



## Inflation Targeting and Economic Growth in South Africa – An Econometric Analysis

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**Abstract:** The article aims at analyzing the influence of inflation on economic growth in South Africa using quarterly data spanning from 2000-2018. The paper focuses on quantitative research, exploratory research design and a positivism research philosophy with the variables of the consumer price index, inflation, gross domestic product, interest rate and unemployment. The data set comprises quarterly data from 2000 to 2018, extracted from the Statistics South Africa (Stats SA) website and also from the South African Reserve Bank (SARB). The Augmented Dickey-Fuller, Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests were conducted. The serial correlation, diagnostic tests, normality test and heteroscedasticity passed expectations of the assumptions. The optimal lag selection was carried out by means of the Akaike Information Criterion (AIC) and the optimal lag length of two was selected. The existence of long-run equilibrium amongst the variables was tested using the Johansen co-integrated test. The VECM results showed that GDP is explained by lagged values of GDP, inflation and the consumer price index control variable in the short run. The relationship between economic growth and inflation targeting found to exist. The analyses in this paper reflected that there is a long-run relationship between inflation targeting and economic growth in South Africa. The study suggests that the monetary policy should be formulated with measures that are innovative to stabilize the exchange rate at a level that can be sustained. Further, the study recommends that the government of South Africa should continually align its economic policies and maintain control measures over the fiscal policy for sustainability.

**Keywords:** consumer price index; monetary policy; interest rate; inflation targeting; fiscal policy; gross domestic product; South Africa

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## 1. Introduction

This paper examines how inflation impacts the growth of the South African economy. Mashele (2012) describes inflation targeting as the method whereby there is an uprising of prices with the increase of the price index percentage, while Issing (2004) had argued that inflation targeting is a monetary policy framework that influences the uprising of the price stability maintenance, which can be seen as the decrease and steady rate of consumer price inflation.

South Africa adopted inflation targeting monetary policy framework in 2000 to ensure the stimulation of economic growth. Inflation targeting produces a low stable inflation environment in terms of economic growth and as Bax (2010:8) explains, South Africa has established a macroeconomic policy with a specific target. The objective of this macroeconomic policy, known as monetary policy, is to ensure that the inflation target is at a low rate to create a conducive environment. For economic growth to be influenced by the inflation target, policymakers have to aim for low inflation rates. Though low inflation may not be sufficient for economic growth, it is necessary. Inflation targeting can influence economic growth if it goes through higher growth and price inflation remains within the targeted levels.

Inflation targeting has both a negative and positive influence on economic growth. The advantage of inflation targeting is that it provides the official announcements of yearly targets that a monetary policy committee uses to determine achievement over a certain period (Wyngaard, 2019). The inflation target improves the relationship between economic policies and monetary policy with the provision that the objectives are consistent. Inflation targeting delegates' accountability to the central bank, since the central bank has a responsibility to explain any deviations of the inflation rate from the target. Furthermore, inflation targeting reduces inflationary expectations. Inflation harms economic growth and inflation targeting has been the subject of criticism in different ways (Kuttner, 2004). Such criticism includes the inflexibility of inflation targeting and its neglect of output stabilisation. The inflexibility of inflation targeting gives the central bank the ability to only focus on the central bank's objective, such as financial stability.

There has been an increase in the inflation rate for the last months of 2019. The annual inflation rate ascended to 4% in December 2019 from 3.6% in November, twinning market expectations. The cost of non-alcoholic beverages and food increased from 3.5% in November to 3.9% in December (SARB, 2019). This study aims to determine the influence that inflation targeting on economic growth in South Africa. The paper elaborates the problem statement, background and objectives of this study.

## **Problem Statement**

South Africa has shown a low rate of economic growth and an increased rate of unemployment, approaching 29.1%, during the third quarter of 2019. According to Wyngaard (2019:5), South Africa experienced a credit downgrade in March 2017 due to volatile exchange and inflation rates.

The *'junk status contributed* to a rise in economic uncertainty, which led to the question as to how South African inflation targeting is influencing the economic growth of the country. The downgrade also raised questions of whether the monetary policy should be converted to an approach of growth targeting, regarding which then Finance Minister, Pravin Gordon, introduced a new tax in 2017 on products such as sugar and the increment of income tax levels (National Treasury, 2017:43).

The increase in prices and taxes has led to a decrease in consumer demand and contributed towards a negative influence on economic growth. Though consumer price inflation came to 4.1 per cent in the third quarter of 2019, the economic growth is projected to slowly rise to 1.7 per cent in 2022 (National Treasury, 2019).

## **Objectives of the Study**

The theoretical objectives of the study include:

- 1) To investigate whether inflation targeting monetary framework objective encounter challenges on the steady price increases, on high and steady long-term economic growth in South Africa.
- 2) To analyse a trend of post-apartheid on the influence of inflation targeting on the economic growth in South Africa.

## **2. Literature Review**

The paper delves into the theories of inflation and economic growth and how these are interrelated, it is worthwhile to conceptualise and discussed the two terms.

### **2.1. Inflation Targeting**

Inflation is considered to be a monetary phenomenon that is addressed through the use of monetary policies by the government and has a significant impact on money supply, the unemployment rate and economic growth (Ruzima & Veerachamy, 2016:19). Akinsola and Odhiambo (2017:42) consider inflation to be the continuous increase in the general level of prices for services or goods over time. This corresponds to the view of Idalu (2015:1) who submitted that inflation can be defined

as the increase in prices sustained over a certain season within the growth of the economy leading to a drop in currency purchasing power. Umaru and Zubairu (2016:21) categorise inflation into low inflation (1%-2% to 5%), moderate inflation (5% to 25%), chronic inflation (15% to 30%) and high inflation (30% to 50%), extremely high inflation growth (50 % to 100%) as well as hyperinflation (which goes beyond 100%).

According to Idalu (2015:2), when the central bank affects a specific rate of inflation as a monetary policy, the process is called inflation targeting. Mashele (2018:112) considers inflation targeting as a process where prices rise while increasing the rate of the price index. The aforementioned adds that inflation targeting influences the transparency of the policy, accountability and predictability of money. Akinsola and Odhiambo (2017:43) argue that inflation targeting represents a monetary policy framework that impacts the price stability, which translates into a low and stable consumer price inflation rate.

## **2.2. Benefits of Inflation Targets**

### *Avoid Boom and Bust*

Most economic cycles may be attributed to a lack of discipline (Marcus, 2015:6). A high inflationary growth is unsustainable and lead to a recession. With an inflation target, there is better monetary policy discipline as it is not too loose. For example, inflation was left to creep upwards in the UK around 1980, in response to high growth, which ended up in a boom that turned into a recession in the early 1990s (Alina & Stone, 2016, p. 302).

### *Reduce Costs of inflation*

Rising inflation creates several economic negatives that include uncertainty triggering lower investment, weak competitiveness and a fall in the value of savings (Debelle, 2017, p. 26). When the central bank maintains inflation within the target, such costs are avoided as the maintenance provides a framework for continued economic growth.

## **2.3. Challenges of Inflation Targets**

### *Limited guide to the economy*

The central banks could disregard more demanding problems. The desire to use monetary policy to maintain inflation on target may downplay the costs associated with rising unemployment (Debelle, 2017, p. 26). The aforesaid goes on to explain by way the example of how the European zone went into a double-dip recession in 2011/12 when regulators remained remarkably unconcerned and fixated on the

significance of low inflation. In a liquidity trap, according to Marcus (2015:7), it is crucial to target a higher rate of inflation to counter deflationary pressures.

#### *Inflation targets are limited*

Inflation targeting may well be able to maintain low inflation, but can be problematic in the event of a housing bubble, credit bubble and growth in consumer spending (Alina & Stone, 2016:304). It can disguise an asset, banking boom and bust, which indicates that low inflation is not a sign of underlying stability (Comert & Epstein, 2016:97). In addition, there are differences between the Consumer Price Index and Core Consumer Price Index of which the former can be greater than the actual inflation that excludes unstable prices, for example, food (Alina & Stone, 2016, p. 304).

## **2.4. Economic Growth**

Musasiwa (2015:52) defines economic growth as the increase in capacity of an economy to produce goods or services from one season to the next and is expressed in a nominal or real rate, with the latter having been adjusted for inflation. Mashele (2018:113) opines that economic growth is driven by factors of production, such as capital, and can be measured by the GDP. According to Katsikeas (2017:68), economic growth is the market value of goods or services produced by an economy within a given period. Oliphant (2017:22) argues that economic growth does not exist in isolation considering the dependence of regions on each other, which affects the price of one currency against the other. Such dependence has a substantial effect on the growth potential of the economy.

### **Factors affecting economic growth**

#### *Technological Development*

This era has witnessed technology becoming the most significant influence on economic growth. Dullabh (2014:26) concurs, stating that countries that introduced technology have experienced high economic growth. Through technology, scientific methods are employed in the process of manufacturing and production (Ductor & Grechyna, 2015:393). In this way, the development of technology enhances output even when resources are limited, as there is increased accuracy and efficiency.

#### *Capital Formation*

This comprises machinery, land, transportation, communication and power (Jouini, 2015:341). Capital formation is the process of acquiring and producing these factors, deemed to influence the availability of capital per worker (Modingwane, 2016:12). If capital per labour is increased, labour productivity subsequently increases as well as economic growth and output.

*Social and Political Factors*

The government may interfere with economic growth through the formulation of various policies related to political factors (Dlamini, 2016, p. 11). The country's ability to trade and Foreign Direct Investment depends on government policies, such as indigenisation and protectionist policies. These policies influence the growth of the economy as they may deter trade or investment. Customs, traditions, beliefs and values fall under social factors that affect economic growth (Jouini, 2015, p. 343). For example, the traditional beliefs of the Bushmen community in South Africa that discourage adopting new ways of living and modern technology negatively affect economic growth (Jouini, 2015, p. 343).

**2.5. Inflation Theories***Keynesian Theory*

The Keynesian theory is one of the key inflation theories. The Keynesian theory involves the aggregate supply and demand curves that indicate the connection between inflation and growth. According to Dullabh (2014:26), aggregate demand (AD) refers to the total amount of goods and services required in the economy whereas aggregate supply (AS) represents the total goods or services that can be supplied. In the short run, the AS-Curve going upwards rather than upright becomes an issue. The upward slope of the Keynesian curve has implications for the changes in demand, which affects output and prices (Ductor & Grechyna, 2015, p. 393).

*The money and monetarism*

Mokgola (2015:79) contends that monetarists consider a positive relationship to exist between inflation and output growth in the short-run, while there is no effect aside from the general price increase in the long run. The Phillip's curve interpretation is thus different from the Keynesians. Mashele (2018:120) describes the quantity theory of money, emphasising the long-run approaches of neutrality of money. Mokgola (2015:79) however asserts that wage inflation cannot be described by one variable and that unemployment cannot be viewed as wage inflation.

Based on the above, inflation targeting can trigger a decrease or increase in economic growth and the unemployment rate in South Africa. The SARB (2015:28) concurs that inflation has a negative impact on society and the economy.

## 2.6. Economic Growth Theories

### *Endogenous growth theory*

The endogenous theory of Paul Romer (1986) espouses that a national economy capital is either constant or rises according to economic growth when factors of production are maintained. These factors of production include increased capital, developing technology and economies of scale. The endogenous theory was motivated by the shortcomings of the neoclassical model of economic growth. The endogenous growth theory is based on the Romer-Lucas growth model that emphasises the capital accumulation process. The accumulation of capital goods for purposes of generating consumer goods allows workers to use and modify technical machines, which leads to technological advancements. The theory further suggests that the technical advancement of capital accumulation does not create any diminishing returns of output. The theory shows benefits from the perspective of trade in developing nations as opposed to countries developing with established technologies.

### *Classical Growth Theory*

Adam Smith formulated the classical growth theory in 1789. It is determined by factors that include capital, labour, output and technology. The main variables influencing the classical growth model are productivity, land and population growth. The model is linked to increases in investment that influence the economic growth rate based on the increase of capital labour. The marginal products are assumed to decrease, making the economy drawback to a long-term growth path (Mokgola, 2015:74). The real GDP increases at the same time as the growth of labour.

### *The Solow-Swan Growth Model*

Mashele (2018:117) considers the Solow-Swan growth model to include variables that determine the state-equilibrium level of economic growth. The variables include population growth, investment proportion and technological progress. The Solow-Swan model emphasises that developing countries should collaborate with developed countries for high economic growth (Mokgola, 2015:75), making it a theory-driven by capital-output ratio and savings.

## 2.7. Inflation Targeting and Economic Growth Model

### **The Phillips Curve**

According to Montoriol-Garriga (2015:42), the Philips curve is the theoretical framework employed in analysing inflation dynamics over the short term. It relates inflation to the economic output gap (the difference between actual and potential

production). The relationship spells that the inflation rate will be stable if the actual GDP equates to the potential GDP (Mashele, 2018:118). Mashele (2018:118) adds that the deviations in actual production are more likely to result in deflationary or inflationary pressure. Phillips (1958), the British economist, related the wages growth to the unemployment rate and submitted that when labour is underutilised, there are fewer wage increases (Montoriol-Garriga, 2015:42). Coibion and Gorodnichenko (2014:32) uncovered that the trade-off of higher inflation results in lower unemployment. This has, however, been contradicted by other economists who feel that leaving the inflation target to increase makes inflationary pressures to be engrained and lose of monetary policy credibility (Edwin, 2017:13).

Low inflation, drawing from the Philips curve, can best be explained as an output gap in economies (Mashele, 2018, p. 116). Above and beyond the output gap, there are other various factors that keep inflation down, such as reducing nominal wages. Inflation is also less sensitive to the economic cycle (Montoriol-Garriga, 2015, p. 42). Montoriol-Garriga (2015, p. 42) adds that fixing inflation expectations through anti-inflationary policies help to keep inflation expectations anchored. Firmly fixed inflation expectations result in smaller cyclical price variabilities.

Coibion and Gorodnichenko (2014) note that when the economy is operating below capacity, an upsurge in aggregate demand can cause a reduction in higher inflation and unemployment. This trade-off is considered short-term to occur in by the Monetarists Daly and Hobijn (2015), whereas Keynesians argue that boosting aggregate demand could lead to a modest inflation increase and lower unemployment. According to Daly and Hobijn (2015), the Bank of England tolerated an inflation level above the target of 2% in 2013 arguing that reducing inflation would cause serious economic growth and unemployment problems.

### **3. Methodology**

The research follows a quantitative research method to quantify, describe and examine the influence of inflation targeting on the growth of the South African economy. Quantitative research facilitates confirmation and validations of the information collected during the course study. It is also more objective than qualitative data and hence, the adoption of this approach (Terre Blanche & Durrheim, 2016, p. 145).

#### **3.1. Data Description**

Time series data is used to examine the influence of economic growth in South Africa for the period of 2000 to 2018, with the usage of 76 quarterly observations. According to Mohr and Fourie (2008:509), Gross Domestic Product (GDP) is a



traditionally used reference point for measuring economic growth levels, thus the study uses real GDP as a measurement of economic growth. Unemployment is one of the variables used in the study. Mishkin (2018:54) considers unemployment a socio-economic problem that is related to economic wellbeing, which supports the view of Ductor and Grechyna (2015:393) that unemployment is a global problem. Interest rate is related to inflation targeting and economic growth as opined by Taylor. The link, according to Mishkin (2018:54), occurs when the SARB calculates the optimal inflation combination under the Phillips curve. This rate is also called the repo rate, which is determined by SARB.

The consumer price index (CPI) refers to a regular measurement, say monthly, of the prices for the bulk of household goods or services (Brito & Bystedt, 2015, pp. 198). According to Bousrih (2015:1), the CPI denotes the prices of a cross-section of services or goods commonly purchased by urban households and is centred on establishing inflation when prices rise and deflation when they fall.

The study's sample period begins from 2000 to 2018 to ensure that the optimal performance of the monetary framework since inception is captured. The study examines six variables, that is, the Interest rate, GDP, inflation, unemployment and Consumer Price Index (CPI). The data for these variables are all derived from the South African Reserve Bank (SARB) database and the World Bank. In conducting the analysis, the statistical software Econometric package, Eviews Enterprise Edition 11 was used.

### 3.2. Model Description

The study took into consideration the use of the dynamic model approach. This approach enabled the correlation of variables included in the study, which ensured that the changes in one or multiple variables affected on the other variables at a certain time.

Econometric approaches focus on the quantitative approach, which supports the method of the economic world. The study used the econometric model according to the following formula:

$$Y_z = f(X_z S_z R_z D_z)$$

The model simplifies to:

$$Y_z = \beta_0 + \beta_1 X_1 + \beta_2 S_z + \beta_3 R_z + \beta_4 D_z + \epsilon_t$$

Where

$Y_z = \text{GDP}$

$X_z = \text{Inflation}$

$S_z$  = Interest Rate

$R_z$  = Unemployment

$D_z$  = Consumer Price Index

### **The Economic estimation approaches used in the study**

The econometric approaches used in the research study are related to quantitative approaches, which is a supported method in the economic world. According to Wyngaard (2019:74), the functionalist approach elaborates further on the investigation of social and economic dynamics. In the event that the variables co-integrated, the vector error correction model (VECM) was used to analyse the interaction between economic growth, inflation, unemployment, interest rate and the consumer price index. The VECM is an econometric framework that incorporates structural equation modelling, which is used to capture linear interdependencies in multivariate time-series models. This model is an extension of a basic VAR where each equation is an auto-regression plus distributed lag, with  $p$  lags of each variable included in the model. The methodology of the study examines by using the econometric analysis tool E-views Enterprise Edition 11 the variables of interest, namely: inflation targeting, economic growth and unemployment.

## **4. Findings and Discussion**

This paper specifically focuses on the presentation of the results of the econometrics analysis. A VECM dynamic model was used to achieve the empirical objectives of the research study. Gross domestic product (GDP), inflation (INF), interest rate (IR), unemployment (UN) and the consumer price index (CPI) are the variables under consideration in this study. This paper begins by graphically representing the variables over time. Necessary econometric methods, such as stationarity tests and the unit root, were done by using the augmented Dickey-Fuller (ADF), Phillips-Perron, Kwiatkowski and Phillips, Schmidt and Shin (KPSS) stationarity test. The co-integration test was carried out after determining the stationarity of variables. The VECM results for both the short run and long run were presented. Thereafter, residual diagnostic tests were conducted and finally, stability analysis was done using CUSUM and CUSUMQ.

### **4.1. Correlation Matrix Results**

The figures displayed in Table 1 report correlation matrix results alongside the corresponding t-statistic and values of the probability of each variable of the research study. The results should in seen therein that the strength of the correlation existing

between the variables is determined by a quantitative approach showing that the coefficients are correlated.

In other words, the relationship between variables is controlled by the estimation of the correlation coefficient, ranging from -1 to 1. Where the relationship coefficient with a value adjacent to -1 shows a strong inverse or negative linear correlation, while a relationship coefficient with a value adjacent to another demonstrating a solid positive linear relationship between the variables. On the other hand, when a relationship coefficient is zero, it demonstrates that there is no association or connection between the variables. This would not justify for further examination of that relationship.

**Table.1. Estimated Correlation Matrix Results**

Variable	GDP	INF	IR	UN	CPI
<b>GDP</b>	1				
<b>INF</b>	-0.5419 [0.0410]*	1			
<b>IR</b>	-0.708456 [0.0461]*	0.683157 [0.0041]*	1		
<b>UN</b>	-0.267811 [0.3448]	0.074017 [0.6130]	0.030299 [0.048]*	1	
<b>CPI</b>	-0.142102 [0.3481]	0.826145 [0.0015]*	0.688450 [0.0051]*	-0.165213 [0.6563]	1
Note: [ ] indicates P-values (* ) P-value significant at 5% significance levels					

Correlations between GDP and INF,  $r(76) = -0.5419$ ,  $p < 0.05$ , INF and IR ( $r(76) = 0.6831$ ,  $p < 0.05$ ), INF and CPI ( $r(76) = 0.826$ ,  $p < 0.05$ ), IR and CPI ( $r(76) = 0.6884$ ,  $p < 0.05$ ), IR and UN ( $r(76) = 0.003$ ,  $p > 0.05$ ), GDP and IR ( $r(76) = -0.7084$ ,  $p < 0.05$ ) showed significant correlation results. However, GDP and UN ( $r(76) = -0.2678$ ,  $p > 0.05$ ), GDP and CPI ( $r(76) = -0.1421$ ,  $p > 0.05$ ), INF and UN ( $r(76) = 0.0740$ ,  $p > 0.05$ ), UN and CPI ( $r(76) = -0.1652$ ,  $p > 0.05$ ) were not statistically significant.

Source: Compiled by the researchers (Data from SARB& World Bank, 2000-2018)

Table 2. The (ADF) Test

Variables	At Level I(0)				At 1 <sup>st</sup> Difference I(1)				Results (order of integration) Order
	Without trend		With trend		Without trend		With trend		
	T-stat	P-value	T-stat	P-value	T-stat	P-value	T-stat	P-value	
<b>GDP</b>	0.44	0.81	-2.10	0.24	-2.22	0.03**	-2.48	0.12	I(1)
<b>INF</b>	-1.1	0.24	-4.10	0.00** *	-3.41	0.00** *	-3.39	0.01* *	I(1)
<b>IR</b>	-0.97	0.29	-3.04	0.04**	-2.62	0.01**	-2.62	0.09*	I(1)
<b>UN</b>	0.29	0.77	-1.82	0.37	-2.99	0.00** *	-2.99	0.04* *	I(1)
<b>CPI</b>	-1.15	0.23	-4.01	0.00** *	-3.22	0.00** *	-3.19	0.02* *	I(1)

(\*\*\*) The rejection of the null hypothesis of not stationary at the 1% significance level  
(\*\*) The rejection of the null hypothesis of not stationary at the 5% significance level  
(\*) The rejection of the null hypothesis of not stationary at the 10% significance level

The results presented in Table 2 shows that the variables were not stationary at the level at both without trend and with the trend. However, variables INF, IR and CPI were the only variable that was significant at level (with trend). At first difference, the variable GDP was not significant at the first difference (with trend), whilst the rest of the variables were significant. However, all the variables including GDP were found to be stationary at the first difference (without trend). Hence, the VECM model will utilise the ‘no intercept in VAR, no trend in data’ deterministic trend specification.

According to Ruzima and Veerachamy (2016:19), inflation is considered to be a monetary phenomenon that is addressed through the use of monetary policies by the government and has a significant impact on economic growth. Dullabh (2014:26) highlights that there is a positive connection of variables, such as the inflation rate (influence of inflation targeting) and the economic growth rate. Inflation is a key variable that is measured by the CPI as the greatest economic threat (Brito & Bystedt, 2015:198). Mokgola (2015:76) found that there is a link between unemployment and inflation in the short run.

Table 3. Phillips-Perron Test

Variables	At Level I(0)				At Level I(1)				Results (order of integration)
	Without trend		With trend		Without trend		With trend		
	T-stat	P-value	T-stat	P-value	T-stat	P-value	T-stat	P-value	
<b>GDP</b>	1.00	0.92	-1.44	0.55	-2.34	0.02**	-2.60	0.09*	I(1)
<b>INF</b>	-0.75	0.39	-2.51	0.12	-3.66	0.00***	-3.64	0.01**	I(1)
<b>IR</b>	-0.80	0.37	-1.89	0.34	-2.768	0.01**	-2.78	0.06*	I(1)
<b>UN</b>	0.11	0.72	-1.22	0.66	-3.16	0.00***	-3.15	0.03**	I(1)
<b>CPI</b>	-0.78	0.37	-2.45	0.13	-3.45	0.00***	-3.42	0.01**	I(1)

(\*\*\*) The rejection of the null hypothesis of not stationary at the 1% significance level  
(\*\*) The rejection of the null hypothesis of not stationary at the 5% significance level  
(\*) The rejection of the null hypothesis of not stationary at the 10% significance level

Source: Compiled by the researchers (Data from SARB & World Bank, 2000-2018)

The variables of GDP, INF, IR, UN and the CPI were all found not stationary at both levels, without trend and with the trend. At first difference (with trend) all the variables were stationary, INF, UN and CPI were stationary at a 1% level of significance whereas GDP and IR were significant at 5% level of significance. Moreover, at the first difference (without trend) all the variables were found to be stationary, GDP and IR were found to be stationary at a 10% level of significance, while INF, UN, and the CPI were stationary at the 5% significance level.

Table 4. (KPSS) Stationarity Test Results

Variables	At Level I(0)				At 1 <sup>st</sup> Difference I(1)			
	Intercept		Trend and intercept		Intercept		Trend and intercept	
	T-stat	Crit. Value	T-stat	Crit. Value	T-stat	Crit. Value	T-stat	Crit. value
<b>GDP</b>	0.87	0.46	0.87	0.74	0.16	0.46	0.07	0.14
<b>INF</b>	0.07	0.46	0.04	0.14	0.04	0.46	0.04	0.46
<b>IR</b>	0.51	0.46	0.06	0.14	0.06	0.46	0.05	0.15
<b>UN</b>	0.23	0.46	0.23	0.15	0.38	0.46	0.06	0.15
<b>CPI</b>	0.06	0.46	0.06	0.15	0.04	0.46	0.04	0.15

Source: Compiled by the authors (Data from SARB & World Bank, 2000-2018)

The above results are in line with the Phillip Perron and ADF unit root tests. The results of the KPSS shows that GDP and UN were not stationary at both “intercept”

and “trend and intercept” at I (0). The variables INF and CPI were stationary at I (0) both at “intercept” and “trend and intercept”. The variable IR was not stationary at “intercept” but stationary at “trend and intercept”. However, all the variables became stationary at I (1) at both “intercept” and “trend and intercept” after being differenced. Thus, the study can indeed move forward to make estimations.

#### 4.2. Lag Length Selection

According to Ogbokor (2015:23), the optimal lag selection serves to determine the number of lags to use. As can be seen from Table 4, the lag length selection criteria show a different lag selection. The LR test statistic (LR), final prediction error (FPE), Akaike information criterion (AIC) and Schwarz information criterion (SC) found lag two to be optimal lag. These lag selection techniques help to choose the best lag to use in the study. McCamel (2017:15) states that if the value of the AIC is lower, the model will be better and especially when the data is not fairly large. The two lags showed an appropriate lag in this study. The two of the lag length was applied both in VECM and co-integration.

**Table 5. Optimal Lag Selection**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-844.3923	NA	16935.52	23.92654	24.08589	23.98991
1	-257.2074	1075.127	0.00250	8.090351	9.046413	8.470546
2	-109.2026	250.1490*	7.11e-05*	4.625426*	6.378206*	5.322451*

Notes:

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

*Source: Compiled by the researchers (Data from SARB& World Bank, 2000-2018)*

#### 4.3. Cointegration

The Johansen co-integration procedure was utilised to test for the existence of a long-run relationship between variables of interests. The variables GDP, INF, IR, UN, and the CPI were included in the co-integration test since they were discovered stationary at first difference. Table 5 demonstrates the results of the trace test and maximum eigenvalue test. The co-integration test is utilised to determine whether the VECM would be appropriate. The null hypothesis for both the trace and maximum eigenvalue test states that there are no co-integrating relationships, while the alternative hypothesis for the trace is that there are more than zero relationships. The alternative hypothesis for the maximum eigenvalue test is that there is at least one

co-integrating equation. The test statistic is compared with the critical value and the null hypothesis is rejected if the calculated statistic is higher than the critical value.

**Table 6. Trace Test and Maximum Eigenvalue Test at the 5% Significance Level**

Co-integrating Equations	Trace Test				Maximum Eigenvalue Test			
	Eigen value	Statistic	Critical Value	Prob	Eigen value	Statistic	Critical Value	Prob.
None*	0.40261	95.07245	69.81889	0.0001	0.4026	36.0639	33.87687	0.0270
At most 1*	0.33460	59.00847	47.85613	0.0001	0.3346	28.5157	27.58434	0.0379
At most 2*	0.24446	30.49707	29.79707	0.0415	0.2446	19.6231	21.13162	0.0802
At most 3	0.11814	10.86965	15.49471	0.2196	0.1181	8.8004	14.26460	0.3031
At most 4	0.02912	2.069218	3.841466	0.1503	0.0291	2.0692	3.841466	0.1503

Source: Compiled by the researchers (Data from SARB & World Bank, 2000-2018)

The results in Table 6 show evidence that co-integration in the series exist, which is why the VECM was selected. The trace test indicates three co-integrating equation(s) at the 0.05 level and the maximum eigenvalue test indicates 2 co-integrating equations at the 0.05 level as well.

**Table 7. Short Run Analysis**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<b>CoIntEq1</b>	-0.002157	0.001195	-1.805443	0.0735*
<b>D(GDP-1)</b>	0.826743	0.137784	6.000293	0.0000***
<b>D(GDP-2)</b>	-0.073753	0.132816	-0.555301	0.5797
<b>D(INF-1)</b>	0.590214	1.526573	0.386627	0.6997
<b>D(INF-2)</b>	-1.390123	1.560608	-0.890758	0.048**
<b>C</b>	2.986677	12.11706	0.246485	0.8057
<b>IR</b>	0.636246	0.545236	1.166917	0.2455
<b>UN</b>	-0.076347	0.422209	-0.180828	0.8568
<b>CPI</b>	-0.853594	0.588129	-1.451371	0.0492**
(***) shows significance of 1% level, (**) shows significance at 5% level and (*) shows significance at 10% level.				

Source: Compiled by the researchers (Data from SARB & World Bank, 2000-2018)

The results of Table 7 shows that GDP is explained by the lagged values of INF and CPI in the short run. There is a short-run relationship result that GDP is explained by the first lag of GDP, second lag of INF and the control variable CPI. From the

results presented in Table 6.7, the following model was built based on the significant p-values at 5% level. The error correction term should lie between 0 and 1. The error correction term shows the long-run elasticity. The error correction term is represented by EC in this study. The short-run relationship is represented as follows:

$$GDP_t = -0.002EC + 0.827GDP_{t-1} - 1.390INF_{t-2} - 0.854CPI$$

The short-run equation shows the coefficient and significant variables that affect GDP. The error correction term (EC) ascertain that the speed at which the model returns to equilibrium following an exogenous shock is 0.002. A negative sign indicates a move back towards equilibrium. Since the value is closer to zero than one, it suggests a small adjustment a one-time period later. Additionally, the model also shows that the lag of GDP has a positive significant effect on economic growth. As INF goes up by 1 percent, economic growth (GDP) goes down by 1.39. The results imply that inflation is some important microeconomic variables that cause changes to GDP. This could inculcate that the rise in the general price level is catastrophic to the economic growth of South Africa. It is also evident that as CPI goes up by 1 percent, economic growth goes down by 0.854.

#### 4.4. Diagnostic Tests

Diagnostic testing served to test for the stability and fitness of the model. The testing of fitness and stability was done in three ways: the normality, heteroscedasticity and autocorrelation tests. Normality was tested by means of the Jarque-Bera test of normality. Autocorrelation was tested using the Lagrange multiplier (LM) and heteroscedasticity with the Breusch Pagan Godfrey test.

**Table 8. The Normality Test**

Model	Jarque-Bera	Prob
Economic Growth Model	1.700410	0.4273

*Source: Compiled by the researchers (Data from SARB & World Bank, 2000-2018)*

According to the normality test, the data was normally distributed. The probability value was more than 0.05, therefore the null hypothesis was accepted.

**Table 9. Serial Correlation Results**

Model	Lags	LM-Stat	Prob
Economic Growth Model	1	9.404264	0.0518
	2	0.775821	0.9417

*Source: Compiled by the researchers (Data from SARB & World Bank, 2000-2018)*



Table 9 indicates that in both the first and second lag no correlation was experienced since the probability values are greater than 5%.

**Table 10. Heteroscedasticity Test**

<b>F-statistic</b>	0.741475	<b>Prob. F(44, 25)</b>	0.6592
<b>Obs. R-Squared</b>	0.566160	<b>Prob. Chi-Square (44)</b>	39.63118

*Source: Compiled by the researchers (Data from SARB & World Bank, 2000-2018)*

The tested raw data was homoscedastic according to the heteroscedasticity testing that was done. The data was homoscedastic from the heteroscedasticity null hypothesis, while the heteroscedasticity alternative hypothesis indicated heteroscedasticity. Since the value of probability was greater than 0.05, it led to the rejection of the null hypothesis and concluded that the data is homoscedastic.

#### 4.5. Discussion of Results

- The primary objective of the study was to analyse the influence of inflation targeting South Africa's economic growth. For the primary objective to be achieved, the following theoretical objectives were set:
- To investigate whether the inflation targeting monetary framework objective encounters challenges on the steady price increases, on the steady and high long term in South Africa's economic growth

The above research objectives were achieved by using the VECM, as described in the preceding sections of this paper. The vector error correlation model was used as an estimation of effects of the short-run influence of inflation targeting on South Africa's economic growth and its long-run effects with the use of the multiple regression model.

The preliminary conclusion that can be drawn from the descriptive statistics evidence is that inflation targeting has positive effects on South Africa's economic growth.

- The study focused on comparing economic growth rate since the period of adoption of inflation targeting. The results showed that economic growth during the period of inflation targeting remained steady and relatively high.
- The descriptive results reflected that after adopting inflation targeting, the output variability was steady output, signifying that inflation targeting reduces the variability in output growth and inflation.

***The following findings were drawn from the econometric approaches employed in the study.***

- 1) The augmented Dickey-Fuller results showed that the variables were not motionless at level (without trend). GDP and UN were the only variables that was

not stationary at the level (with trend). At first difference (without trend), all the variables were found stationary. Furthermore, the Phillips-Perron (PP) test and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) stationarity test denoted stationarity at first difference. The diagnostic tests (normality test, serial correlation and heteroscedasticity) surpassed the expectations of the assumptions. The optimal lag selection was carried out using the Akaike information criterion (AIC) and the lag length of two was found to be the optimal one.

2) The existence of a long-run equilibrium between the variables of interest was checked using the Johansen co-integrated test, which indicated co-integration equations. The VECM was used to assess the model both in the short and long run.

3) According to the VECM results, the GDP was explained by the first lagged value of GDP, second lag of inflation and the consumer price index in the short run. The relationship of main interest between economic growth and inflation targeting was established. Moreover, the analyses depicted a long-run relationship between inflation targeting and economic growth in South Africa. These results match that of Bousrih (2015), who discovered that inflation targeting was significant in improving output growth.

4) A positive relationship exists between economic activities and inflation in the long run, determined by conducted a stability analysis using CUSUM and CUSUMQ. The model was stable for both CUSUM and CUSUMQ according to the test results.

## 5. Conclusion

The main objective of this paper was to examine the influence of inflation targeting on economic growth in South Africa. Annual time-series quarterly data for the period of 2000 to 2018 were investigated. The diagnostic tests of normality, serial correlation and heteroscedasticity that were conducted on all the variables were satisfied, implying that the estimates were reliable. The methodology employed in this study included the vector error correction model to examine the influence of inflation targeting on economic growth. The results of unit root testing suggested that all variables in the model were stationary after the first difference. The results from the analysis revealed that inflation influences on the economic growth of South Africa.

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