tenets on which these schools of thought are based explains the differences in conclusions derived on the impact of inflation and inflation uncertainty on economic growth. Understanding this background assists in evaluating this relationship.

Accordingly, this section is divided into two subsections with the first section focusing on how schools of thought explain the relationship between inflation and economic growth. The second section reviews theoretical underpinnings on the relationship between inflation, inflation uncertainty and economic growth.

3.2.1 Schools of thought on inflation and economic growth nexus

The schools of thought discussed under this section explain how inflation is related to economic growth. They range from the classical school of thought to the New Keynesian school of thought.

3.2.1.1 Classical growth theory

The classical school of thought is one of the oldest economic ways of thinking, hence it lays the foundation for a number of growth theories (Gokal and Hanif, 2004). The classical growth model explains economic growth as a supply-side phenomenon based on a production function laid as:

$$Y = f(L, K, N) \qquad \text{Eq 3.1}$$

where Y is the level of output, L represents labour, while K denotes capital and N represents land. This then implies that output growth (g_y) is a function of population growth (g_L) which determines the amount of labour (L) available, investment (g_K) and land growth (g_N) as well as increases in overall productivity (g_f) of these inputs. Therefore:

$$g_y = \varphi (g_f, g_k, g_L, g_N) \qquad \text{Eq 3.2}$$

Adam Smith, often revered as the father of Classical Economics, argues that technology assists in helping postpone the diminishing returns of growth due to the rise in one of the inputs while the other input is held constant (Snowdon and Vane, 2005), hence growth exhibits increasing returns to scale (Gokal and Hanif, 2004).

Classical economists are also known for their belief in an economy that self-equilibrates to full employment without use of any discretionary policies. Money is regarded as nothing other than a medium of exchange without any effect on the level of economic growth. Nominal variables are regarded as being neutral on real variables, leading to what is termed as the classical dichotomy.

Classical theory also explains pursuance of self-interest by capitalists who compete with each other in the labour market, driven by their insatiate drive to accumulate profits. This competition in the labour market results in an increase in labour wages – and inflation, which increases cost of production and erodes the capitalists' profits. The fall in the profits discourages capitalists from production. Therefore, a rise in price will have a negative impact on the capitalist's production, which leads to a decline in economic growth (Pentecost, 2000).

3.2.1.2 Keynesian theory

The birth of Keynesian economics lies in its criticism of classical economics' tenets and assumptions. The Keynesian economists deny the existence of a self-equilibrating economy and believe in a demand driven economy. With reference to the quantity theory of money, Keynesians differ from classical economists in that they argue that the velocity of circulation of money (V) is not constant (Patinkin, 1972).

Keynesian theory explains the relationship between inflation and economic growth, with considerable reference to the Phillips Curve. Lipsey (1960) postulates that demand for labour is positively related to employment creation, and also to nominal wages. This implies that any increase in the demand for labour, which reduces unemployment while increasing economic growth, would in turn result in higher nominal wages.

Following this, wages are a part of costs of production. Any increase in wages would lead to a subsequent rise in the costs of production. In turn, prices are determined by the costs of production. Accordingly, a rise in the wages would push the price level higher. Therefore, according to Lipsey (1960), a higher rate of economic growth can only be achieved at a cost of higher inflation, hence a positive relationship. This leaves policymakers with a dilemma over whether to achieve higher economic growth at the cost of higher inflation, or price stability while sacrificing economic growth.

Keynesians argue that macroeconomic equilibriums can be accompanied with involuntary unemployment, while full employment can only be reached through stimulating aggregate demand (Tcherneva, 2008). They advocate for discretionary stabilisation policies in the economy, with more bias on the fiscal policy than monetary policy. Expansionary fiscal policies would increase the level of income and output in the economy, however, at the cost of higher prices. Therefore, according to the

Keynesian school of thought, economic growth and inflation have a stable long term positive relationship (Aaron, 2007). Prices and wages are rigid, and it takes long to drive the economy to the equilibrium, and hence there is no visible relationship between the variables in the short run (Snowdon and Vane, 2005).

3.2.1.3 The monetarist school of thought

Milton Friedman is credited for his pioneering work on the monetarist view of macroeconomic theory. Friedman (1958), in explaining the quantity theory of money, argues that monetary changes are a cause rather than consequence of economic disturbances and business cycles in the economy.

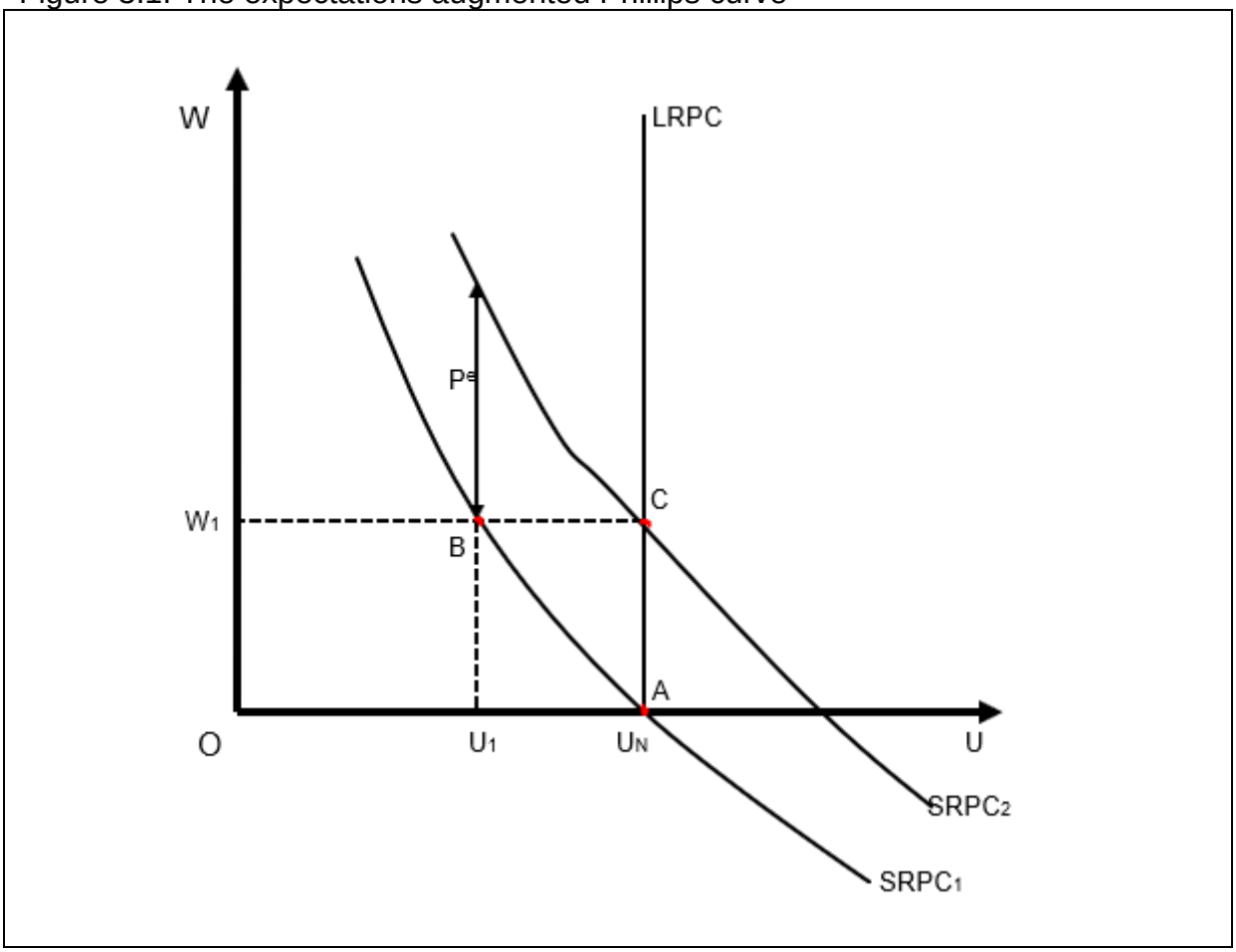
Regarding the Phillips curve interpretation, monetarists differ sharply with the Keynesians and the original specification of the Phillips curve. They argue that the rate of nominal wages is not only determined by the demand for labour (or inversely, unemployment) but also by the rate of inflation (Snowdon and Vane, 2005). Workers are rational beings and do not suffer from money illusion as they negotiate for their nominal wages with expected prices in mind (Leeson, 1994). They are, therefore, more interested in real wages than nominal wages. Since wages are negotiated for discrete time periods, it is the expected rate of inflation expected throughout the period of contract that determines the anticipated real wage.

According to the monetarists, therefore, nominal wages are determined by both demand for labour and the expected rate of inflation. The introduction of expected rate of inflation in addition to demand for labour leads to a family of a set of Phillips curves associated with different levels of expected inflation. This gives rise to the expectations-augmented Phillips curve, illustrated in Figure 3.1. Monetarist analysis of the Phillips curve differs from the Keynesian analysis in that while Keynesians treat expectations as exogenous, monetarists base their analysis on adaptive expectations (error-learning expectations). Economic participants make their inflation expectations based on their past experiences and information.

Figure 3.1 serves to explain this concept, assuming the economy is initially at point A which is consistent with the full employment level of output and income, and a nominal wage rate of zero. Suppose policymakers reduce the level of unemployment from the natural rate of unemployment (U_N) to a lower level of unemployment U_1 by stimulating aggregate demand through monetary easing. The demand for labour rises due to the

increase in aggregate demand, which would in turn push nominal wages and prices higher. However, prices of goods and services rises faster than nominal wages due to institutional factors in the economy.

Figure 3.1: The expectations augmented Phillips curve



Source: Snowdon and Vane (2005)

Workers would temporarily suffer from money illusion as they will misconstrue the increase in their nominal wages as a real wage increase and in turn supply more labour while in actual fact real wages would have fallen due to prices rising faster than the increase in nominal wages. Induced with lower real wages, firms would demand more labour, translating to low unemployment rate at a higher rate of nominal wage – W_1. The equilibrium point would therefore be at point B.

However, this condition would not last long. Workers would then adapt their inflation expectations with respect to the actual rate of inflation experienced and would come

to the realisation that their real wages have fallen. They would then bargain for higher nominal wages, which increases the cost of production and shifts the short run Phillips curve from $SRPC_1$ to $SRPC_2$. Firms would respond to the increase in nominal wages and the corresponding rise in cost of production by reducing the wage bill through laying off workers. Unemployment would rise until it is restored to the original unemployment rate equal to the natural rate of unemployment, at point C, while the real wage is restored to its original level.

This implies that the increase in inflation would only accommodate economic growth and low unemployment for a short period of time, until economic participants adjust their expectations. Therefore, according to monetarists, inflation has a positive relationship with economic growth in the short run, or for a very short period of time as determined by the speed through which workers adjust their expectations. However, the positive relationship in the short run is only experienced if the policy measure is not anticipated, and accordingly, no effect would be experienced if the policy measure is anticipated (Friedman, 1976).

Although a positive relationship exists between economic growth and inflation in the short-run, however, monetarists conclude that no relationship exists in the long run. Since workers adjust their inflation expectations in line with the actual rate of inflation, thereby moving from point B to point C in Figure 3.1, leaving the level of unemployment and economic growth unchanged, however, at higher inflation. Monetarists would conclude that monetary policies only result in changes in prices, while leaving output unchanged in the long run.

3.2.1.4 The new classical school of thought

The new classical school of thought is rooted in its renaissance of the classical modes of equilibrium characterised with continuous market clearing within a framework of competitive markets and rational decision making (Hoover, 1992). The new classical school of thought marks a stark contrast with the Keynesians through their inclusion of rational expectations by economic agents which Keynesians did not consider in their macroeconomic model.

In explaining the Phillips curve, new classicals differ with the monetarists' expectations-augmented Phillips curve by assuming that economic agents use available information leading to forward-looking, as opposed to the backward-looking

approach of the monetarists. In the monetarists' adaptive expectations hypothesis, economic agents base their expectations of future inflation only on the values of past inflation. One of the criticisms levelled against this hypothesis is that expectations will not be correct until the variable being predicted has become stable for a period of time (Snowdon and Vane, 2005).

On the other hand, under the rational expectations hypothesis, economic agents form rational expectations based on all publicly available information and will form unbiased expectations over time. New classicals therefore live in an ergodic world where decisions are determined by rational economic agents based on meaningful, calculated probability distributions.

Based on the abundance of information as well as the rationality of economic agents, expansionary monetary policies are associated with a rise in inflation. Suppose the economy is initially at point A in Figure 3.1 and policymakers decide to institute an expansionary policy, resulting in lower interest rates. Workers would anticipate a rise in the rate of inflation due to the drop in interest rates and would immediately bargain for higher nominal wages to beat the anticipated inflation. This action shifts the Phillips curve from $SRPC_1$ to $SRPC_2$, and the economy moves directly to point C. Therefore, inflation would rise without an increase in economic growth or a decrease in unemployment.

The rise in inflation would be associated with an increase in economic growth only if the policy is unanticipated (Lucas, 1973). However, even if the policy is unannounced and therefore unanticipated, Lucas (1996) argues that output will only deviate from the full employment output for the short-run and revert back to its original state in the long-run.

Unlike the orthodox Keynesians, wages and prices are assumed to be fully flexible and there is zero sacrifice ratio for reducing inflation if future inflation is anticipated. This implies that policymakers can announce a tight monetary policy, and since anticipated, it leads to a drop in inflation without any sacrifice on output in the short run, as predicted by the Keynesians.

New classicals differ from monetarists in that they conclude that monetary policy is used to control inflation and not alter aggregate demand. Under the new classicals, monetary policies are supernatural and there is no relationship between inflation and

economic growth in both the short-run and the long-run. Only supply side policies are credited for achieving higher economic growth (Lucas, 1996).

3.2.1.5 The new Keynesian school of thought

The new Keynesian school of thought sought to consolidate the differences between the orthodox Keynesian school with some of the new classical ideas. In so doing, it provided the microeconomic analysis (prominent in classical schools of thought) which was missing in the orthodox Keynesian equilibriums. The new Keynesian model is similar to the new classicals in that it accepts the existence of rational expectations by economic agents while on the other hand, differs as they assume that prices and wages are 'sticky' to changes in economic conditions thereby sustaining involuntary unemployment (Ball, Mankiw and Romer, 1988).

In the same vein, the rigidity of prices and wages plays an instrumental role in exaggerating economic shocks that are from either the demand or the supply side (Blanchard and Gali, 2007). A tight monetary policy would result in a decrease in aggregate demand which will in turn lower economic growth, however, without inflation decreasing due to the rigidity of wages and prices.

In addition to the assumption of nominal wage and price rigidities, New Keynesians also assume that the market is characterised with uncertainties and market imperfections which explains variations in output even if the assumption of wage and price rigidity is to be relaxed. New Keynesians explain that inflation uncertainty harms economic growth in the economy. Lubik and Krause (2003) argue that inflation uncertainties result in risk-averse firms reducing their output as a way of cushioning against the risk of losing output and profits from price fluctuations, in the process thereby harming economic growth.

Furthermore, New Keynesians seeks to explain the inflation-unemployment trade-off through employing the New Keynesian Phillips curve that links price inertia, inflation and changes in the real economy by relating inflation to production costs. An increase in the rate of inflation harms economic growth and stability. However, contractionary monetary policies result in recessions, without an accompanying decrease in prices due to rigidities in prices and wages. Therefore, New Keynesians would advise that monetary policies are set with prior information about future values of inflation and output – a feature that justifies the use of inflation targeting.

New Keynesians accept that inflation is positively related to economic growth in the short run, and monetary policies stimulate economic growth without creating inflation due to nominal wage rigidities, explained by the presence of menu costs. This proposition violates the classical dichotomy that regards money as being super neutral. However, in the long run, the economy always reverts back price and wage flexibility, paving the way for money neutrality again (Motyovszki, 2013). Inflation creates inflationary uncertainties which harms economic growth in the long run.

Despite the strong theoretical base associated with the New Keynesian economics, however, its predictions failed to conform with empirical evidence as pointed out by Ball (1991), Estrella and Fuhrer (2002) and Dennis (2007). Table 3.1 provides a summary of schools of thought and main conclusions on inflation-growth nexus.

Table 3.1 Summary of schools of thought and main conclusions on inflation-growth nexus

School of Thought	**Basic Tenets**	**Short-run relationship between inflation and economic growth**	**Long-run relationship between inflation and economic growth**
Classicals	• Full employment as a normal state of the economy • Inherent stability due to quick and efficient market mechanism to correct deviations or disturbances, • Stabilisation policies are not necessary or desirable. • Classical dichotomy	• negative	• negative
Keynesians	• The economy is inherently unstable • Money is non-neutral • Full employment is a special state of an economy that may never be achieved unless government intervenes	• No visible relationship	• positive
Monetarists	• Inherently stable private sector (unemployment converges to its natural rate) • Adaptive expectations	• positive	• No relationship
New Classicals	• Rational expectations • Continuous market cleating	• No relationship	• No relationship

	• Aggregate supply hypothesis • Ergodic world		
New Keynesians	• Nominal wage and price rigidities • Assumptions of maximising behaviour and rational expectations • Existence of real-world imperfections in explaining economic fluctuations • Money as non-neutral	• Positive	• No relationship

Source: Author's own compilation

3.2.2 Theoretical review on the relationship between inflation, inflation uncertainty and economic growth

The previous section reviewed the evolution of theory that explains the impact of different levels of inflation on the rate of economic growth. These schools of thought paid less attention to the impact of inflation uncertainty on the rates of economic growth. This section will therefore review different theories that explain the link between inflation, inflation uncertainty and growth.

Different scholars who contributed to the body of knowledge on the relationship between inflation, inflation uncertainty and growth tend to arrive at different conclusions. The debate surrounding the theory is still ongoing and inconclusive. There are several studies demonstrating how inflation and inflation uncertainty enhance growth. For example, Tobin (1965) proposes that an increase in inflation uncertainty leads to a decline in accumulated wealth, prompting households to hold lesser of non-interest-bearing assets but induced to hold more real capital assets, which then stimulates capital productivity and an increase in economic growth. Tobin (1965) further proposes that under inflationary conditions, savings, investment spending and government spending increases which stimulates economic growth.

In the same vein, Ungar and Zilberfarb (1993) theoretically argue that high inflation and its uncertainty induces economic agents to invest more in generating accurate forecasts on future values. This lessens inflation uncertainty over time as economic agents generate accurate predictions of future inflation. These accurate predictions, in a way, help in making informed investment decisions, which may promote investment spending, culminating in an increase in economic growth.

Correspondingly, Aghion and Saint-Paul (1998) argue that economic fluctuations promote economic growth. In supporting the hypothesis, Aghion and Saint-Paul (1998) demonstrate that inflation and inflation uncertainty lower the opportunity cost of investing in capital or labour resources in technological improvements. The lower opportunity costs are explained by the profits that are forgone during turbulent periods. The lower opportunity costs then induce firms to increase their investment spending. Hence, it is argued that uncertainties in the economy generate productivity, which acts autonomously as an engine for automatic recovery.

In congruence with Aghion and Saint-Paul (1998), Blackburn (1999) queries if short term stabilisation policies (that reduce uncertainties in the economy) reduce economic growth in the long-run. Uncertainties induce an increase in expenditure on research and development as learning models, which advances technological changes in the economy. Inarguably, technological advances increase economic growth in the long run, therefore, inflation uncertainty is positively related to long-run economic growth.

On the other hand, some studies found that inflation and inflation uncertainty inhibit growth. For example, Stockman (1981) argues that in an economy with a cash-in-advance constraint on both consumption and investment, inflation dampens growth. The paper drew an analogy between studies, such that of Tobin's (1965), that support the notion that higher inflation and inflation uncertainty leads to portfolio substitution of money into real capital stock and ultimately economic growth, and those studies that establish that economic growth is independent of inflation and inflation uncertainty, such as a study by Sidrauski (1967). Stockman (1981), however, separated current inflation from anticipated inflation, and emphasised that higher anticipated inflation, or uncertainties about inflation, negatively affects the efforts of acquiring capital stock in an economy.

In addition, De Gregorio (1993) supports that inflation dampens economic growth since it increases the cost of capital, which inhibits capital accumulation and productivity. De Gregorio (1993) asserts that as capital accumulation is a positive factor of economic growth, any factor that slows down capital accumulation will, by extension, harm economic growth. Inflation forces the cost of capital, which in turn reduces capital accumulation and productivity. Therefore, theoretically, inflation

inhibits economic growth. However, De Gregorio (1993) does not separate the short-run and long-run effects of inflation on economic growth.

Furthermore, Friedman (1977), induced by the stagflation periods of the 1970s, criticises the positive relationship between economic growth and inflation. Although inflation rate was high it failed, however, to accommodate higher economic growth rates and was associated with higher levels of unemployment. This contradicted with the orthodox Phillips curve, and the Keynesian interpretation of the Phillips curve that there is a positive relationship between inflation and economic growth. Friedman (1977) informally argues that inflation harms economic growth as it weakens the price mechanism.

Okun (1971) revisits the inflation - unemployment trade off and challenges the notion that regarded a 4% rate of unemployment as the full employment level and that it could be accommodated with an inflation rate of at most 3%. Instead, Okun (1971) argues that inflation which develops in periods of stable conditions creates significant social costs and distortions to national income. Furthermore, inflation uncertainty exposes wealth and incomes to greater risk since individuals forgone the purchase of goods to cushion against the possible decrease in their real incomes, thereby harming economic growth.

Citing the explanations given by Okun (1971) as loosely structured while attempting to formalise the hypothesis given by Friedman (1977), Ball (1992) explains that high rates of inflation generate inflation uncertainty and uncertainty about future monetary policy. The public casts doubt on the monetary policy authorities during periods of high inflation, which negatively affects the credibility of monetary policy authorities. In the same vein, increase in inflation uncertainty inhibit decision making by the public, thereby negatively affecting economic growth.

On the other hand, there are some studies which demonstrate that the relationship between inflation, inflation uncertainty and growth is inconclusive. For example, Caballero (1991) adopts a moderate approach which admits that inflation uncertainty has an ambiguous effect on the economy, depending on the behaviour of the stock market participants. In explaining the costs of inflation uncertainty economic growth, Caballero (1991) stresses that inflation uncertainty affects growth through its distortions on investment decisions by firms. However, investment decision by firms

exclusively depends on the price of capital as well as the expected marginal profitability of capital, argues Caballero (1991). Therefore, this draws to the conclusion that uncertainty plays a minor role in the determination of investment spending by firms. Markets dominated with risk-averse firms will see inflation uncertainty dampening economic growth, whereas in a market dominated with risk-tolerant firms, the effect is positive since firms seek out risk.

In support, Dotsey and Sarte (2000) raise the possibility of a positive effect of inflation uncertainty on economic growth due to increased precautionary savings (which acts as a source of funds for investment) by risk-averse agents, but only in the short run. The study contends that although a positive relationship may exist between inflation and economic growth in the short run, however, it dissipates and may even be negative for economies that have limited financial markets. Their study provides a theoretical support to the empirical body of studies such as one by Boyd, Levine and Smith (1998) which supports the notion that economies with religiously high inflation yield a positive relationship between inflation and nominal stock returns while in low inflationary economies, high inflation is not matched by higher nominal stock returns. Dotsey and Sarte (2000), however, argue that inflation is negatively related to economic growth in the long-run, even though the presence of uncertainty reduces the effect.

In summary, theoretical work points to different conclusions on the relationship between inflation, inflation uncertainty and economic growth. Notably, Tobin (1965), Ungar and Zilberfarb (1993), Aghion and Saint-Paul (1998) as well as Blackburn (1999) pinned a positive relationship between inflation and economic growth as well as inflation uncertainty and economic growth. On the other hand, Okun (1971), Friedman (1977), Stockman (1981), Ball (1992) and De Gregorio (1993), among others, argue that the relationship is negative. Furthermore, Caballero (1991) and Dotsey and Sarte (2000) demonstrate the inconclusive relationship between inflation, inflation uncertainty and economic growth. These ambiguous theoretical underpinnings on the inflation, inflation-uncertainty and growth nexus have attracted academic attention in examining the relationship empirically. Table 3.2 provides a summary of findings on theoretical literature on the inflation, inflation uncertainty-growth nexus.

Table 3.2 Summary of findings on theoretical literature on inflation, inflation uncertainty-growth nexus

Author(s)	Relationship between inflation and economic growth	Relationship between inflation uncertainty and economic growth
Positive relationship		
Tobin (1965)	Positive relationship	Positive relationship
Ungar and Zilberfarb (1993)	Positive relationship	Positive relationship
Aghion and Saint-Paul (1998)	Positive relationship	Positive relationship
Blackburn (1999)	Positive relationship	Positive relationship
Negative relationship		
Okun (1971)	Negative relationship	Negative relationship
Friedman (1977)	Negative relationship	Negative relationship
Stockman (1981)	Negative relationship	Negative relationship
Ball (1992)	Negative relationship	Negative relationship
De Gregorio (1993)	Negative relationship	N/A
Inconclusive relationship		
Caballero (1991)	N/A	Ambigous effect, depending on behaviour of financial market participants
Dotsey and Sarte (2000)	Negative in the long run	Positive relationship in the short run but negative in the long run

Source: Author's own compilation

3.3 Empirical literature review

The body of literature in this section focuses on empirical tests done on the evidence of the relationship between inflation, inflation uncertainty and economic growth. As informed by the theoretical review in the previous section, there is no theoretical consensus on the impact of inflation and inflation uncertainty on economic growth. The inconclusive relationship also mirrors in the empirical evidence.

Available literature exists in three forms consisting of studies that focus on the impact of inflation without controlling for the role of inflation uncertainty, the second category

that focuses on the impact of inflation uncertainty without including the role of inflation and the third category that includes the joint impact of both inflation and inflation uncertainty on growth. This section will therefore be grouped in accordance with these three forms.

3.3.1 Empirical evidence on inflation-growth nexus, without controlling for the role of inflation uncertainty

The empirical evidence of the inflation-growth link indicates that most of the studies that do not control for inflation uncertainty find a robust negative relationship, while some of them derive non-linear relationships. In a study on twelve Latin American countries, De Gregorio (1993) found a negative relationship between inflation and economic growth for the period 1950 to 1985 using cross-country regression. The study pinpointed inefficiencies in the tax system as the driver for inflation in the economy. The study concluded that inflation negatively impacts growth due to a reduction in investment and productivity of investment as a result of an increase in the actual price of capital goods.

Gylfason and Herbertsson (2001) also derive the same conclusion. The study models the impact of inflation on long-run growth through four channels, namely, the saving and real interest rates channel, velocity and financial development channel, the government budget deficit channel as well as the production channel. The study was based on 170 countries over the period 1960 to 1992. To correct the issues arising from the inclusion of dummy variables in the then recent literature, which resulted in time-related errors or cross-sectional errors, the study employed the random-effects model. The finding was that inflation harms economic growth as demonstrated by the empirical evidence obtained across the countries and time. The study concluded that inflation erodes savings in the economy, which will signal households to slow down consumption, thereby ultimately hurting economic growth.

In a similar fashion, Gillman, Harris and Mátyás (2004) present a monetary model of endogenous growth and employed a fixed effects approach on a pack of panel data from the Organisation for Economic Co-operation and Development (OECD) and Asia-Pacific Economic Cooperation (APEC) countries over the period stretching from 1961 to 1997. The data from both member groups showed a negative impact of inflation on economic growth.

Barro (2013) assessed the effect of inflation on economic growth for 100 countries with data covering the period from 1960 to 1990. Barro (2013) based his model on the neo-classical growth model where he estimates the impact of inflation on growth while keeping other determinants of growth constant. Using panel estimates of different equations, the study found that inflation adversely affects economic growth and standards of living in the long run. The paper argues that a greater willingness by the private sector to save raises standards of living in the long run.

Guerrero (2006) also adds to the body of empirical evidence which supports the negative impact of inflation on economic growth on developed economies. The study focuses on a number of countries dating from 1949 to 2002. The study employs hyperinflationary experiences from various countries to estimate the effects of inflation on economic growth. Using ordinary least squares method, the study found a robust and economically significant negative effect of inflation on long-term economic growth. The study also notes that countries that have experienced hyperinflation in the past became disciplined afterwards such that price stability became one of the strong pillars of their economic policies.

In contrast, there is a body of empirical literature that challenges the notion of a linear relationship between inflation and economic growth. These studies found a non-linear relationship between inflation and economic growth where the impact of inflation on growth is positive until a certain threshold and becomes negative afterwards. In line with this, Ndoricimpa (2017) employed a novel dynamic panel threshold regression model to examine the nonlinearities in the inflation-growth nexus on 47 African economies for different periods. The study confirmed a non-linear relationship between inflation and economic growth in Africa with an inflation threshold of 6.7% for the whole sample but 9% for low-income countries and 6.5% for middle-income countries. The paper suggested that relatively lower inflation favours higher economic growth only in African middle-income countries while inflation rates beyond a certain threshold are detrimental to economic growth for all countries.

Similarly, Sarel (1996) examined the possibility of nonlinear effects of inflation on growth using the ordinary least squares method on 87 countries for the period covering 1970 to 1990. The study argues that below an inflation rate of 8%, inflation does not have any impact on economic growth, however, if present, it can only be an

insignificant positive relationship. Any inflation rate above 8%, however, yields a strong negative relationship.

In addition to studies that obtained a non-linear relationship between inflation and economic growth, Bruno and Easterly (1998) challenge the notion of an outright negative long-run relationship between inflation and economic growth. The study investigated the patterns of economic growth before, during and after inflation crisis for different countries around the world, over different periods. Bruno and Easterly (1998) chose 40% as the threshold, citing the proneness of inflation to spur volatility and spiral to sharp accelerations as they linked it to earlier work by Dornbusch and Fischer (1993). From pooled cross-country datasets, the study derives that there is no compelling evidence on the effect of inflation on economic growth at lower ranges of inflation, while, in contrast, data on discrete high inflation episodes shows a strong and robust negative relationship between high inflation and economic growth.

The similar view is also shared by Khan and Senhadji (2001) who examines the issue of the existence of threshold effects in the relationship between inflation and growth on a dataset comprising of 140 countries. The choice of countries covered both industrial and developing countries, for the period spanning from 1960 to 1998. In consideration of the presence of heteroscedasticity in the panel data, the study employed the generalised least squares method. The model tested the existence of threshold effect where first differenced logarithm of real GDP was used as the dependent variable, with a vector of control variables such as investment as a share of GDP, population growth and trade variables. In partial control of endogeneity problems caused especially by the endogeneity of investment (as a share of GDP) to growth, the study used the two-stage least squares method. The conclusion confirmed the existence of a threshold beyond which inflation harms economic growth. The threshold obtained for developed economies was, however, lower than the one for developing economies.

While investigating the growth effects of inflation on both industrialised and emerging economies, López-Villavicencio and Mignon (2011) find a non-linear relationship between inflation and economic growth. The study employed the panel smooth transition regression (PSTR) model to investigate the non-linearity relationship between inflation and economic growth on a data set of 44 countries comprising of

high-income OECD countries, upper and lower middle countries as well as emerging countries. The period covered 1961 to 2007 with initial level of real GDP per capita, inflation rate, government spending and trade openness as regressors. To address the issue of endogeneity of explanatory variables, while also eliminating reverse causality problems, the study further used the generalised method of moments. The study found a lower threshold for advanced economies, and a higher one for emerging economies.

Kremer, Bick and Nautz (2013) used a dynamic panel threshold model to estimate inflation thresholds for long-term economic growth using a dataset of 124 countries for the period 1950 to 2004. The results found by Kremer, Bick and Nautz (2013) also corroborate with the findings by López-Villavicencio and Mignon (2011), that developed economies have a lower threshold level of inflation as compared to developing and emerging economies. However, there is a possibility of endogeneity bias in the explanatory variables, which is not considered in the study.

In the same vein, Yilmazkuday (2013) investigated inflation thresholds that lead to higher growth rates for 84 countries from 1965 to 2004. The paper used base line growth equations with real per capita output growth as the dependent variable while the explanatory variables were initial per capita GDP, initial secondary enrolment rate, ratio of liquidity liabilities to GDP, ratio of M3 to M1 to GDP, inflation rate, openness and government size. The paper finds that any inflation level beyond 8% harms economic growth in the long run, while inflation benefits growth for any levels below 8%.

The studies that empirically tested the inflation-growth nexus without controlling for inflation uncertainty can therefore be grouped into two categories, based on their findings. One category finds a negative relationship between inflation and economic growth, implying that economic growth decreases as the rate of inflation rises. On the other hand, the other category challenges the existence of a monotonic relationship between inflation and economic growth. These studies suggest, rather, the existence of a non-linear relationship between inflation and economic growth. These studies suggest a threshold level of inflation below which inflation positively affects economic growth, while beyond this point inflation harms economic growth.

Although these two categories of studies differ on the linearity, or lack of it, of the relationship between inflation and economic growth, however, they both agree that high levels of inflation harm economic growth. Table 3.3 provides a summary of the empirical studies that tested the inflation-growth nexus without controlling for the role of inflation uncertainty.

Table 3.3 Studies showing inflation-growth nexus without controlling for the role of inflation uncertainty.

Author(s)	Region/Country	Variables	Methodology	Empirical Findings
Negative Relationship				
De Gregorio (1993)	Two Latin American economies for the period 1950-1985	• GDP per capita growth • Investment • Literacy • Foreign Investment • Efficiency of Investment • Employment ratio • M1 Growth • Base Money Growth • Inflation • Variance of inflation • Government Consumption • GDP 1960	Cross-country regressions	Negative relationship
Gylfason and Herbertsson (2001)	170 countries from 1960 to 1992	• GDP • Inflation • Investment • Openness • Primary exports • School enrolment	Random-effects panel model	Negative relationship
Gillman, Harris and Mátyás (2004)	OECD and APEC member countries from 1961 to 1997	• Per capita GDP • Proportion of gross domestic investment in GDP • GDP Deflator • Average annual growth rate of GDP	Fixed effects approach	Negative relationship
Guerrero (2006)	A number of countries from the IFS database from 1949 to 2002	• Inflation • Economic growth • Different set of dummies • Human capital • Rule of law • Index of macro policies	Ordinary least squares regression	Negative relationship
Barro (2013)	100 countries from 1960 to 1990	• Inflation rate • Real per capita GDP • Ratio of investment to GDP • Standard deviation of inflation rate	Panel estimates of different equations	Negative relationship

Non-linear relationship or existence of a threshold				
Sarel (1996)	87 countries from 1970 to 1990	• Population • GDP • CPIs • Terms of Trade • Real exchange rates • Government expenditures • Investment rates	OLS	Non-linear relationship Existence of a threshold where inflation has no significant relationship with growth at low rates but negative at higher rates
Bruno and Easterly (1998)	A number of countries, over different time periods	• Inflation • Economic growth	Different estimation methods	Non-linear relationship
Khan and Senhadji (2001)	140 countries covering the period from 1960 - 1998	• Real GDP • Investment spending • Population growth • Trade variables • inflation	Generalised Least Squares method Two-Stage Least Squares	Non-linear relationship
López-Villavicencio and Mignon (2011)	44 different countries covering the period 1961 to 2007	• Real GDP per capita • Inflation rate • Government spending • Trade openness	Panel smooth transition regression (PSTR) model General methods of moments	Non-linear relationship
Kremer, Bick and Nautz (2013)	124 countries from 1950 to 2004	• GDP • Inflation rate	Dynamic panel threshold model	Non-linear relationship
Yilmazkuday (2013)	84 countries from 1965 to 2004	• Real per capita output growth • initial per capita GDP, • initial secondary enrollment rate, • ratio of liquidity liabilities to GDP • ratio of M3 to M1 to GDP • inflation rate • openness • government size	Two-Stage Least Squares	Non-linear relationship
Ndoricimpa (2017)	47 African countries	• Growth rate of real GDP • Inflation • Population growth • Investment spending • Terms of trade • openness	Dynamic panel threshold regression method	Threshold effects at different rates of inflation

Source: Author's own compilation

3.3.2 Empirical evidence on inflation uncertainty-growth nexus, without controlling for the role of inflation

Studies that investigate the relationship between inflation uncertainty and economic growth without controlling for the role of inflation draw inconclusive results. Some studies found a positive relationship between inflation uncertainty and economic growth while others established a negative relationship between the two variables.

Jansen (1989) queried if inflation uncertainty affects economic growth. The study employs the ARCH techniques on USA time series data from 1960 to 1988. The results of the study do not support the orthodox belief that inflation uncertainty harms economic growth. Rather, the evidence supports that inflation uncertainty results in an increase in economic growth.

Using the bivariate GARCH-M model on 5 Asian economies, namely India, South Korea, Singapore and the Phillipines, for the period covering 1962 to 2000, Bredin, Elder and Fountas (2009) test the effect of macroeconomic uncertainty on economic growth. The study uses output uncertainty and inflation uncertainty as the explanatory variables on economic growth. Contrary to theoretical propositions by renowned scholars such as Friedman (1977), the study found evidence that inflation uncertainty is beneficial to economic growth, thereby supporting theoretical underpinnings by Dotsey and Sarte (2000).

Coulson and Robins (1985) employ the Engle's ARCH model on a Lucas supply framework on the USA quarterly time series data stretching from 1951 Quarter 1 to 1979 Quarter 4. The study aims to investigate the relationship between inflation volatility and key macroeconomic variables. The empirical evidence proves that increase in inflation uncertainty stimulates economic growth through increased production and lower unemployment.

These studies by Coulson and Robins (1985), Jansen (1989) and Bredin, Elder and Fountas (2009) in one way or another support Dotsey and Sarte's (2000) theoretical argument that higher inflation uncertainty results in an uncertainty in money balances, pulling down demand for real money balances and consumption and thereby increasing precautionary savings. This increases funds for investment, which increases economic growth.

In contrast, a study by Baharumshah, Hamzah and Sabri (2011) employs the least absolute deviation autoregressive conditional heteroscedastic model to investigate the relationship between inflation uncertainty and economic growth on the economies of Malaysia, Singapore, Thailand, Indonesia and the Phillipines (ASEAN-5). The study focuses on different periods on the economies and obtains a significant negative effect of inflation uncertainty on economic growth. The study suggests greater stability in the economy to stimulate economic growth.

Using the GARCH method on panel data from OECD economies covering the period from 1969 to 1999, Apergis (2005) tests the impact of inflation uncertainty on economic growth. Apart from inflation uncertainty and economic growth, the study uses variables such as consumer prices, per capita real GDP, terms of trade, budget deficit as a ratio of GDP, investment spending and financial development. The study finds evidence that inflation uncertainty negatively affects economic growth.

Adding to the body of empirical literature that finds a negative relationship between inflation uncertainty and economic growth, without considering inflation is also a study by Grier and Perry (2000). The study uses the GARCH-M method USA time-series data dating from 1948 to 1996. In a variety of models and sample periods, the study finds that inflation uncertainty decreases economic growth.

In addition, Grier, Henry, Olekalns and Shields (2004) sample monthly USA data from April 1947 to October 2000 to infer on the asymmetric effects of uncertainty on inflation and output growth. The study criticises ‘virtually all existing’ ARCH or GARCH models of inflation and or economic growth as misspecified. Using generalised impulse response experiments, the study finds strong evidence in support of a negative relationship between inflation uncertainty and economic growth.

Heidari, Katircioglu and Bashiri (2013) employed a Bivariate Generalised Autoregressive Conditional Heteroskedasticity-in-Mean (BGARCH-M) model to examine a unified empirical framework of all possible interactions between inflation uncertainty and growth on the Iranian economy. The study used quarterly data ranging from 1988 to 2008. In support of the Friedman (1977) hypothesis, the study also obtained a negative relationship between inflation uncertainty and economic growth.

These studies prove the existence of inconclusive empirical findings on the inflation uncertainty-growth nexus. Some studies find a negative relationship between inflation

uncertainty and growth, while others find conflicting results – a positive relationship between inflation uncertainty and economic growth. This leaves the relationship ambiguous. Table 3.4 summarises the findings from these studies.

Table 3.4 Studies showing inflation uncertainty-growth nexus without controlling for the role of inflation

Author(s)	Region/Country	Variables	Methodology	Empirical Findings
Positive Relationship				
Coulson and Robins (1985)	USA data from 1951:1 to 1979:4	• Industrial production • Unemployment • Inflation uncertainty	Engle's ARCH model	Positive relationship
Jansen (1989)	USA time series data from 1960 to 1988	• Economic growth • Inflation uncertainty	ARCH techniques	Positive relationship
Bredin, Elder and Fountas (2009)	5 Asian countries	• Industrial production index • CPI	GARCH-M model VAR-GARCH-M Model	Positive relationship
Negative Relationship				
Grier and Perry (2000)	United States from 1948 to 1996	• Inflation • Inflation uncertainty • Economic growth	GARCH-M method	Negative relationship
Grier, Henry, Olekalns and Shields (2004)	USA data from April 1947 to October 2000	• Inflation uncertainty • Economic growth	Generalised impulse response experiments	Negative relationship
Apergis (2005)	OECD economies from 1969 to 1999	• Consumer prices • Per capita income • Terms of trade • Budget deficits • Investment spending • Financial development	GARCH method	Negative relationship
Baharumshah, Hamzah and Sabri (2011)	Malaysia, Singapore, Thailand, Indonesia and the Phillipines (ASEAN-5) for various periods	• Inflation uncertainty • Economic growth	Least absolute deviation autoregressive conditional heteroscedastic model	Negative relationship
Heidari, Katircioglu and Bashiri (2013)	Iranian economy for data ranging from 1988:1 to 2008:4	• Inflation uncertainty • Economic growth	Bivariate Generalised Autoregressive Conditional Heteroskedasticity-in-Mean (BGARCH-M)	Negative relationship

Source: Author's own compilation

3.3.3 Empirical evidence on inflation, inflation uncertainty and growth nexus

Adding to the literature, the third category of studies which included both inflation and inflation-uncertainty arrived at mixed conclusions. A certain quarter of studies found

that both variables negatively inhibit growth, while another group of studies derived contrary results where both variables positively contribute to growth. On the other hand, some scholars derived different impacts of the variables on economic growth.

Judson and Orphanides (1999) examined the relationship between inflation, inflation uncertainty and economic growth using cross-country panel data for 119 countries over the period 1959 to 1992. The study used the consumer price index as a proxy for inflation as well as standard deviation of the four quarterly inflation observations as a measure of inflation uncertainty. The study draws a number of conclusions. It finds that inflation uncertainty is negatively correlated with economic growth at all levels of inflation, and on all types of economies – whether advanced, emerging or developing. Further, inflation rates above double digits affect economic growth negatively, which may also be interpreted as having the presence of threshold effects.

Wilson (2006) investigated the nexus between inflation, inflation uncertainty and output growth on the Japanese economy spanning from 1957 to 2002. The study employs the E-GARCH model and obtains evidence that both inflation and inflation uncertainty negatively affect economic growth.

In addition, Rother (2004) investigated the role of fiscal policies on inflation volatility, and ultimately the impact of inflation and inflation uncertainty on economic growth. The paper samples OECD economies over the time span from 1967 to 2001 using the Generalised Least Squares method. The study used the standard deviation of inflation as a measure of inflation volatility. The study argues that although inflation is harmful to economic growth, the effect of inflation uncertainty is of a greater concern. The study ascertains that high inflation uncertainty distorts inflation expectations, which increases the risk premia on long-term nominal contracts and costs of hedging against inflation risk. This leads to an unanticipated redistribution of wealth which impedes growth even if inflation is low.

In addition, a recent empirical study by Iyke and Ho (2019) investigated the effects of inflation and inflation uncertainty on economic growth on the economy of Ghana. Citing the limitations in the availability of data while also avoiding a pretesting bias problem, the study motivates for the suitability of the Autoregressive Distributed Lag Model (ARDL) in its estimations. The study used data covering the period from 1963 to 2015. Economic growth was used as the dependent variable, with nominal interest, inflation

and inflation uncertainty as the independent variables. The study establishes that both inflation and inflation uncertainty negatively impact economic growth in both the short and long run. This led to a recommendation that policymakers should pursue policies that maintains low rates of inflation, as well as inflation uncertainties.

Slightly different from these findings, Grier and Grier (2006) find that inflation does not negatively affect growth directly once inflation uncertainty is accounted for. Rather, inflation affects growth through inflation uncertainty. The study also found that inflation uncertainty negatively affects growth. The study estimates an augmented multivariate GARCH-M model on the Mexican economy using monthly data covering January 1972 to December 2001.

Grier and Tullock (1989) analysed the variabilities in economic growth on a number of economies, over the period stretching from 1960 to 1980. The study uses different estimation methods as well as the standard deviation of inflation as a measure of inflation uncertainty. The other variables used in the study, apart from inflation uncertainty, are population growth, inflation, income growth uncertainty, government spending, economic growth and a number of dummies. The study finds that rather it is inflation uncertainty, and not inflation, that significantly lowers economic growth. Put differently, the study asserts that inflation has no impact on economic growth if it is predictable and stable.

Even more extreme, Clark (1997) discovers that neither inflation nor inflation uncertainty is significantly related to economic growth. The study focused on 85 countries for different time spans and used cross-country regressions to analyse the evidence of the impact of inflation on long-run growth.

Fountas, Ioannidis and Karanasos (2004) investigated the relationship between inflation and inflation uncertainty on six European economies (Germany, UK, Netherlands, Italy, Spain and France) as well as its effects on economic growth. The study covered the period 1960 to 1999 and used exponential generalised autoregressive conditional heteroscedasticity models as a measure of inflation uncertainty. The study derived conflicting results. A conclusion was obtained on all countries, except the UK, that inflation uncertainty does not harm economic growth.

Moreover, Baharumshah, Slesman and Wohar (2016) investigated the relationship between inflation, inflation uncertainty and economic growth in a panel of 94 emerging

and developing countries over the period 1976 to 2010. The study estimated the relationship using the system generalised method of moments (SGMM) model. The study confirms the existence of threshold effects of inflation where high inflation harms economic growth while low inflation enhances growth. On inflation targeting, the study finds that inflation targeting actually enhances economic growth.

In addition, Fountas (2010) found strong evidence that inflation uncertainty does not affect economic growth negatively, thereby proposing that the emphasis placed by central banks on price stability may be exaggerated. The study focused on the relationship between inflation, inflation uncertainty and economic growth using the GARCH-in-Mean (GARCH-M) model on 21 advanced economies for different time periods. The study proxied inflation uncertainty using the conditional variance of inflation shocks. The study warned against using its findings for policymaking, however, arguing that the conclusions may be due to misspecification in the model or possibilities of correlations within the model.

From these studies it is clear that there is no convincing answer to the relationship between either inflation on economic growth, inflation uncertainty on economic growth or joint impact of both on economic growth. Table 3.5 gives a summary of these studies.

Table 3.5 Studies showing inflation, inflation uncertainty-growth nexus

Author(s)	Region/Country	Variables	Methodology	Empirical Findings
Grier and Tullock (1989)	A number of economies, over the period stretching from 1960 to 1980	• Inflation uncertainty, • population growth, • inflation, • income growth • uncertainty, • government spending • a number of dummies	Different estimation methods	• Inflation uncertainty is negative related to economic growth • Inflation, under condition of stability, has no effect on economic growth
Clark (1997)	85 countries for different time spans	• Inflation • Inflation uncertainty • Economic growth	Cross-country regressions	• Neither inflation nor inflation uncertainty is related to economic growth
Judson and Orphanides (1999)	119 countries, from 1959 to 1992	• Inflation • Inflation volatility • Economic growth	Cross country regressions	• Inflation uncertainty negatively affects economic growth • Double digit inflation negatively harms growth

				• Combined effects of both, negatively correlates with growth
Fountas, Ioannidis and Karansos (2004)	6 European economies	• Inflation • Inflation uncertainty • Economic growth • Output fluctuations	E-GARCH Model	• Inconclusive evidence, different results from different countries
Rother (2004)	OECD countries	• Economic growth • Fiscal shocks • Inflation • Inflation volatility	Generalised Least Squares Method	• Inflation and inflation uncertainty both negatively affects economic growth
Grier and Grier (2006)	Mexico from 1972 to 2001	• Inflation • Industrial production • IP growth • Real budget deficit • Oil prices	VAR-GARCH-M model	Negative effect of inflation uncertainty on economic growth
Wilson (2006)	Japan	• Inflation • Inflation volatility • Output growth	• Bivariate EGARCH-M model	Inflation and inflation uncertainty both negatively affect economic growth
Fountas (2010)	Different industrial economies	• Inflation uncertainty • Inflation • Economic growth	GARCH-in-mean model	Positive effect of inflation uncertainty on economic growth
Baharumshah, Slesman and Wohar (2016).	94 emerging and developing countries	• Economic growth • Inflation • Inflation uncertainty	System generalised method of moments	• Negative relationship between inflation and economic growth • Positive effect of inflation uncertainty on economic growth
Iyke and Ho (2019)	Ghana from 1963 to 2015	• Economic growth • Inflation • Inflation uncertainty • Nominal interest rates	ARDL Model	Inflation and inflation uncertainty both negatively affects economic growth

Source: Author's own compilation

3.3.4 Empirical evidence on the South African economy

A number of studies on the South African economy have been done to test the nexus between inflation, and economic growth. Nell (2000) queried if inflation at any given level is always harmful to growth using South African data covering the period 1960 to 1999. The study was motivated by previous studies which cited excessively high real interest rates and religious inflation controls as being a hindrance to the success of South Africa's GEAR (Growth, Employment and Redistribution) programme. Nell (2000) suggests that inflation within single-digit zone is beneficial to growth, while rates beyond single digit results in sluggish growth.

In addition, Hodge (2006) investigated the relationship between inflation and economic growth in South Africa using different estimation methods with data covering 1950 to 2002. Hodge (2006) argues that inflation harms economic growth in South Africa over the long term, while concurring with Nell (2000) that inflation is beneficial to economic growth in the short-run. Hodge (2006) subsequently recommends abandoning the inflation targeting as a measure of stimulating growth in the short run.

From a different perspective, Kumo (2015) investigated the impact of inflation targeting on monetary policy and inflation volatility on economic growth in South Africa for the period 1960 to 2013. The study employed the GARCH model to investigate the relationship. Real GDP growth was regressed against investment spending, exports, gross savings and inflation volatility. The data was then analysed in three different horizons, namely, the pre-inflation targeting monetary policy regime covering 1960:1 to 1998:4, the inflation targeting regime covering 2000:1 to 2013:3 and the combined model running from 1960:1 to 2013:3. The study found that inflation uncertainty negatively affected economic growth during the pre-inflation targeting era but did not yield any significant negative effect on economic growth during the inflation targeting era. Considering the whole period, inflation uncertainty negatively affects economic growth in South Africa. However, the study did not consider the joint impact of inflation and inflation uncertainty on South Africa, leaving room for more research on the topic.

Phiri (2018) challenges the notion of a monotonic relationship between inflation and economic growth in South Africa using the data from 2001Q1 to 2016Q2. Phiri (2018) used the smooth transition regression method for estimations. The study finds that inflation rates above 5.3% harm economic growth while any level below accommodates growth. This is lower than the 6% upper band of South Africa's inflation targeting framework.

Munyeka (2014) used the ordinary least squares method and obtained a negative relationship between inflation and economic growth. The period covered by the study was 1993 to 2011. Munyeka (2014) recommends an inflation targeting framework as the best possible policy to stabilise inflation and promote growth in South Africa. The paper criticises arguments that link inflation targeting with limited employment creation as well as economic growth as being weak, unreliable and invalid as they ignore the true determinants of unemployment in South Africa.

Niyimbanira (2013) used the Johansen-Juselius co-integration technique on South African data from 1980 to 2010 to confirm the existence of a long-run negative relationship between inflation and economic growth. The study encouraged policymakers to keep inflation under control to reap the benefits of a long-run economic performance.

Table 3.6 Studies showing the inflation, inflation uncertainty and economic growth nexus on the South African economy

Author(s)	Period	Variables	Methodology	Empirical Findings
Nell (2000)	1960 - 1999	• GDP growth rate • Terms of trade • Price inflation • M3 money stock • Nominal lending rate	• Vector Autoregressive (VAR) model • Ordinary Least Squares method	Negative relationship between inflation and growth
Hodge (2006)	1950 -2002	• GDP • CPI • Labour productivity • Gross fixed investment • Tax burden • Terms of trade	• OLS method	Positive inflation, economic growth relationship in short run but; Negative relationship in the long run
Niyimbanira (2013)	1980 - 2010	• Inflation • Economic growth	• Johansen-Juselius co-integration technique	Long-run negative relationship between inflation and economic growth
Munyeka (2014)	1993 - 2011	• Economic growth • Inflation • Inflation targeting	• Ordinary least squares regression method	Negative relationship between inflation and economic growth
Kumo (2015)	1960 to 2013	• Real GDP growth • investment spending • exports • gross savings • inflation volatility	• GARCH model	Inflation uncertainty negatively affects economic growth
Phiri (2018)	2001 to 2016	• Inflation • GDP • Investment spending • M2 money supply • Government spending • Nominal effective exchange rate	Smooth transition regression (STR) model	Threshold effect of inflation on economic growth, hence non-linear relationship

Source: Author's own compilation

3.4 Conclusion

The inflation, inflation uncertainty-growth debate remains a highly contentious issue without consensus of a certain relationship the world over. The differences in conclusions start with the schools of thought which derive different conclusions on the relationship. Furthermore, theoretical underpinnings point to different interpretations, where Tobin (1965), Ungar and Zilberfarb (1993), Aghion and Saint-Paul (1998), Blackburn (1999) and Dotsey and Sarte (2000) argue that either inflation or uncertainty or both lead to an increase in economic growth. Contrary to this, Okun (1971), Friedman (1977), Stockman (1981) and De Gregorio (1993) stress that either inflation or inflation uncertainty or both harm economic growth. Theoretically, this gives multiple heads to the argument with no single conclusion. The relationship also theoretically varies between the long-run and short-run.

These differences do not only end theoretically, but also extend empirically. There is no consensus on the relationship between either inflation and economic growth, inflation uncertainty on economic growth or both variables on economic growth. An example is empirical evidence between inflation and economic growth, without controlling for inflation uncertainty points to different conclusions – some derived an outright negative relationship while others obtained a non-linear relationship.

Empirical evidence differs not only from the divide between the developed and developing world but also within developed economies and within developing economies and even within an economy. There is, however, a substantial agreement between many scholars and studies that economic growth can be achieved at lower inflation thresholds in advanced economies than developing economies. Inflation thresholds that are consistent with economic growth decrease as the institutional quality increase.

The differences also extend to the relationship between inflation uncertainty and economic growth. Internationally, some scholars modelled the impact of inflation and inflation uncertainty on economic growth. While Iyke and Ho (2019), Wilson (2006), Rother (2004) and Judson and Orphanides (1999) obtained negative effects of inflation and inflation uncertainty on economic growth, in contrast Grier and Tullock (1989) found that inflation uncertainty harms economic growth while the effect of inflation is neutral. On the extreme, Fountas (2010) asserts that inflation and inflation

uncertainty positively impact growth. Clark (1997) found no significant evidence that inflation and inflation uncertainty affects economic growth.

On the South African economy, Kumo (2015) reveals a negative relationship between inflation volatility and economic growth, however, the study did not control for inflation. The rest of the studies only focused on the inflation-growth nexus, without controlling for inflation uncertainty. These studies obtained conflicting results. Hodge (2006) found different results with respect to the timespan where inflation has a positive impact on growth in the short run, while the relationship is negative in the long run. Niyimbanira (2013) and Munyeka (2014) find a negative relationship between inflation and economic growth, while Phiri (2018) among others, find a non-linear relationship.

The differences in results may owe to the exclusion of inflation uncertainty (Judson and Orphanides, 1999). In South Africa, none of the available literature examines the joint impact of inflation and inflation uncertainty on economic growth. Although the relationship also differs between long-run and short-run, as documented in theory, none of the studies on South Africa employ the Autoregressive Distributed Lag model to examine the short-run and long-run effects. This study therefore fills the gap in the available literature through estimating the joint impact of inflation and inflation on economic growth in the short- and long-run using the autoregressive distributive lag model.

CHAPTER 4

EMPIRICAL MODEL SPECIFICATION AND ESTIMATION TECHNIQUES

4.1 Introduction

This chapter discusses the empirical model specification and estimation techniques that are employed to examine the impact of inflation and inflation uncertainty on economic growth in South Africa. The chapter is divided as follows. Section 4.2 discusses the empirical model specification, which encompasses the general empirical model adopted in the study. Section 4.3 presents the estimation techniques based on the Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration. Furthermore, the section will also discuss the unit root tests carried out in the study. Section 4.4 presents a battery of post-estimation diagnostic tests carried out on the model. In Section 4.5, the study provides sources of data, as well as description and definitions of variables. Section 4.6 concludes the chapter.

4.2 The Empirical Model Specification

The main objective of this study is to empirically examine the inflation, inflation uncertainty and economic growth nexus in South Africa. To achieve this, the study must specify the general empirical model adopted, while also justifying the variables used.

The study specifies a modified version of the empirical model used by other studies such as those of Grier and Grier (2006), Iyke and Ho (2019) and Živkov, Kovačević and Papić-Blagojević (2020). The model specified is as follows:

$$Y_t = \alpha_0 + \alpha_1 INF_t + \alpha_2 VOL_t + \alpha_3 R_t + \mu_t \qquad \text{Equation (4.1)}$$

Where Y is economic growth; INF represents the rate of inflation; VOL represents a measure of inflation uncertainty; R denotes nominal interest rates; α ($\alpha_0, \alpha_1, \alpha_2$ and α_3) represents the coefficients of the model; μ is the white-noise error term, while t represents the time subscript. Section 4.3 provides a detailed discussion on the data sources and the justification of variables in the model.

4.3 Data sources, description and justification of variables

4.3.1 Sources of data and definition of variables

This study uses quarterly time-series data for South Africa covering the period from 1961Q1 to 2019Q4. Since one of the objectives of the study is to compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting, the data is therefore further split into two data sets. This includes one for the period from 1961Q1 to 1999Q4, being the period before adoption of inflation targeting, while the other data set covers the period from 2000Q1 to 2019Q4 being the time period when South Africa falls under the inflation targeting regime. The timespan of the data is limited to 1961Q1, and not periods before, due to availability of data. The data ends at 2019Q4 and does not include 2020 due to the economic lockdowns from the prevalence of Covid-19 in 2020 which disturbed production and economic growth.

Although this study gives the impression that South Africa's monetary policy is characterised by two periods since 1960, being the pre-inflation targeting period and the inflation targeting period, however, in reality (as detailed in Chapter Two) it has gone through five monetary policy regimes. This impression is in line with the fourth objective of this study, which aims to compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting. Due to the presence of five monetary policy regimes and not two, it is statistically impossible to include a dummy variable for the policy changes from pre-inflation targeting to inflation targeting under the full sample period (1961Q1 to 2019Q4). The pre-inflation targeting period includes up to four policy regimes.

4.3.2 Description and justification of variables

In assessing the inflation, inflation uncertainty and economic growth nexus, the variables used in the study are economic growth, inflation, inflation uncertainty and the nominal interest rates. Descriptions, as well as justification of these variables will be explained.

4.3.2.1 Economic growth (Y)

Economic growth is the dependent variable in the study. Economic growth, defined as an increase in production in a country in a given time period, is measured using

different proxy variables. Some studies such as Barro and Lee (1994), Bittencourt, Eyden and Seleteng (2015), as well as Iyke and Ho (2019) employ growth in per capita real gross domestic product as a measure of economic growth. In contrast, some studies use growth in real domestic product as a measure of economic growth, such as Hodge (2006), Adusei (2012) and Phiri (2018). Of these two measures, South Africa uses growth in real gross domestic product as a measure of economic growth.

StatsSA (n.d) measures economic growth using two different approaches: firstly, the quarterly growth rate of real GDP at a seasonally adjusted and annualised rate; and secondly, unadjusted year-on-year quarterly growth of real GDP. Although seasonally adjusted quarterly growth at an annualised rate is used as the official growth rate, irregular occurrences in specific quarters may render the data volatile. To circumvent this weakness, this study measures economic growth using the unadjusted year-on-year quarterly growth of real GDP since it eliminates the impact of seasonal variations. This method compares a given quarterly real GDP against quarterly real GDP of the same quarter from the previous year. The growth rates are then expressed as percentages.

4.3.2.2 Inflation (INF)

Inflation is one of the independent variables in the study. CPI is the standard index used to calculate the rate of inflation in South Africa (StatsSA, 2017). Different measures of inflation are used, such as month on same month of previous year, month on previous month at an annual rate, quarterly average on previous quarterly average at an annual rate and quarter on quarter of previous year (Mohr, 2016). This study uses the quarter on quarter of previous year. This method is chosen for its alignment and consistency with the method used for calculating economic growth in this paper. The inflation rate is expressed as a percentage.

Theoretically, inflation has an ambiguous relationship with economic growth. On one end, there is a body of literature that posits that high inflation spurs economic growth (see Mundell, 1963; Tobin ,1965; Ungar and Zilberfarb, 1993; Aghion and Saint-Paul, 1998). On the other end Okun (1971), Friedman (1977), Stockman (1981) and Ball (1992) insist that high inflation hurts economic growth. Furthermore, some scholars such as Friedman and Schwartz (1963) and Caballero (1991) postulate that there is no significant relationship between inflation and economic growth. The rate of inflation

has also been used as a yardstick for evaluating government's effectiveness in managing the economy (Fischer, 1993), while Barro (2003) emphasises that inflation is a good measure of economic performance.

Although empirical evidence overwhelmingly supports a negative relationship between economic growth and inflation from a number of scholars such as De Gregorio (1993), Nell (2000), Gylfason and Herbetsson (2001), Gillman, Harris and Mátyás (2004), Guerrero (2006), Barro (2013), Munyeka (2014) as well as Iyke and Ho (2019), some scholars, however, also challenge the notion of a monotonic relationship between inflation and economic growth. These scholars obtained empirical evidence supporting threshold effects of inflation on economic growth (see Bruno and Easterly, 1998; Khan and Senhadji, 2001; López-Villavicencio and Mignon, 2011; Kremer, Bick and Nautz, 2013; Yilmazkuday, 2013; Ndoricimpa, 2017; Phiri, 2018). Adding to the ambiguity of empirical evidence, Hodge (2006) found that inflation positively affects growth in the short run, but negatively in the long run. Therefore, a priori expectation is either a positive or negative relationship between inflation and economic growth.

4.3.2.3 Inflation uncertainty (VOL)

Inflation uncertainty is the second explanatory variable in the study. Inflation uncertainty, defined by Grier and Perry (1998) as unpredictable volatility in the general prices, is an unobserved variable. Inflation uncertainty can be measured ex-ante, that is, before the period of inflation has passed; or ex-post, which is measured after the inflation period has occurred. This study uses ex-post inflation uncertainty. Sample standard deviations of the inflation rate expressed as a percentage are used as the proxy for inflation uncertainty, in line with empirical work by different scholars such as Foster (1978); Çekin and Valcarcel (2019), Barro (2013) as well as Iyke and Ho (2019).

Theories point to different relationships between inflation uncertainty and economic growth. Tobin (1965) argues that inflation uncertainty prompts households to move assets from non-interest-bearing accounts to real capital accounts, thereby enhancing capital productivity and ultimately spurring economic growth. Dotsey and Sarte (2000) further linked inflation uncertainty with increased savings, which act as funds for investment spending and in turn, increase economic growth. On the other hand, Okun (1971) and Friedman (1977) argue that inflation uncertainty reduces the

informativeness component of price movements, thereby inhibiting economic activities and growth. Therefore, no definite answer is reached theoretically.

In addition, empirical evidence points to an ambiguous conclusion. Grier and Perry (2000), Apergis (2005), Grier and Grier (2006), Bredin, Elder and Fountas (2009), Baharumshah, Hamzah and Sabri (2011) as well as Ilke and Ho (2019) derived evidence of a negative relationship between inflation uncertainty and economic growth. In contrast, scholars such as Coulson and Robins (1985) and Fountas (2010) found a positive relationship between inflation uncertainty and economic growth. On one extreme, Jansen (1989) and Fountas, Ionnidis and Karansos (2004) obtained mixed results on different European economies. Therefore, a priori expectation is either a positive or negative relationship between inflation uncertainty and economic growth.

4.3.2.4 Interest rates (R)

The third explanatory variable in the study is interest rates. The interest rates on 91-day treasury bills are used as the proxy for nominal interest rates in the study. The treasury bill rate is chosen instead of the official repo rate due to its reasonable variation over time. The Treasury bill rates are commonly used as the proxy for the official repo rate, for example, in Boinet and Martin (2008), Naraidoo and Raputsoane (2015) and Lee and Werner (2018), among others. Botha (2002) also states that treasury bills serve as a reference rate for the determination of interest rates on other money-market instruments. The inclusion of nominal interest rates is informed by literature from different studies such as Amusa, Gupta, Karolia and Simo-Kengne (2013) as well as Bonga-Bonga and Simo-Kengne (2018) which proxied 91-day treasury bills for nominal interest rates as a control variable to investigate inflation and output growth dynamics. Furthermore, Lee and Werner (2018) used 91-day treasury bills as a proxy for nominal interest rates on economic growth. Saymeh and Orabi (2013), Chu, Cozzi, Furukawa and Liao (2017) as well as Behera and Mishra (2017) also included nominal interest rates in their estimations, on the determination of economic growth. Although real interest rates reflect the true cost of borrowing, however, interest rates are quoted in their nominal form and it is this form which informs the choice of decisions by financial market participants (Hegji, 1992).

The relationship between nominal interest rates and economic growth is explained in theoretical literature by the interest rate transmission mechanism. The interest rate transmission mechanism explains that an increase in interest rates increases the cost of borrowing, thereby reducing investment and consumption spending. In turn, aggregate spending decreases, and through the multiplier effect, economic growth diminishes.

Although theoretically the relationship between interest rates and economic growth is monotonic and negative, empirical evidence points in two directions. While studies such as Obamuyi (2009) as well as Semuel and Nurina (2014) obtained results consistent with theory, other empirical evidence points in the opposite direction. Yang, Groenewold and Tcha (2000), Gumus (2015) as well as Fornah and Yuehua (2017) find that high interest rates are an important determinant that attracts foreign direct investment, thereby, fostering a positive relationship with economic growth. Therefore, a priority expectation is either a positive or negative relationship between interest rates and economic growth.

Table 4.1: Definitions and sources of variables

VARIABLE	DEFINITION	SOURCE
Economic Growth (Y)	**Dependent Variable** Economic growth defined as the growth rate of Real Gross Domestic Product, in 2010 constant prices	South African Reserve Bank (SARB) (2020)
Inflation (INF)	Inflation Rate defined as the growth rate of the Consumer Price Index (CPI) (2010=100)	International Financial Statistics (IFS) (2020)
Inflation Uncertainty (VOL)	Standard deviation of inflation rate used as a measure of inflation uncertainty	Calculated by the author using the Inflation Rate derived from CPI figures extracted from International Financial Statistics (2020)
Interest Rates (R)	Nominal Interest Rates, with rates on 91-day Treasury Bills used as the proxy	International Financial Statistics (2020)

4.4 Estimation Techniques

4.4.1 Stationarity Tests

Unit root tests will be done to determine the stationarity properties of the variables before investigation of the relationship between economic growth and its regressors was carried out. Non-stationary time-series data may lead to incorrect conclusions and

spurious regressions which is associated with misleadingly high adjusted R^2 and t-values but with an extremely low Durbin-Watson statistic (Granger and Newbold, 1974). The study employs the Autoregressive Distributed Lag (ARDL) approach which, according to Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001) is applicable regardless of whether the variables are integrated of order zero [I(0)], integrated of order 1 [I(1)], a mixture of both, or are fractionally integrated but not integrated of order 2 [I(2)]. To examine the stationarity properties, Augmented Dickey-Fuller (ADF) and the Dickey-Fuller Generalised Least Squares (DF-GLS) unit root tests are conducted.

4.4.1.1 Augmented Dickey-Fuller (ADF) Unit Root Test

The Augmented Dickey-Fuller (ADF) test is an augmented version of the original Dickey-Fuller (1979) unit root test through adding lagged values of the dependent variable, thus addressing the presence of autocorrelation in a given equation. This gives it an advantage over other tests such as the Phillips-Perron (1988) unit root test, which performs poorly in cases with finite samples. The ADF is given as:

$$\Delta Y_t = \alpha Y_{t-1} + \delta_i X_t + \sum_{i=1}^{n} \beta_i \Delta Y_{t-1} + u_t \qquad \text{Equation (4.2)}$$

where X_t comprises of optional independent variables such as a constant, or combination of a constant and linear time trend. The test statistic follows the conventional t-ratio. Schwarz Information Criterion is used to determine the lag length in the test.

4.4.1.2 Dickey-Fuller Generalised Least Squares (DF-GLS) Unit Root Test

Davidson and MacKinnon (2004) argue that the inclusion of optional independent variables in the ADF test may result in larger computed critical values, thereby reducing the power of the test. To circumvent this weakness, Elliot, Rothenberg and Stock (1996) modified the standard ADF test by detrending the time-series before estimation of the test equation, thereby getting rid of optional independent variables in the time series. Furthermore, Caner and Kilian (2001) stress that the DF-GLS performs better in the presence of large and negative moving averages in the underlying series, a case where ADF and the Phillips-Perron (PP) tests erroneously reject the null hypothesis of unit roots. Schwarz Information Criterion (SIC) is used to determine the lag length in the test.

The DF-GLS test regression is estimated as follows:

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \sum_{i=1}^{k} \rho_i \Delta y_{t-i} + \epsilon_t \quad \text{Equation (4.3)}$$

Where y_t represents the time-series; α, β, δ and ρ are the coefficients of the test equation, i denotes the number of lags, Δ represents the first difference operator, t denotes the time subscript and ϵ represents the white-noise error term.

After passing the stationarity tests, the study proceeds with ARDL bounds testing approach.

4.4.2 ARDL Bounds Testing Approach

In the empirical analysis, the ARDL bounds testing approach to co-integration introduced by Pesaran and Shin (1999) and later modified by Pesaran, Shin and Smith (2001) is employed in the study. The variables in equation 4.1 must be non-stationary, implying that the variables can converge in the long-run even if they drift apart in the short-run, hence the need to test for cointegration.

The approach is chosen on account of its favourable properties. First, the modelling framework can derive a cointegrating relationship even when variables are integrated of either order one, or order zero; or even if it is a mixture of both (Pesaran, Shin and Smith, 2001). This gives the modelling framework an edge over traditional estimation methods such as the Engle and Granger (1987), the Full-Maximum Likelihood Test of Johansen (1988; 1991) and Johansen and Juselius (1990) which assumes that variables are integrated of order one.

Second, the ARDL bounds test comprises lags of both dependent and independent variables, making it a powerful tool for estimating both short- and long-run cointegrating relationships (Pesaran and Shin, 1999). Third, ARDL is not sensitive to sample sizes and produces robust results even if the sample size is small. Fourth, the ARDL model captures the data generating process in general to specific modelling frameworks due to its ability to accommodate a sufficient number of lags (Pesaran, Shin and Smith, 2001). Finally, even if there is endogeneity in the explanatory variables, ARDL provides unbiased estimates of the long-run model, with valid t-statistics (Odhiambo, 2013). Therefore, the ARDL approach was considered suitable for the study. The ARDL model used in this study can be expressed as follows:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Y_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta INF_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta VOL_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta R_{t-i} + \delta_1 Y_{t-1} + \delta_2 INF_{t-1} + \delta_3 VOL_{t-1} + \delta_4 R_{t-1} + \varepsilon_t \quad \text{Equation (4.4)}$$

The parameters β and δ are, respectively, the short-run multipliers (elasticities) and the long-run multipliers (elasticities) of the model. The white noise residual term is denoted by ε_t, and is assumed to be independent and identically distributed. Δ is the first difference operator, t denotes the time period and n is the maximum number of lags in the model which is based on the Schwarz Information Criterion (SIC). The SIC criterion eliminates the uncertainty problem in model selection (Yang, 2005). Vrieze (2012) also emphasises that SIC is consistent in selecting the true model, and the probability of efficacy approaches one as the sample size grows.

Some of the independent variables may have no lagged terms in the ARDL model and are called static regressors. The ARDL bounds testing for cointegration is applied for the three periods under study, that is the full sample period (i.e., 1961Q1 to 2019Q4), the pre-inflation targeting era (i.e., from 1961Q1 to 1999Q4) and the inflation targeting era (i.e., 2000Q1 to 2019Q4) using equation 4.4 by following the coming procedures. The first procedure involves setting the following null hypothesis, which disputes existence of a cointegration relationship:

$$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$$

which is tested against the alternative hypothesis which supports the existence of a cointegration relationship:

$$H_1 : \delta_i \neq 0$$

Evidence of cointegration from equation 4.4 is found if at least one of the long-run multipliers is significantly different from zero. Failure to reject the null hypothesis will be sufficient proof for lack of evidence of cointegration between economic growth and its explanatory variables in the study.

The second procedure is testing the existence of level relationships by comparing the F-statistic to the two sets of critical values constructed by Pesaran, Shin and Smith (2001). The first of critical values, known as the lower critical bound (LCB), assumes that the variables are integrated of order zero, I(0); while the second set of critical values, known as the upper critical bound (UCB) assumes that the variables are

integrated of order one, I(1). The following rules are followed in deriving the decision when carrying out the bounds test:

$If\ F_{bound} > UCB,$
$\rightarrow Existence\ of\ Long\ Run\ Relationships\ (reject\ null\ hypothesis\ of\ no\ long\ run\ relationships);$

$If\ F_{bound} < LCB, \rightarrow No\ existence\ of\ Long\ Run\ Relationships;$

$If\ LCB \leq F_{bound} \leq UCB, \rightarrow Results\ are\ inconclusive.$

A rejection of the null hypothesis of no long-run relationships implies that there is a long-run stable relationship between the set of explanatory variables and economic growth in the study. The next step will be estimating the error correction model (ECM). The ECM can be formulated as follows:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Y_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta INF_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta VOL_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta R_{t-i} + \delta ECM_{t-1} + \varepsilon_t \quad \text{Equation (4.5)}$$

In equation 4.5, δ is the coefficient of the error correction term - ECM_{t-1} , which measures the short-run speed of adjustment towards the long-run equilibrium path of the estimated ARDL model. The coefficient of the error correction term is expected to be a negative sign. The error correction model will be run for three periods, that is, the full-sample period (1961Q1 – 2019Q4), the pre-inflation targeting period (1961Q1 – 1999Q4) and the inflation targeting period (2000Q1 – 2019Q4).

4.5 Post-estimation diagnostic tests

The ARDL estimation is ordinary least squares regression based, hence it is subjected to some diagnostic tests. Accordingly, Pesaran and Shin (1999) proved that ARDL estimations suffer from misspecification unless the residuals do not suffer autocorrelation, having a zero expected value and a constant covariance matrix. Further, Pesaran and Shin (1999) advised addition of lags to correct for autocorrelation, which influences the choice of lags in the model. Presence of autocorrelation results in ARDL technique producing biased estimators. The following subsections discusses the post-diagnostic tests employed in the study.

4.5.1 Parameter and variance stability tests

The cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ) tests introduced by Brown, Durbin and Evans (1975) is employed to test for parameter and variance stability of recursive residuals respectively, in the ARDL model. CUSUM tests for parameter stability, with upper and lower critical lines at 5% level of significance, tests the null hypothesis of parameter stability. If the cumulative sum of recursive residuals is outside either (or both) the upper or (and) lower critical lines, the null hypothesis is rejected, and a conclusion drawn that the parameters exhibit instability.

CUSUMQ tests for variance instability, with upper and lower critical lines at 5% level of significance tests the null hypothesis of variance stability. If the cumulative sum of squares of recursive residuals is outside either (or both) the upper or (and) lower critical lines, the null hypothesis is rejected, and a conclusion drawn that the model exhibits variance instability. If there is evidence of either parameter instability or variance instability, lags should either be added or removed from the ARDL model.

4.5.2 Serial correlation test

Serial correlation occurs when the error term of preceding periods carries over to the successive periods thereby resulting in a correlation between error terms from various time periods in the data set. The inclusion of lagged dependent variables as an explanatory variable makes the ARDL techniques vulnerable to the presence of serial correlation. Presence of serial correlation results in biased and inconsistent estimates that are inefficient, and accompanied with underestimated standard errors (Breusch, 1978).

The Breusch (1978)-Godfrey (1978) Lagrange Multiplier (LM) test will be employed to test for serial correlation in the study. The Breusch-Godfrey LM test assesses the independence of the residuals with a null hypothesis assuming no serial correlation in the residuals. Failure to reject the null hypothesis would be proof of lack of serial correlation in the model.

4.5.3 Heteroskedasticity test

Heteroscedasticity occurs when the variance of residuals varies over time, which results in estimates that are unbiased but inefficient. This reduces the power test, leading to type II error, in which one fails to reject a false null hypothesis (White, 1980).

The Breusch-Pagan-Godfrey Lagrange Multiplier (BGP-LM) test for heteroscedasticity is used in this study. It has a null hypothesis assuming homoscedasticity in the model. Failure to reject the null hypothesis will imply the absence of heteroscedasticity in the model.

4.5.4 Autoregressive Conditional Heteroskedasticity (ARCH) Test

An auto regressive conditional heteroskedastic (ARCH) process may arise where a relationship exists between the variance of the disturbances and the squared residual term (Engle, 1982). The ARCH test is based on the F-distribution which tests for omitted variable(s) for the joint significance of all lagged squared residuals. Engle (1982) argues that although ARCH does not invalidate the standard ordinary least squares inference, however, it results in loss of efficiency if not addressed. In such instances, generalised least squares would be more efficient, as compared to ordinary least squares. This study therefore tested for the presence of ARCH in the model.

4.5.5 Specification test

The model may suffer from various misspecification issues such as the omission of variables, incorrect functional form, simultaneous equation problems and heteroscedasticity. This leads to inefficient inference procedures, with biased and inconsistent estimates. Incorrectly specified equations yield misleading results from misspecification bias and wrong functional forms that cause high adjusted R^2.

The Ramsey (1969) Regression Specification (Ramsey RESET) test is used in this study to test for misspecification. The Ramsey RESET is based on the assumption of independent and identically distributed residuals and examines the distribution of the classical linear least-squares disturbance term. The null hypothesis tests the joint null hypothesis (of all functional specifications) that the model is correctly specified, while the alternative hypothesis assumes that the model suffers from at least one specification error.

4.6 Concluding remarks

This chapter discussed the specification of the empirical model and the estimation techniques used to assess the joint impact of inflation and inflation uncertainty on economic growth. The unit root tests that were carried out before the ARDL approach is estimated are also discussed in the chapter. The procedures followed in the ARDL

approach were also explained. After that, post-estimation diagnostic tests performed on the model were discussed. Lastly, sources of data, definition, description, and justification of variables used in the study were covered.

CHAPTER 5

ECONOMETRIC ANALYSIS AND EMPIRICAL FINDINGS

5.1 Introduction

This chapter presents the econometric analyses and empirical findings in line with the specifications and estimation techniques outlined in Chapter Four. The significance of this chapter lies in empirically addressing the objectives of this study, outlined in Chapter One. The main objective of this study is to empirically examine the inflation, inflation uncertainty and economic growth nexus in South Africa, while the specific objectives of the study are to: (i) explore the dynamics of inflation, inflation uncertainty and economic growth in South Africa, from 1960 to 2019, (ii) review and analyse the theoretical and empirical literature on the inflation, inflation uncertainty and economic growth nexus, (iii) examine the short- and long-run impact of inflation and inflation uncertainty on economic growth in South Africa and (iv) compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting. The first and second objectives were addressed in Chapter Two and Three respectively, and this chapter address the last two objectives.

Accordingly, to address these objectives, the study makes use of the ARDL bounds testing approach to cointegration. The chapter is structured as follows: Section 5.2 provides the descriptive statistics of variables used in the study, while Section 5.3 presents the unit root test results of all the variables used, the ARDL cointegration test results, ARDL-based empirical analysis and concludes with the post-estimation diagnostic test. Section 5.4 concludes the chapter.

5.2 Descriptive statistics

Descriptive statistics, giving summary statistics of the time-series data used in the study, are presented in Tables 5.1, 5.2 and 5.3 for the full sample period, that is, 1961Q1 – 2019Q4, and two sub-sample periods of 1961Q1 – 1999Q4 and 2000Q1 – 2019Q4, respectively. Descriptive statistics gives a hindsight of the historical background and behaviour of the data. From the tables, the mean and the median

indicate the measures of central tendency. The mean gives the average value while the median gives the central value if the data were to be arranged in ascending order.

For the full sample period (1961Q1 - 2019Q4), economic growth was 2.9% on average. The median economic growth was 3.06%, which was greater than the mean, implying that economic growth was in most cases higher than the average growth of 2.9%.

Table 5.1: Descriptive statistics for the full sample period (1961Q1 - 2019Q4)

	Y	**INF**	**VOL**	**R**
Full Sample Period (1961Q1 – 2019Q4)				
Mean	2.949	8.022	65.112	8.794
Median	3.055	6.894	48.186	7.403
Maximum	10.133	19.250	361.563	21.75
Minimum	-3.707	-1.761	0.928	1.803
Std. Dev.	2.724	4.770	59.315	4.510
Skewness	-0.037	0.310	1.682	0.766
Kurtosis	2.756	2.098	6.643	2.718
Jarque-Bera	0.640	11.769	241.720	23.833
Probability	0.726	0.003	0.000	0.000
Sum	696.005	1893.286	15366.39	2075.423
Sum Sq. Dev.	1743.802	5346.917	826781.300	4780.874
Observations	236	236	236	236

Skewness measures the data's level of symmetry around the mean, and the closer the coefficient of symmetry to zero, the more symmetrical the data is. The coefficient of skewness can also be used in conjunction with the mean and the median in analysing the symmetrical properties of data. Negatively skewed data is associated with a negative coefficient of skewness and a mean less than the median while positive skewed data has a positive coefficient of skewness and a mean greater than the median.

Economic growth data of South Africa for the full sample period in the study is, in general, negatively skewed, depicting that economic growth has been more than the average growth for most of the periods with fewer cases of below average growth (outliers). The maximum growth recorded for the period was 10.1% while the minimum growth was -3.7%.

Data for inflation shows that for the past four decades spanning from the early 1960s to the late 2010s, inflation was, on average, 8.02%. The median of 6.89%, lower than the average inflation, depicts that the rate of inflation has frequently been below the average rate of inflation. This is also supported by the positive coefficient of skewness of 0.31. The highest inflation rate ever experienced during this period was 19.25%, with a minimum rate of inflation of -1.8%, which was deflationary. Table 5.2 presents the descriptive statistics for the pre-inflation targeting period.

Table 5.2: Descriptive statistics for the pre-inflation targeting period (1961Q1 - 1999Q4)

	Y	**INF**	**VOL**	**R**
Pre-Inflation Targeting Period (1961Q1 – 1999Q4)				
Mean	3.107	9.415	65.178	9.353
Median	3.149	10.055	53.039	7.893
Maximum	10.133	19.250	279.418	21.75
Minimum	-3.707	0.856	1.028	1.803
Std. Dev.	3.038	5.000	56.524	5.285
Skewness	-0.105	-0.130	1.341	0.433
Kurtosis	2.448	1.822	4.86	1.911
Jarque-Bera	2.273	9.460	69.265	12.587
Probability	0.321	0.009	0.000	0.002
Sum	484.716	1468.692	10167.69	1459.07
Sum Sq. Dev.	1430.678	3876.113	495212.2	4329.093
Observations	156	156	156	156

The economic growth recorded during the pre-inflation targeting period, on average, was 3.1%, which is higher than the full sample average. The maximum and minimum levels of economic growth were also recorded during this period. The presence of both the high and low rates of economic growth in this period may signal that the period was marred with turbulence and instability in economic growth. This can be due to policy uncertainties.

Inflation rate, on average, was 9.4% during the pre-inflation targeting period. On average, inflation during this period was higher than the average for the full sample period in the study. Unlike under the full sample period, inflation under the pre-inflation targeting period was negatively skewed indicating that inflation was in most cases above its average of 9.4%. This incurs a high possibility that the rates of inflation

experienced were likely double digit rather than single digit. Moreover, the highest rate of inflation of 19.3% experienced during the four decades under the study was recorded during the pre-inflation targeting era.

Table 5.3 presents the descriptive statistics for the inflation targeting period. The average economic growth for the period was 2.6%, with a median of 2.9%. This depicts that economic growth was negatively skewed during this period, implying that economic growth was in most cases higher than its average of 2.6%. The South African economy grew slower under the inflation targeting period in comparison to the pre-inflation targeting period, data reveals.

Table 5.3: Descriptive statistics for the inflation targeting period (2000Q1 - 2019Q4)

	Y	**INF**	**VOL**	**R**
Inflation Targeting Period (2000Q1 – 2019Q4)				
Mean	2.641	5.307	64.984	7.704
Median	2.875	5.274	46.318	7.218
Maximum	7.109	13.569	361.563	12.567
Minimum	-2.582	-1.761	0.928	4.953
Std. Dev.	1.954	2.707	64.785	1.975
Skewness	-0.199	0.070	2.103	0.704
Kurtosis	2.773	4.376	8.451	2.581
Jarque-Bera	0.698	6.373	158.041	7.197
Probability	0.705	0.041	0	0.027
Sum	211.289	424.594	5198.697	616.353
Sum Sq. Dev.	301.637	578.714	331567.1	308.056
Observations	80	80	80	80

Data for inflation shows that between 1961Q1 and 1999Q4, inflation has been negatively skewed. However, it turned to positive skewness after adoption of inflation targeting, being the period between 2000Q1 and 2019Q4. This implies that inflation was frequently above the average inflation of 9.4% before inflation targeting but consistently stayed below an average of 5.3% after adoption of inflation targeting. This may be attributed as a success of the inflation targeting framework in taming down inflation.

In terms of inflation uncertainty, it is positively skewed in all periods under study. This implies that in most cases, inflation uncertainty has been below its average. However,

the coefficient of skewness for the period 2000Q1 to 2019Q4 is greater than the other two periods, implying that inflation uncertainty increasingly frequented below its average values during this period.

The sample standard deviation measures the dispersion of the data from the mean. This property makes it a good measure of volatility and uncertainty. Standard deviation makes sense when analysed in relative terms, where the higher the standard deviation, the higher the dispersion. Highest volatility and hence uncertainty in both economic growth and inflation was experienced during the pre-inflation targeting era in comparison to the inflation targeting period. This is supported by the higher values of sample standard deviations for economic growth and inflation under the pre-inflation targeting era, compared to the inflation targeting period. The standard deviations of inflation for the periods 1961Q1 to 2019Q4, 1961Q1 to 1999Q4 and 2000Q1 to 2019Q4 are 4.77, 5.0 and 2.71, respectively. This implies a decrease in inflation uncertainty after adoption of inflation targeting. It can be interpreted as the genesis of policy stability and certainty ushered by the adoption of inflation targeting policy. The following section presents the empirical results and the econometric analysis from the study.

5.3 Econometric analyses and empirical results

ARDL estimation techniques requires that variables be integrated of order not exceeding order one (1), to avoid spurious regressions. Accordingly, this section begins by testing for the order of integration using unit root tests. After satisfying the stationarity requirements of the model, the subsection that follows tests for the existence of cointegration. Thereafter, empirical analysis of ARDL-based results for the periods 1961Q1 to 2019Q4, 1961Q1 to 1999Q4 and 2000Q1 to 2019Q4 are presented. The chapter concludes by presenting post-estimation diagnostic tests.

5.3.1 Unit root tests

Table 5.4 presents the results of stationarity tests, which determines the order of integration of the variables under study. Augmented Dickey-Fuller (ADF) and the Dickey-Fuller Generalised Least Squares (DF-GLS) unit root tests are used in this

study. Absolute values of test statistics greater than the absolute values of the test critical values shows evidence of stationarity in the variables.

Table 5.4: Stationarity Tests for all Variables, and Time-periods

Full Sample Period (1961Q1 – 2019Q4)									
	Augmented Dickey-Fuller Test				Dickey-Fuller Generalised Least Squares Test				
	At Level I(0)		At First Difference I(1)		At Level I(0)		At First Difference I(1)		
Variables	Without Trend	With Trend	Without Trend	With Trend	Without Trend	With Trend	Without Trend	With Trend	Decision
Y	4.12***	4.62***	-	-	3.33***	4.63***	-	-	I(0)
INF	1.75	1.89	12.18***	12.26***	1.04	1.18	12.18***	12.21***	I(1)
VOL	4.53***	4.49***	-	-	2.53**	3.58***	-	-	I(0)
R	2.74*	2.72	-	-	2.01**	2.60	-	-	I(0)
Pre-Inflation Targeting Period (1961Q1 – 1999Q4)									
Y	3.51***	5.92***	-	-	3.08***	5.73***	-	-	I(0)
INF	1.41	0.10	8.07***	8.45***	0.76	0.51	8.02***	8.04***	I(1)
VOL	10.74***	11.35***	-	-	0.85	10.7***	-	-	I(0)
R	2.18	3.50***	-	-	1.62*	3.40**	-	-	I(0)
Inflation Targeting Period (2000Q1 – 2019Q4)									
Y	2.25	3.32*	-	-	2.15**	3.21**	-	-	I(0)
INF	4.16***	4.13***	-	-	2.25**	3.88***	-	-	I(0)
VOL	1.87	5.46***	-	-	1.90*	5.15***	-	-	I(0)
R	2.77*	3.28*	-	-	1.50	3.33**	-	-	I(0)

Note: *, ** and *** denote significance at 10%, 5% and 1% respectively; - denotes not applicable and all values are expressed in their absolute values.

The stationarity test results illustrated in Table 5.4 for South Africa for the periods 1961Q1 to 2019Q4, 1961Q1 to 1999Q4 and 2000Q1 to 2019Q4 conclusively show that economic growth, inflation uncertainty and interest rates are integrated of order zero. The tests shows that inflation is integrated of order one for the periods 1961Q1 to 2019Q4 and 1961Q1 to 1999Q4; and integrated of order zero for the period 2000Q1 to 2019Q4. Therefore, all the variables are integrated of orders not exceeding two. Accordingly, the study proceeds to employ the ARDL bounds testing procedure to test for cointegration between economic growth and its regressors in the study.

5.3.2 ARDL bounds test for co-integration.

The stationarity tests conducted in Section 5.3.1 indicates that all variables in the different periods in the study are either stationary at level [I(0)] or at first difference [I(1)], which allows the study to employ the ARDL bounds test for co-integration. The approach tests for the existence of long-run relationships and impact of explanatory variables in the study on economic growth under the different periods are investigated in the study.

With reference to Pesaran, Shin and Smith (2001) asymptotic critical value bounds, the results show that the optimal model for the periods 1961Q1 to 2019Q4 and 1961Q1 to 1999Q4 is Case III: Unrestricted intercept and no trend while for the period 2000Q1 to 2019Q4 is Case IV: Unrestricted intercept and restricted trend. The Schwarz Information Criterion (SIC) was used to select the optimal lag length in the study. The optimal models selected for the periods 1961Q1 to 2019Q4, 1961Q1 to 1999Q4 and 2000Q1 to 2019Q4 are ARDL(4,0,0,1), ARDL(4,0,0,1) and ARDL(1,0,0,1) respectively. Table 5.5 presents the cointegration results.

As illustrated in Table 5.5, all computed F-statistics for the periods 1961Q1 to 2019Q4, 1961Q1 to 1999Q4 and 2000Q1 to 2019Q4 show that the estimated equations are statistically significant at 1%, confirming evidence of long-run relationship between the dependent variable and the set of explanatory variables in the study. The computed F-statistics are 17.0322, 16.7406 and 8.6690 for the periods 1961Q1 to 2019Q4, 1961Q1 to 1999Q4 and 2000Q1 to 2019Q4, respectively. The computed F-statistics are greater than the Pesaran *et al.* (2001) set of critical values.

Table 5.5: ARDL Bounds Test Results for Cointegration

Period	Dependent Variable	Function	F-Statistic	Cointegration Status
1961Q1 – 2019Q4	Y	F(Y|INF, VOL, R)	17.0322***	Cointegrated
1961Q1 – 1999Q4	Y	F(Y|INF, VOL, R)	16.7404***	Cointegrated
2000Q1 – 2019Q4	Y	F(Y|INF, VOL, R)	8.6690***	Cointegrated

Null Hypothesis: No long run relationship exists.
Asymptotic Critical Values (Pesaran *et al.,* 2001; Case III and IV, p. 300 - 301)

	1%		5%		10%	
Case	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
III	4.29	5.61	3.23	4.35	2.72	3.77
IV	4.30	5.23	3.38	4.23	2.97	3.74

Note: *** denotes significance at 1%

Since there is evidence of cointegration in all the estimations, the study proceeds with short- and long-run estimation of the impact of inflation and inflation uncertainty on economic growth using the ARDL bounds test approach. Interest rates are also included as a control variable. Section 5.3.3 presents the empirical analysis of ARDL-based results for the full sample period (1961Q1 to 2019Q4).

5.3.3 Empirical analysis of ARDL-based results for the full sample period (1961Q1 – 2019Q4)

The whole period under study stretches from 1961Q1 to 2019Q4. The study goes on to split the periods into two – the pre-inflation targeting period (1961Q1 to 1999Q4) and the inflation targeting period (2000Q1 to 2019Q4). The prime motive behind this is to address the fourth specific objective of the study – to compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting. This also assists in probing and examining if adoption of inflation targeting results in tying down inflation uncertainty as the rate of inflation is kept within the target range of 3% to 6%. Introduction of a new policy may also result in a change in the behaviour of variables, which may reconfigure the priori expectations. Table 5.6 presents the regression results for the full sample period 1961Q1 to 2019Q4.

Table 5.6: The long-run and short-run results for the full sample period (1961Q1 to 2019Q4)

1961Q1 – 2019Q4, Panel A: Long-Run Results Dependent Variable is Y				
Regressor	Coefficient	Standard Error	t-statistic	Probability
INF	-0.1491**	0.0675	-2.2101	0.0281
VOL	-0.0016	0.0046	-0.3375	0.7361
R	-0.2365***	0.0719	-3.2907	0.0012
1961Q1 – 2019Q4, Panel B: Short-Run Results Dependent Variable is ΔY				
Regressor	Coefficient	Standard Error	t-statistic	Probability
ΔY(-1)	-0.0327	0.0623	-0.5254	0.5998
ΔY(-2)	0.1312**	0.0623	2.1045	0.0365
ΔY(-3)	0.2860***	0.0593	4.8260	0.0000
ΔINF	-0.1744**	0.0840	-2.0768	0.0390
ΔVOL	-0.0025*	0.0015	-1.7255	0.0858
ΔR	0.2658**	0.1110	2.3949	0.0175
C	2.3044***	0.3229	7.1359	0.0000
ECM	-0.3640***	0.0482	-7.5524	0.0000

R-squared	0.6935	Mean dependent var	2.9336
Adjusted R-squared	0.6825	S.D. dependent var	2.7410
S.E. of regression	1.5446	Akaike info criterion	3.7454
Sum squared resid	532.0189	Schwarz criterion	3.8791
Log likelihood	-425.4670	Hannan-Quinn criter.	3.7993
F-statistic	63.0578	Durbin-Watson stat	1.8436
Prob(F-statistic)	0		

Note: *, ** and *** denote significance at 10%, 5% and 1% respectively; Δ is the first difference operator. Results are obtained using eViews software version 9.5.

Panel A in Table 5.6 presents the long-run results of the explanatory variables – inflation, inflation uncertainty and interest rates on the level of economic growth. The results reveal that inflation has a significant negative long-run impact on economic growth in South Africa. The results show a negative long-run relationship between inflation and economic growth, statistically significant at 5%.

The results reveal that under the full sample period ranging from 1961Q1 to 2019Q4, economic growth decreased by 0.149% for every 1% change in inflation in the long-run. The results of a long-run negative relationship between economic growth and inflation are well documented, both theoretically and empirically. Theoretically, these results are consistent with studies such as, among others, Okun (1971), Friedman (1977), Stockman (1981), Ball (1992) and De Gregorio (1993) while empirically in line with studies by Judson and Orphanides (1999), Grier and Grier (2006), Barro (2013) as well as Munyeka (2014) among others.

Interest rates show a significant long-run negative relationship with economic growth. Data shows that under the full sample period, for every 1% increase in interest rates, economic growth decreases by 0.234% in the long run. Theoretically, this is justified by the Keynesian transmission mechanism which explains that interest rates are negatively related with economic growth, through the decrease in investment spending. Muhammad *et al.* (2013) also theoretically argue that lower interest rates stimulate investment spending, and ultimately economic growth. Empirically, among others, Jordaan (2013) as well as Wuhan and Khurshid (2015) also obtained similar results.

However, unlike inflation rate and the interest rates, inflation uncertainty shows an insignificant long-run relationship with economic growth.

Panel B in Table 5.6 presents the short-run results. In the short-run, data proves that inflation has a short-run relationship with economic growth in South Africa. The short-run inflation coefficient for periods 1961Q1 to 2019Q4 is -0.1744. This implies that 1% increase in the rate of inflation attracts a decrease in economic growth of 0.1744%.

Although inflation uncertainty shows an insignificant long-run impact on economic growth, however, it nurtures a significant negative relationship in the short-run. This suggests that inflation uncertainty is a short-run phenomenon. The adaptive expectations theory by Friedman (1957) can be employed to justify this phenomenon on the basis that uncertainties in decision making by economic agents decrease over time. This implies that, in the long run, inflation uncertainty may lose relevance and significance as an economic variable. For every 1% increase in inflation uncertainty, data shows contraction in economic growth of 0.0025% in the short-run.

Data shows short-run results that conflict with long-run results for interest rates. In the short-run, interest rates positively impact economic growth. An increase of 1% in interest rates shows an economic expansion of 0.266% in the short-run. Theoretically, higher interest rates attract capital inflows, which stimulates economic growth. A positive impact of interest rates on economic growth found in this study is consistent with empirical findings from studies by, among others, Yang, Groenewold and Tcha (2000), Gumus (2015) as well as Fornah and Yuehua (2017).

The error correction term (ECM) which measures the speed of adjustment towards the long-run equilibrium was significant at 1%. The results show that 1% deviation from the equilibrium path in each quarter was corrected in the successive quarter at a rate of -0.36%.

5.3.4 Empirical analysis of ARDL-based results for the pre-inflation targeting period (1961Q1 – 1999Q4)

There was a policy change in 2000 when South Africa adopted the inflation targeting policy framework. It is therefore imperative that the full sample results are split into two subperiods with one focusing on the period before the policy change and the other one on the period under the new policy. Since the policy works on keeping the rate of inflation within the target range of 3 to 6%, this may reduce inflation uncertainty. This can be ascertained if the periods are split, and the impacts compared. Also, this assists in addressing the second and third objectives, which reads to (i) compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting and (ii) assess the effectiveness of inflation targeting in controlling inflation and inflation uncertainty in South Africa. Table 5.7 presents the regression results for the pre-inflation targeting period, spanning from 1961Q1 to 1999Q4.

Table 5.7: The long-run and short-run results for the pre-inflation targeting period 1961Q1 to 1999Q4.

1961Q1 – 1999Q4, Panel A: Long-Run Results Dependent Variable is Y				
Regressor	Coefficient	Standard Error	t-statistic	Probability
INF	-0.1937***	0.0615	-3.1502	0.0020
VOL	-0.0070	0.0046	-1.5247	0.1295

R	-0.2455***	0.0575	-4.2682	0.0000
1961Q1 – 1999Q4, Panel B: Short-Run Results Dependent Variable is ΔY				
Regressor	Coefficient	Standard Error	t-statistic	Probability
ΔY(-1)	0.0171	0.0749	0.2290	0.8192
ΔY(-2)	0.1679**	0.0743	2.2590	0.0254
ΔY(-3)	0.3247***	0.0694	4.6760	0.0000
Δ(INF)	-0.2543**	0.1155	-2.2016	0.0293
Δ(VOL)	-0.0046**	0.0019	-2.4573	0.0152
Δ (R)	0.2497*	0.1300	1.9206	0.0568
C	3.9806***	0.5491	7.2489	0.0000
ECM	-0.5145***	0.0689	-7.4708	0.0000

R-squared	0.7107	Mean dependent var	3.0875
Adjusted R-squared	0.6945	S.D. dependent var	3.0703
S.E. of regression	1.6971	Akaike info criterion	3.9531
Sum squared resid	411.8510	Schwarz criterion	4.1321
Log likelihood	-291.4340	Hannan-Quinn criter.	4.0258
F-statistic	43.9050	Durbin-Watson stat	1.9285
Prob(F-statistic)	0		

Note: *, ** and *** denote significance at 10%, 5% and 1% respectively; Δ is the first difference operator. Results are obtained using eViews software version 9.5.

Panel A in Table 5.7 shows long-run regression results for the pre-inflation targeting period. Inflation shows a negative long-run relationship with economic growth statistically significant at 1%. An increase of 1% in the rate of inflation contracted the economy by 0.1937% in the long-run during the pre-inflation targeting period. The repercussions of an increase in the rate of inflation on economic growth were more severe during the pre-inflation targeting era than under the full sample period.

The results for long-run inflation uncertainty under this period were also statistically insignificant, in consistency with the results for the full sample period.

Interest rates nurtured a statistically significant long-run relationship with economic growth. For every 1% increase in interest rates, an economic contraction of 0.2455% in the long run was experienced. This implies that monetary contractions costed long-run economic growth during this period. These results were also in consistency with the results obtained from the full-sample period.

Panel B in Table 5.7 presents the short-run results for the pre-inflation targeting period. The rate of inflation showed a negative short run relationship impact on economic growth, statistically significant at 5%. The results show that an increase in the rate of inflation by 1% resulted in an economic contraction of 0.2543% in the short run. The short run costs of inflation were severe during the pre-inflation targeting period as compared to the full sample results. Accordingly, an increase in the rate of inflation by 1% would result in an economic contraction by 0.2543% and 0.1937% in the short run and long run, respectively.

The results for inflation uncertainty under the pre-inflation targeting period further synthesised the notion that inflation uncertainty is a short-run phenomenon. Although inflation uncertainty was insignificant in the long run, however, the results show a significant relationship in the short run. An increase in inflation uncertainty by 1% resulted in a decrease in economic growth by 0.0046% in the short run.

As the case under the full sample period, interest rates showed a positive relationship with economic growth in the short run. An increase in interest rates by 1% attracted an increase in economic growth of 0.2497% in the short run. These results show consistency with those obtained for inflation, and parades economic consistency. Higher interest rates result in lower inflation, thereby promoting price stability. Therefore, one can equate high interest rates to low rates of inflation. Accordingly, the data shows that low inflation or high interest rates promote economic growth, proving consistency in the results.

The speed of correction after deviations from the long-run equilibrium shows an improvement under the pre-inflation targeting framework, as compared to the full sample period. Under the pre-inflation targeting framework, a 1% deviation from the equilibrium path in each quarter was corrected in the successive quarter at a rate of -0.5145%.

5.3.5 Empirical analysis of ARDL-based results for the inflation targeting period (2000Q1 – 2019Q4)

The period 2000Q1 marks the introduction of inflation targeting policy. The success of this policy is in its ability to reduce inflation uncertainty, while maintaining the rate of inflation within the targets of 3% and 6%. Accordingly, this sub-section therefore compares and analyses the joint impact of inflation and inflation uncertainty on

economic growth, before and under inflation targeting. Table 5.8 presents the regression results under the inflation targeting period.

Table 5.8: The long-run and short-run results for the inflation targeting period 2000Q1 to 2019Q4.

2000Q1 – 2019Q4, Panel A: Long-Run Results Dependent Variable is Y				
Regressor	Coefficient	Standard Error	t-statistic	Probability
INF	-0.4143***	0.1475	-2.8098	0.0064
VOL	0.0093	0.0061	1.5391	0.1282
R	-0.4081	0.2531	-1.6125	0.1112
Trend	-0.0735***	0.0174	-4.2346	0.0001
2000Q1 – 2019Q4, Panel B: Short-Run Results Dependent Variable is ΔY				
Regressor	Coefficient	Standard Error	t-statistic	Probability
Δ (INF)	-0.1504*	0.0876	-1.7177	0.0902
Δ (VOL)	0.0017	0.0014	1.2169	0.2276
Δ (R)	0.8751***	0.2062	4.2430	0.0001
C	2.9835***	0.4540	6.5711	0.0000
ECM	-0.2914***	0.0432	-6.7451	0.0000

R-squared	0.8787	Mean dependent var	2.6296
Adjusted R-squared	0.8686	S.D. dependent var	1.9638
S.E. of regression	1.7118	Akaike info criterion	2.2425
Sum squared resid	36.4842	Schwarz criterion	2.4525
Log likelihood	-81.5797	Hannan-Quinn criter.	2.3266
F-statistic	86.9359	Durbin-Watson stat	1.9083
Prob(F-statistic)	0.0000		

Note: *, ** and *** denote significance at 10%, 5% and 1% respectively; Δ is the first difference operator. Results are obtained using eViews software version 9.5.

Panel A in Table 5.8 presents the long-run regression results for the inflation targeting period. The long-run impact of inflation on economic growth is consistent under all three periods in the study. The long-run impact of inflation on economic growth remained negative even under inflation targeting. Comparing the pre-inflation targeting period (1961Q1 to 1999Q4) to the inflation targeting era (2000Q1 to 2019Q4), the long-run repercussions of inflation on economic growth are more severe under the inflation targeting era than under the pre-inflation targeting era. Data shows, under the inflation targeting era, a 1% change in the rate of inflation results in a 0.414% decrease in economic growth in the long-run, which is higher than the impact of -0.194% under the pre-inflation targeting era.

Inflation uncertainty remained insignificant in the long-run under all three periods in the study. This implies that inflation uncertainty does not have any long-run bearing on economic growth in South Africa.

Although interest rates are statistically significant in the long-run under the full sample period and the pre-inflation targeting period, however, they turned insignificant, hence failing to explain long-run economic growth dynamics under the inflation targeting framework. The main policy instrument for inflation targeting in South Africa is the repo rate, which is a short-term interest rate. This may explain the insignificance of the long-run relationship between interest rates and economic growth in South Africa under the inflation targeting framework.

Data for the inflation targeting period shows the presence of a trend, which justified the inclusion of a trend-variable in the data. The trends could have been eliminated using natural logarithms, however, the presence of negative observations in economic growth and inflation data rendered this impossible. IHS Global Inc (n.d) warns that ignoring a trend may lead to spurious regressions problems. The trend co-efficient obtained shows a contraction in economic growth by 0.0735% per season (per quarter, in this study). Periods of economic contractions, such as the 2007/8 financial recession may explain this trend.

The short-run regression results are presented in Panel B of Table 5.8. Although the results shows that the long-run impact of inflation on economic growth is more severe under the inflation targeting than under the pre-inflation targeting, the short-run impact of inflation on economic growth was, however, more severe during the pre-inflation targeting period as compared to the inflation targeting era. This is an indication that the adoption of inflation targeting eased the short-run impact of inflation on economic growth but attracted severe repercussions in the long-run.

Before the adoption of inflation targeting, inflation uncertainty was a significant variable in explaining short-run economic growth. After the adoption of inflation targeting, however, it lost its significance in explaining economic growth in the short-run. The lack of significance under inflation targeting can be attributed to the effectiveness of the inflation targeting policy in taming down inflation uncertainty to levels insignificant enough to explain short-run economic growth dynamics.

Interest rates, consistent with the other periods, shows a short-run positive relationship with economic growth under inflation targeting. An increase in interest rates of 1% attracts an increase in economic growth of 0.8751%.

The speed of correction after deviations from the long-run equilibrium is slower under the inflation targeting framework, as compared to the pre-inflation targeting period. This is shown by the Error Correction Term (ECM). Under the inflation targeting framework, a 1% deviation from the equilibrium path in each quarter is corrected in the successive quarter at a rate of 0.2914%. This is slower than the rate of 0.5145% under the pre-inflation targeting period. The lags in making decisions on the adjustment of the repo rate by the monetary policy committee can explain the slower rate of adjustment under inflation targeting as compared to the pre-inflation targeting period.

5.3.6 Post-estimation diagnostic and stability test results

Table 5.9 presents the post-estimation diagnostic and stability test results from the estimations for all the periods in the study. The table presents the probability values (p-values) of the test statistics, tested at 5% level of significance. All tests done yielded p-values greater than 5%, signalling absence of autocorrelation, heteroskedasticity and incorrect functional forms. This implies that the estimated ARDL models for all the periods are correctly specified, and the parameter estimates are unbiased.

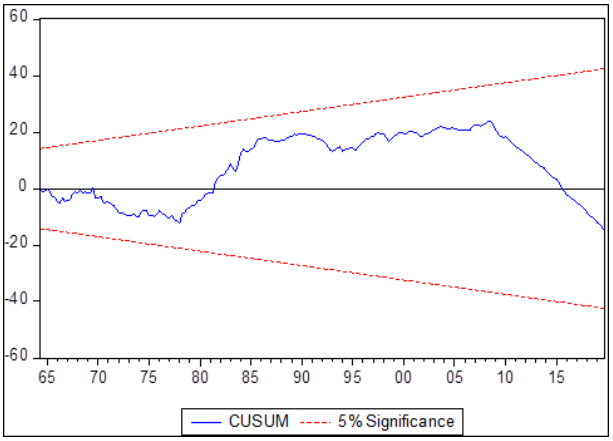
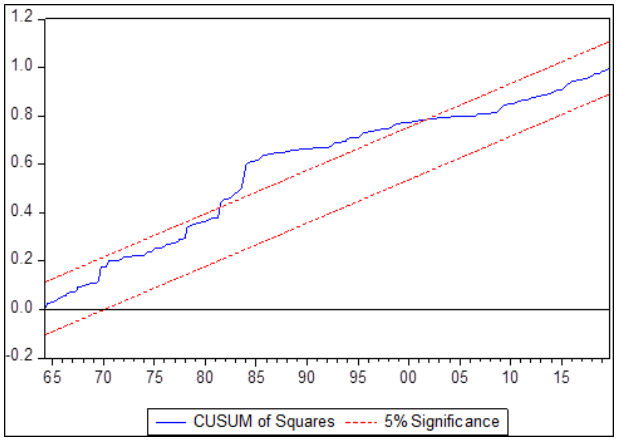
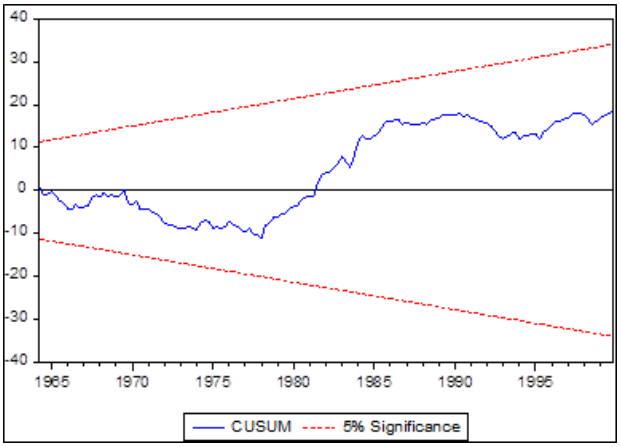
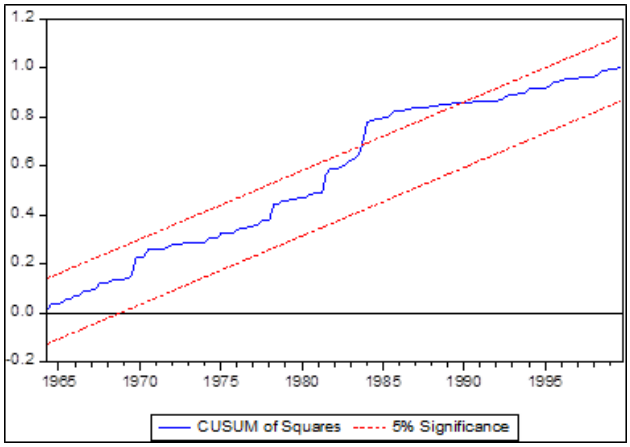
Table 5.9: Post-estimation diagnostic and stability tests

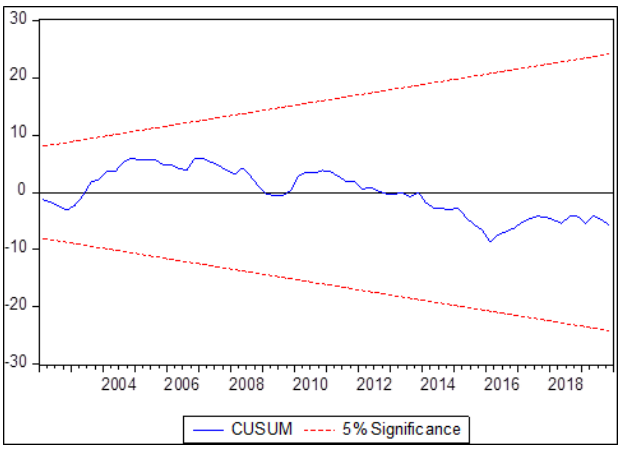
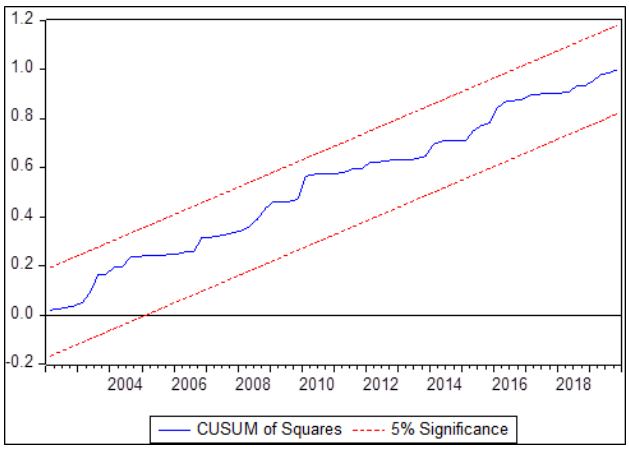
Test (Null Hypothesis)	**1961Q1 – 2019Q4**	**1961Q1– 1999Q4**	**2000Q1 – 2019Q4**
Breusch-Godfrey Test (No Autocorrelation)	0.0815	0.6504	0.9554
Breusch-Pagan- Godfrey Test (No Heteroskedasticity)	0.2211	0.1846	0.5584
ARCH Test (no ARCH terms)	0.0800	0.3201	0.5373
Ramsey RESET (Incorrect functional form)	0.7612	0.5111	0.8813

Table 5.10 presents the CUSUM and CUSUMQ results for the different periods in the study. For all the periods, the CUSUM passes the stability tests. This confirms parameter stability in the model. Although the CUSUMQ slightly deviates the upper

bound for the periods 1961Q1 to 2019Q4 and 1961Q1 to 1999Q4, however, it returns to the critical bounds of variance stability later. For the period 2000Q1 to 2019Q4, the CUSUMQ remains within the critical bounds. This confirms variance stability in the models.

Table 5.10: CUSUM and CUSUMQ Test Results

Period	**Stability Test**	
	CUSUM	**CUSUMQ**
1961Q1 – 2019Q4		
1961Q1 – 1999Q4		

2000Q1 – 2019Q4		

5.4 Conclusion

The primary objective of this chapter was to empirically examine the inflation, inflation uncertainty and economic growth nexus in South Africa. Accordingly, the ARDL cointegration techniques were employed to empirically address the objectives of the study. The chapter presented descriptive statistics of the variables, giving a historical background of the variables used in the study.

The second step was to test for stationarity. All the stationarity tests conducted were passed. The third step was testing for cointegration in the model. After showing evidence of cointegration, the study proceeded with employing ARDL bounds testing procedures. The study found that inflation harms economic growth in both the short- and long-run, consistently under all the periods estimated. Inflation uncertainty showed an insignificant long-run relationship with economic growth under all the periods in the study. For the periods 1961Q1 to 2019Q4 and 1961Q1 to 1999Q4, inflation uncertainty showed a significant negative short-run impact on economic growth. However, inflation uncertainty turned insignificant after adoption of inflation targeting.

The study passed the post-estimation diagnostic and stability tests conducted. This showed that the ARDL model estimations carried out in the study yielded parameter estimates that are consistent, efficient, unbiased, and correctly specified.

CHAPTER 6

CONCLUSION AND POLICY RECOMMENDATIONS

6.1 Introduction

This chapter concludes the study on the inflation, inflation uncertainty and economic growth nexus in South Africa by providing a synopsis of the study. A summary of the study is provided in Section 6.2. Section 6.3 presents a summary of the empirical findings of the study, followed by recommendations for policy in Section 6.4. In closing, Section 6.5 presents limitations and suggested areas for future research.

6.2 Summary of the study

In this study, the inflation, inflation uncertainty and economic growth nexus in South Africa has been examined. In order to achieve that, this study pursued four specific objectives. First, it explored the dynamics of inflation, inflation uncertainty and economic growth in South Africa from 1960 to 2019. Second, it reviewed and analysed the theoretical and empirical literature on the inflation, inflation uncertainty and economic growth nexus. Third, it examined the short- and long-run impact of inflation and inflation uncertainty on economic growth in South Africa. Finally, it compared and analysed the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting.

The study focus was inflation, inflation uncertainty and economic growth in South Africa. The choice of focusing on South Africa was justified on two reasons. The first reason is the South African financial sector's influential role and presence in Africa. Second, its dominating influence and significance as a member of the Common Monetary Area where currencies are pegged one-for-one to the South African Rand and adoption of its monetary policy by member states. This anchors the inflation and inflation uncertainty variables of those member states to South Africa's, giving this study an extension over the variables in those member states.

To achieve the first specific objective, which is, to explore the dynamics of inflation, inflation uncertainty and economic growth in South Africa from 1960 to 2019, the study

gave a critical assessment of the dynamics of inflation, inflation uncertainty and economic growth in South Africa under Chapter Two. Chapter Two presented episodes of inflation, inflation uncertainty and economic growth for South Africa from the year 1960 until 2019. Although the study estimation starts from 1961Q1, Chapter Two starts its analysis from 1960 since the policies that determined the trends from 1961Q1 ran from 1960. Inflation and inflation uncertainty dynamics were analysed in line with the monetary policy regimes that South Africa adopted from 1960 to 2019. The trends showed that inflation and inflation uncertainty were more rampant before inflation targeting than they were under inflation targeting. Economic growth dynamics were analysed in line with major events such as the apartheid policy, economic embargoes on South Africa and the 2007/8 global financial recession, among others, which South Africa went through, as well as government policies, such as GEAR, ASGISA and NGP. Economic growth reached its lowest point in response to the 2007/8 global financial recession, and economic growth has hardly breached the 3% mark since then.

To achieve the second specific objective, which is, to review and analyse the theoretical and empirical literature on the inflation, inflation uncertainty and economic growth nexus, the third chapter presented the theoretical and empirical literature review. The theory explaining the relationship between inflation and economic growth was drawn in line with the economic schools of thought, dating as far back as the classical growth theory up to the New Keynesian school. The different schools draw different conclusions on the relationship between inflation and economic growth. Theoretical underpinnings from different scholars were also reviewed on the impact of inflation and inflation uncertainty on economic growth, also pointing to ambiguous conclusions without a definite answer. Empirical evidence further fails to provide a monotonic relationship among the variables. Different scholars pinned the differences in empirical results on the appropriateness of the estimation methods, the length of time under the study, the data frequency, and the variable under the studies, among other reasons. The study, therefore, enriched literature through a review of both the theoretical and empirical literature on the variables, including focus on the empirical literature on South Africa.

It is against this background that this study intended to estimate the nexus among the variables. Chapter Four explains the methodology used in the study. The study used an estimation method unique from previous studies done for South Africa on the nexus among the variables – the ARDL estimation method while applying it on a longer time span ranging from 1961Q1 to 2019Q4, and uniquely estimating the joint impact of the rate of inflation and inflation uncertainty on South African growth. Furthermore, the study carefully splits the full sample data between the pre-inflation targeting period data (1961Q1 to 1999Q4) and the inflation targeting period data (2000Q1 to 2019Q4). The motive behind this was to compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting.

Chapter Five addresses the third and fourth objectives of the study. The third objective aims to examine the short- and long-run impact of inflation and inflation uncertainty on economic growth in South Africa while the fourth objective aims to compare and analyse the joint impact of inflation and inflation uncertainty on economic growth, before and under inflation targeting. Chapter Five presented the econometric analyses and derived empirical findings for the study from the data. This chapter built up from the groundwork laid down in Chapter Four. The study (in Chapter Five) used the ARDL estimation techniques introduced by Pesaran and Shin (1999) and later modified by Pesaran, Shin and Smith (2001) to empirically evaluate the inflation, inflation uncertainty and economic growth nexus in South Africa. The study began by presenting the descriptive statistics of the variable used in the study. Since the ARDL estimation technique requires that variables be integrated of either at level or of order one, therefore, ADF and DF-GLS unit root tests were conducted. The results conducted provided the basis for continuation with the ARDL estimations. The study then examined the short- and long-run impacts of inflation and inflation uncertainty on economic growth in South Africa, whilst also giving a comparison and analysis of the joint impacts of inflation and inflation uncertainty on economic growth, before and under inflation targeting. Chapter Five then concluded with the diagnostic tests as well as the stability tests. The details of empirical findings from Chapter Five are presented under Section 6.3. Chapter Five then lays the base for this current chapter, Chapter Six, which concludes the study.

6.3 Summary of the empirical findings

The study revealed the following main empirical findings:

1) Inflation has a significant negative short-run and long-run impact on economic growth in South Africa. This implies that high rates of inflation harm economic growth, both in the short-run and in the long-run. The negative relationship was consistent for all the periods in the study.
2) Inflation uncertainty does not have a significant long-run relationship with economic growth in South Africa. However, the short-run relationship is negative in the full sample period and the pre-inflation targeting results.
3) Interest rates, which were introduced as a control variable, have a significant short-run positive impact on economic growth. However, interest rates show a significant negative long-run impact on economic growth under the full sample data and the pre-inflation targeting period, but an insignificant long-run relationship after the adoption of inflation targeting.
4) The repercussions of high inflation on economic growth decreased in the short-run but increased in the long-run after the adoption of inflation targeting. This is evident by the decrease in the absolute value of the short-run inflation coefficient from 0.2543 (before the pre-inflation targeting) to 0.1504 (under inflation targeting), and an increase in the absolute value of the long-run inflation coefficient from 0.1937 (before the pre-inflation targeting) to 0.4143 (under inflation targeting).

6.4 Recommendations for policy

Some recommendations for policy can be derived from the empirical findings presented in Section 6.3. South Africa has a background marked with high levels of inflation rates, and low economic growth. Faced with high income inequality and poverty, low economic growth exacerbates the already high levels of unemployment in South Africa. Knowledge of the impact inflation and inflation uncertainty has on economic growth assists in informing the South African central bank, The South African Reserve Bank, on the policy approach to adopt on inflation and inflation uncertainty. It also assists in choosing the macroeconomic policy goals to achieve.

The empirical results show that the rate of inflation in South Africa negatively impacts economic growth in both the short- and long-run. This implies that higher rates of inflation apply brakes to efforts that are applied to stimulate economic growth, in both the short-run and the long-run. This finding debunks the proposition of the existence of price stability and economic growth trade-off in South Africa. Moreover, the trends observed in Chapter Two of this study further show that South Africa experienced low economic growth during the periods preceding high rates of inflation. Accordingly, this study recommends policymakers in South Africa to adopt or maintain policies that ensure inflation is kept under control to create a conducive environment for short-run and long-run growth. In the same vein, the study further recommends continued application of the inflation targeting policy by the SARB since it is an inflation-centred policy that prioritises price stability.

The evidence in the study suggests that inflation uncertainty does not nurture a relationship with economic growth in the long run in South Africa. However, there is evidence of a negative relationship between inflation uncertainty and economic growth in South Africa. This implies that inflation uncertainty is a short-run phenomenon, and not a long-run phenomenon, in the case of South Africa. The study therefore recommends keeping inflation uncertainty under control in South Africa to assist stimulated short-run growth. Inflation targeting, which ties the rate of inflation within the 3 to 6% range, limits uncertainty about inflation since the variance of inflation is limited to vary within the targets.

Although the empirical findings show evidence that high rates of inflation and inflation uncertainty harms economic growth, however, the economic growth trends drawn in Chapter Two in line with the economic policies and events show that hardly any of the economic policies by government were successful in stimulating economic growth. The government must devise measures and policies to stimulate economic growth whilst allowing the SARB commit to fighting inflation and inflation uncertainty. The government should also further adopt economic policies that cushion the economy from the effects of economic crises, such as the COVID-19 pandemic.

6.5 Limitations and suggested areas for future research

Although significant efforts have been made to ensure that the study is empirically defensible, a few limitations may have affected the study, as is the case with many scientific research studies. One of the limitations is on the choice of proxy on inflation uncertainty. Inflation uncertainty can be measured ex-ante, that is, before the period of inflation has passed; or ex-post, which is measured before the inflation period has occurred. Data for ex-ante inflation uncertainty is not easily and readily available in South Africa, as compared to ex-post inflation uncertainty. Ex-ante inflation uncertainty takes the form of consensus generated from the forecasts by leading economists and renowned economics institutions or survey data. This study opted for ex-post data, which is authoritative since it is derived from the official data. However, Abel, Rich, Song and Tracy (2016) find a weak correlation between ex-post and ex-ante inflation uncertainty data. It would be of interest to also compare the results in this study with future studies that use ex-ante data for inflation uncertainty.

Another limitation is on the frequency of the data. Although this study used a considerably longer time span, covering four decades ranging from 1961Q1 to 2019Q4, however, parameter precision could have improved immensely had monthly data been used. Instead, South African data for Gross Domestic Product is limited to quarterly and annual data only, and no monthly data is available. The study, therefore, had to resort to quarterly data. It would be interesting to compare the results in this study with future studies that use monthly data.

This study captured inflation uncertainty using the standard deviation of the inflation rate expressed as a percentage. While this measure captures the anticipated effects of inflation uncertainty on economic growth, however, it does not capture the unanticipated effects of inflation uncertainty on economic growth. Anticipated effects of inflation can be controlled using policies such as the inflation targeting policy, while it may not be the case with the unanticipated effects of inflation. It is therefore, recommended that apart from the anticipated effects of inflation uncertainty, future studies should also consider the effects of unanticipated effects of inflation uncertainty on economic growth in South Africa.

Lastly, in the wake of the Covid-19 pandemic that has disrupted production through economic lockdowns whilst imposing strains on governments, this study recommends further studies on the impact of pandemics and natural disasters on the inflation, inflation uncertainty and economic growth nexus. Covid-19 has also caused economic uncertainties and policy disruptions. Future studies should also assess the effectiveness of inflation targeting policy during the turbulent times of a pandemic.

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