STUDIA UNIVERSITATIS BABEŞ-BOLYAI OECONOMICA
VOLUME 63, ISSUE 3, 2018, pp. 68-90
DOI: 10.2478/subboec-2018-0015

AN ANALYSIS OF THE EFFECTIVENESS OF INTEREST RATES TO FACILITATE PRICE STABILITY AND ECONOMIC GROWTH IN SOUTH AFRICA

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Abstract. Price stability supports accelerated economic growth (GDP), thus the main objective of most central banks is to ensure price stability. The South African economy is experiencing a unique monetary policy dilemma, where a high inflation rate is accompanied by high interest rates and low GDP. This is an unconventional monetary policy scenario and may hold strenuous repercussions for the South African economy. This dilemma was held as the rationale behind this study. The study investigated the effectiveness of the use of the repo rate as an instrument to facilitate price stability and GDP in South Africa. Long-run, short-run and casual relationships between interest rates, inflation and GDP were therefore analyzed. The methodology is based on an econometric process which included a Johansen co-integration test, with a Vector Error Correction model (VECM). Casual relationships were also tested using Granger causality tests. Results of the Johansen Co-integration test indicated the presence of co-integrating long-run relationships between the variables and a significant and negative long-run relationship between the repo rate and inflation rate was revealed, whereas GDP and inflation rate exhibited a significant and positive long-run relationship. The study also found short-run relationships between inflation and GDP, but not for inflation and the repo rate. Further areas of potential research may fixate towards the assessment of other significant alternative policy tools which may be utilized by various countries' monetary policy authorities to influence supply specific inflationary pressures led by the cost-push phenomena, especially in the short-run.

JEL classification: E65, O11, O55;

Keywords: Monetary policy, interest rates, price stability, economic growth, VAR model.

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1. Introduction

Over the years, central banks in developing countries have been seeking to implement a viable monetary policy approach to guide their economies in achieving price stability and sustainable economic growth (Montes, 2010:2). Price stability provides an enabling environment for sustainable growth, where economic decisions taken by economic agents are independent of price changes (Bagsic and Glindro, 2006:4). According to Kaseeram (2012:1), price stability is a prerequisite for achieving faster sustainable growth, as it facilitates long-term financing for private-sector and government debt. In addition, long-term price stability ensures efficient allocation of resources and eradicates potential drags on sustainable growth, whilst instilling the economy with the confidence that the value of money will be stable in the long-run (Kaseeram, 2012:42). This situation encourages people to save and invest, since their respective disposable incomes will be less sensitive to price changes (Elmendorf, 1996).

Similar to most developing countries, the central objective of the South African Reserve Bank (SARB) is to ensure price stability in the economy (van der Merwe, Mollentze, et al., 2014:222). Although this objective is considered to be broad, it is usually interpreted to mean a low and stable rate of price inflation maintained over a long period of time (Poole and Wheelock, 2008). In achieving the objective, the SARB follows a conventional monetary policy approach known as the Inflation Targeting Framework (ITF). The ITF was first adopted by New Zealand in the 1990, and in the case of developing countries, Chile was the first to adopt an ITF (Mishkin, 2000). Since then, the ITF has been practiced by many central banks globally. The ITF enunciates that the short-term interest rate (or repo rate) is the main monetary policy instrument that can be used to achieve price stability (Arestis and Sawyer, 2003).

According to Sarwat (2012), the central banks implement the ITF by estimating and producing a targeted range for inflation and then attempts to steer actual inflation towards that target using the repo rate. Under the ITF, monetary policy sets the repo rate with respect to recommendations within the Taylor rule in response to changes in price level (Arestis *et al*., 2009:2). The repo rate should thereby be increased (or reduced) amidst expected inflationary pressures above (or below) the set and agreed upon target range (Begg et al., 2003:340). This implies raising the repo rate when inflation is high and above the inflation target, and reducing the repo rate when inflation is low and below the inflation target (Williamson, 2016). According to Stiglitz (1999), whenever price growth exceeds a target level, the repo rate should be raised.

In South Africa, the SARB have set the inflation target at a range of 3 - 6 percent, implying that price inflation exists when the average prices rise above 6 percent and price deflation exists when the average price is below 3 percent (SARB, 2016). South Africa's inflation rate was 4.7 percent in January 2018, well below the target range of 3 – 6 percent (Stats SA, 2017). However, the inflation rate changed from 6.6 percent to 4.6 percent during 2017, mostly below the target range as set, compared to a repo rate of 6.75 percent and a prime rate of 10.5 percent during

2017. This situation leaves the South African monetary policy with virtually no room to facilitate economic growth. South Africa's GDP grew by only 1.3 percent in 2017. South Africa is experiencing high inflation, accompanied by high interest rates and low GDP growth. This constitutes a monetary policy dilemma, since South Africa's monetary status quo is contrary to the SARB conventional monetary policy of the ITF, which enunciates that high interest reduces inflation and GDP growth.

The review of empirical literature indicated conflicting results regarding the relationships between inflation, the repo rate and economic growth. This situation indicates a gap in the literature, especially in emerging economies. As such, this study investigates the effectiveness of the current monetary policy approach of the ITF that uses the repo rate as an instrument to manage, control and stabilize inflation, and create an environment where sustainable economic growth can be achieved. In doing so, a substantive analysis with empirical evidence is provided by the study. This analysis includes detail on the cause, effect and relationship between the interest rate, inflation and GDP, with a primary aim to establish if the use of the repo rate is effective in controlling and managing inflation in South Africa.

2. Literature review

2.1 Monetary policy approaches in South Africa post – 1994

According to Kifa (2013:13) South Africa's monetary policy is distinguished by two main monetary regimes. Firstly, pre-targeting that was announced prior to 1994 and uses money supply as its monetary regulatory tool, and secondly, post-inflation targeting that was announced post 1994 and uses short-term interest rates as a monetary regulatory tool. Post 1994, South African monetary policy authorities had to introduce new monetary policies that would serve to address economic growth inhibiting factors at the time, in order to create more conducive economic conditions for growth and employment as well as to fulfill the central bank's mandate (Aron and Muellbauer, 2006). As such, two substantial monetary policies were introduced including a broad-based approach, introduced in 1998 and lasted until 1999, and the ITF, introduced in 2000 and still implemented (Casteleijn, 2001:5). These monetary policy approaches are discussed:

- ***Broad-based approach (1998-1999)***

According to Kifa (2013:16), the objective of the broad-based approach monetary policy was to limit the amount of liquidity in the banking system as efficiently as possible. During this period the South African monetary policy authorities highlighted the broad-based approach's agenda through the amount accessible in the daily sale in order to purchase the transactions again (Casteleijn, 2001:5). However, Shelile (2006:40) stated that the policy drawback was the fact that the contradictory signals were set for inflation and money supply and this caused a significantly biased relationship between output, prices and money supply growth. This weakened the

effectiveness of the money supply targets, and thus made money supply an insignificant tool to be used to predict future trends in macroeconomic variables (Nell, 1999).

- ***Inflation Targeting Framework (ITF) (2000-current)***

Inflation targeting is a framework that comprises a feature of a greater degree of transparency (SARB, 2016). It is all about keeping South Africans updated with the monetary climate of the country. Under this regime the SARB announces the targeted inflation rate and introduces policies to achieve the target (Kamal, 2010). Succinctly, Figure 1 depicts the steps taken when implementing the ITF.

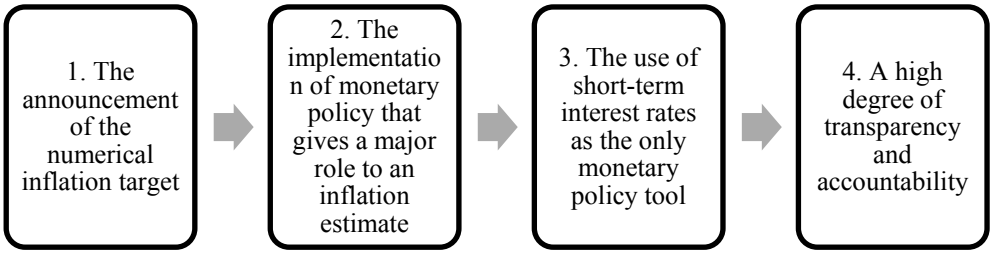

Fig 1: The Inflation Targeting Framework (ITF)
Sources: Author's construction; Svensson (2007)

With regards to the effectiveness of the ITF, previous empirical research has been established by various studies (e.g. Aziakpono and Wilson (2010); Shelile (2006); Kaseeram (2012); Bernard *et al*. (2015); Svennson (1990)). Aziakpono and Wilson (2010:3) provided an assessment of the different periods of monetary policy in South Africa, and revealed that the ITF appeared to be more sufficient in addressing macroeconomic issues and maintaining a steady macroeconomic climate when compared to the previously implemented monetary policy frameworks. In addition, the ITF shares a common target with other economic policies, which is, coordination between monetary policy and other policies (Shelile, 2006:41).

According to Kaseeram (2012:15) the ITF enables monetary policy to focus on domestic considerations and to respond to shocks to the domestic economy. The central bank's commitment to retain inflation within the specified target range, enables monetary policy to balance expectation and predictability (Bernard, *et al*., 2015:20). This prevents people from having high inflation expectation, preventing domestic firms from raising prices and demands for higher compensation by workers (Svennson, 1990:12). The setting of a specific target range, also provides a safety net for the economy, preventing shocks resulting from economic boom and bust cycles (SARB, 2016). However, Pettinger (2011:6) posits that cost-push inflation may cause a temporary blip in inflation. This may result in high inflation compelling the central bank to raise the repo rate. A higher repo

rate will inhibit GDP growth and it is expected to reduce inflation in a normal situation (Schwartz, 2008:16). Although this may be true, alternative empirical evidence on the subject encountered by supporters of ITF is yet to be assessed in the context of various economies (Epstein and Yeldan, 2007). The South African economy is no exception, since the country's inflation is fairly high irrespective of a high repo rate, whilst economic growth is low (Stats SA, 2017). Under these circumstances, the current status quo of the South African economy is a cause for concern, does South Africa's ITF achieve the goals of monetary policy or not.

2.2 Monetary policy approaches in South Africa post – 1994

Monetary policy is said to be effective through the so called "transmission mechanisms". Smal and de Jager (2001:6-9) ascribe that the various monetary transmission mechanisms include the interest rate channel, asset price channels, exchange rate channel, and the credit channel. These channels present mediums by which monetary policy influences aggregate demand, and ultimately, a country's level of inflation (Smal and de Jager (2001:6). The interest rate channel encompasses the change in the monetary policy's official rate which affects loans and other interest rates of building societies, banks and the various financial institutions. Gilt-edges, houses, and shares, are resultingly affected by the latter, which ultimately affects aggregate demand and inflationary levels through underlining transitioning (Muric, 2010). The exchange rate channel, primarily in open economies, are consequent to additional real effects of changes in policy induced short-term interest rates. In the case of a rise in local nominal interest rate at a faster tempo than international counterparts, this leads to a gradual depreciation in the domestic currency at a rate which equates the various debt instruments' risk adjusted returns as required for establishing equilibrium in the foreign exchange market (Ireland, 2005:4). An initial domestic currency appreciation is required by the anticipated future currency depreciation, so that in the scenario where there is a slow adjustment of prices, locally produced goods become more expensive relative to internationally produced goods. Thus, local employment and output fall in the face of a decrease in net exports (Ireland, 2005:4).

As pertains to the credit channel, or the loan market, a monetary policy tightening induces reduced volume of total new loans and an increase in lending rates by commercial banks. This affects aggregate demand, particularly the demand by businesses, mostly small businesses in need of financing (Dovciak, 1999:4). The asset price channel posits that the increase in the short-term nominal interest rates, induced by monetary policy, makes equities less attractive than debt instruments in the investors' eyes. Therefore, a contraction in monetary policy, implies that securities market equilibrium needs to be reestablished, partly through a decrease in prices of equity (Ireland, 2005:4).

Amongst the theories on the maintenance of macroeconomic stability, the classical school of thought propagates market liberalization under perfect competitive markets in which state intervention is minimal (Mohr and Fourie,

2015:35). Under the principle of the "invisible hand", full employment relies on the equilibrium adjustment of market forces inclusive of prices, wages and interest rates (van der Merwe and Mollentze; 2010:154). Henceforth, optimal market activities or transactions only take place when equilibrium market-clearing prices are set and equilibrium interest rates between savings and investment is achieved to ensure demand absorbs supply (Tobin, 1993:53). In the case of interest rate disequilibrium, a mismatch between savings and investments, where interest rates set below equilibrium, leaves firms demanding more funds for investments than savers are willing to provide through savings (van der Merwe and Mollentze, 2010:151).

The classical economic theory asserts that money serves as a determinant of absolute price level or the level of inflation. The quantity theory of money and the Cambridge cash-balance approach insists that an overflow of money stock or money supply instigates an increase in price levels or inflation levels (Ahiakpor, 2009:147; Humphrey, 2004:2). The classical transmission mechanism of the classical theory therefore proposes that under demand-pull inflation, an increase in money supply increases general price levels, implying chasing after the same quantity of output or "too few goods" (Congdon, 2005:131). Changes in equilibrium money supply induces proportional and sustained changes in price levels (Lewis and Mizen, 2000:62). Contrary to this, the Neo-Fisherism theory argues that a lower nominal interest rate target, promotes a decrease in inflation or price level as opposed to the conventional notion of lower interest rates for higher inflation, and vice versa (Williamson, 2016:7).

The "quantity theory of money" under the monetarist approach propagates that increased money supply at a rate greater than economic and income growth may promote increased nominal demand and inflation as a result of the inability to produce additional goods or services (Aubrey, 2015:15). In turn, the monetarist approach identifies inflation as an "ever-present monetary phenomenon" and strongly emphasizes the importance of money under the notion "money matters" (Nelson, 2002:2). Money influences the business cycle's upswings and downswings within the short-run including real economic activity and prices, while causing inflation in the long-run. Rather than applying discretionary measures, the state should thus observe monetary targeting (van der Merwe and Mollentze, 2010:162).

Contrary to the classical and monetarist theory, the Keynesian theory insists that the classical school of thought is only applicable in special economic scenarios of full economic activity (Piedra, 2004:105). The Keynesian theory argues that the moment of cause and effect by market forces inclusive of prices, wages and interest for the adjustment of full-employment and output takes longer than expected as perpetuated by the classical and monetarist theories (Clarke, 1987:398). The period awaiting the proposed classical effect within the long-run implies prolonged economic costs of unemployment and low output levels within the short-run (Davidson, 1998:825). Inflation is thereby cost-push autonomous to pressures of demand until full-employment is reached (Chicheke, 2009:46). As such, Keynes asserts that state intervention by means of fiscal policy through public spending and taxation is actively required in directing economic activity in support of monetary policy.

In efforts to establish the extent to which monetary policy's inflation targeting activities affect the real economy, various studies have investigated the relationship between interest rates or the repo rate and inflation (e.g. Kandel *et al*. (1996);

Asghapur *et al*. (2014); Tobin (1965); Huizinga and Mishkin (1984); Nelson and Schewert (1977); Barsky (1987); Ghazali (2003); Lardic and Mignon (2003); Berument *et al* (1999); Booth and Ciner (2001)). The reason for this is the fact that interest rates play an integral role as a monetary policy tool towards the counterbalancing of inflation (Asghapur, *et al*., 2014). Therefore, a study by Kandel *et al*. (1996) on real interest rates and inflation found a negative correlation between interest rates and inflation. Similarly, Asghapur *et al*. (2014) also found a negative relationship between interest rates and inflation in developing countries.

On the contrary, studies by Tobin (1965), Nelson and Schewert (1977), encountered similar findings that underpins a positive relationship between interest rates and inflation. Equally so, Berument *et al*. (1999) addressed the role of interest rates in the absence of explicit inflation prospects, and discovered that increased inflation uncertainty, induces an increase in nominal interest rates. While, Huizinga and Mishkin (1984) concluded that there is no relationship between interest rate and inflation. However, Huizinga and Mishkin's (1984) findings were disputed by further empirical results produced by Umoru and Oseme (2013), who found an existing long-run negative relationship between interest rates and inflation in Nigeria.

Empirical findings on the relationship between inflation and economic growth present results varying from positive, negative and no relationship. A study established by Mokgola (2015) on the long-run and short-run dynamics using co-integration and error correction techniques revealed that South Africa's inflation targeting regime holds a non-significant negative relationship with the country's economic growth. The study thereby deemed the notion of a relatively low inflation being achieved at the cost of low economic growth as a "misconception". Similarly, Munyeka (2014) established that South Africa's economy has a negative, but significant relationship between economic growth and inflation, findings also suggested that economic growth has a minimal impact on either the decrease or increase in inflation rate. Various authors, Ahmed and Mortaza (2005), Enu *et al*. (2013), Kiliç and Arica (2014), Salian and Gopakumar (2008) also reiterate the significantly negative relationship between the variables under concern in the case of Bangladesh, Ghana, 23 upper-middle income countries and India, respectively.

Contrary to the previous findings, empirical results by Makuria (2014), Mallik and Chowdhury (2001), respectively revealed a positive relationship between inflation and economic growth in Ethiopia, and selected South Asian countries (Bangladesh, India, Pakistan and Sri Lanka). Results by Mallik and Chowdhury (2001) in the case of Bangladesh where further reiterated by Majumder (2016) who also established a significant positive relationship between inflation and economic growth in the long-run as pertains to the period 1975-2013. On the one hand, findings by Anidiobu *et al*. (2018) established a positive but non-significant relationship between the considered variables in the context of the Nigerian economy along the period 1986-2015, based on the Ordinary Least Squares (OLS) method. General findings by Miller *et al*. (2012) on the effects of inflation targeting economic growth amongst developing and developed countries notably suggested that inflation targeting has no effect on developed countries' economic performance, whereas, it exerts a positive effect on developing countries' economic performance. Similar studies by Ball and Sheridan

(2005), Lin and Ye (2007), and Walsh (2009) demonstrate that evidence based on grouped developed countries did not support the notion that inflation targeting affects economic growth and its variability. Nonetheless, a study conducted by Vega and Winkelried (2005) established that inflation targeting affects both developed and developing countries for both grouped and sub-sample estimates, although the effect is greater for developing countries. Gonçalves and Salles (2008) and Lin and Ye (2009) reiterate that the inflation rate and its variability can significantly be lowered for developed countries.

Consequently, Neumann and von Hagen (2002) assesses the performance of interest rates and inflation in inflation targeting and non-inflation targeting countries, the results reveal that inflation targeting is an essential mechanism in curbing and lowering the level and volatility of inflation. Additionally, credibility in inflation targeting by central banks was significantly higher than non-inflation targeting central banks. Similarly, Apergis (2005) asserts that forward looking rules within inflation targeting is attributed to macroeconomic stability and monetary policy credibility. Sound inflation target contributes to less volatility in output. In essence, the results revealed in the aforementioned studies provide a mixed set of findings. Most studies have attributed inflation targeting to an essential mechanism for managing the level and volatility of inflation, as well as promoting macroeconomic stability and monetary policy credibility. While other studies have found insignificant effects of inflation targeting on economic growth, others have found negative effects pertaining to its pro-cyclical and asymmetric effects on aggregate demand.

Contrary to the preceding results, Wray and Forstater (2006) state that ITF is not the best approach to achieve stable prices and economic growth. The reason is that, the ITF is inflexible in nature, it's a solution limited to solving one economic drag (inflation). It has a single focus to meet the central bank's objectives, as it excludes other objectives such as financial stability and growth (Mokgola, 2015:27). Stiglitz (2008) suggested that in trying to contain inflation through the ITF, the "cure would be worse than the disease". On the other hand, findings established by Mwakanemela and Kasidi (2013) showed no long-run relationship between inflation and economic growth in Tanzania, and this was the case for Behera (2014) who revealed that amongst six South Asian economies, only Malaysia exhibited a long-run relationship, countries such as Bangladesh, Bhutan, India, Maldives and Sri Lanka showed no long-run relationship.

According to Mishkin (2000), the ITF is not the solution and may not be effective in most developing countries, but it can be a useful monetary policy approach in a number of these countries. In spite of this, Roger and Stone (2005) argued that the ITF goes hand in hand with improved economic performance. In support, Aron and Muellbauer (2007) applauded the implementation of ITF in South Africa, claiming that it led to stable inflation and improved macroeconomic performance. Similarly, Svensson (2010) argued that the ITF has improved macroeconomic performance among developing economies. Thus, the study attempts to investigate the effectiveness of the ITF in achieving price stability and economic growth in a developing country such as South Africa with high levels of inflation, high interest rates and low GDP growth.

3. Methodology

The research methodology follows a quantitative approach and it adopts a functionalist perspective, as it provides a body of methods and principles for a study concerned with maintaining social stability (Teddlie and Tashakkori, 2009). The study is assessed within the approximations of the Taylor rule and the monetarist approach following the analysis of the concordance among South Africa's inflation levels and the changes in the interest rate. This pertains to the raising and decreasing of interest rates by monetary authorities in line with inflationary changes. Also, the inflation and economic growth nexus is assessed in conjunction with the undersigned principles of the Philips curve.

3.1 Data description

The study uses time series data to examine the relationship between the repo rates, economic growth and inflation in South Africa for the period of 2000 to 2016, using 64 quarterly observations i.e. from the first quarter of 2000 until the fourth quarter of 2016. 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. The use of interest rates in the study was based on its merits as a primary monetary policy tool, whereas South Africa's consumer price index (CPI), was chosen based on its consideration as a yardstick for gauging the aggregate consumer induced general levels in consumption inflation. It should be noted that the South African monetary authorities first implemented the inflation targeting monetary framework in 2000 (SARB, 2016). For that reason, the study's sample period begins from 2000 in order to capture the optimal performance of the monetary framework since inception. In light of this, the study examines three variables, that is, the repo rate, real GDP and inflation. The data for these variables are all derived from the South African Reserve Bank (SARB) database. With all the series constituting of all positive values, the series are transformed to their natural logarithmic values to ensure that variation is reduced within the data sets. Variables are thus subsequently, identified as LREPO, LGDP and LCPI. In conducting the analysis, the statistical software Econometric package, eviews 9 was used.

3.2 Model description

The study investigates the relationship between the repo rate, economic growth and inflation using the following model:

$$LCPI = f(LGDP, LREPO, e) \quad \ldots\ldots (1)$$

Where: LCPI is the log of inflation rate; LGDP is the log of Gross Domestic Product; LREPO is the log of the Repo rate; and *e* is the error term. Thus, to achieve the objective of the study, a regression analysis is used to provide estimates between

the repo rate, economic growth and inflation. This is because a regression analysis is a statistical technique that serves to determine movements in one variable. According to Mosikari (2013), more often than not, there is always variation that is obtained from sources such as the measurement error, incorrect functional form or a completely random and totally unpredictable occurrences. This study considers the existence of such inherent unexplained variation error by clearly incorporating a stochastic error term in the model.

Due to the nature of time series data, the study will have to test whether or not the data series are stationary or non-stationary (Thayaparan, 2014). This is because time series data more often than not is faced with a problem where the independent variable can appear to be significant than it actually is if it has the same underlying trend as the dependent variable (Achen, 2001). Consequently, this results in a situation where the non-stationary series appear to be correlated even if they are not. For that reason, it is essential for this study to test for stationarity conditions of variables in order to avoid spurious results. The study thus employs the Dickey and Fuller's (1981) Augmented Dickey Fuller for all three variables to test whether variables are stationary at either levels (I(0)) or first difference (I(1)). This will then permit the study to test for co-integration among the variables concerned in the study using the Johansen's (1991) co-integration test.

In conducting the latter test, the optimal lag length of the model is estimated using a Vector Autoregressive (VAR) Model. Subsequent to this, the Johansen's co-integration test is then estimated to assess the long-run relationship between the study variables. It should be noted that the Johansen's co-integration test involves two test statistics, namely; the Max-Eigenvalue and the Trace statistic. According to Yadav *et al*. (2016) the long-run association between variables is determined if the calculated value from both tests is greater than their respective critical values. As such, the Johansen's co-integration test procedure is expressed as follows:

Trace test

λ_{trace} *(r)* = - T ∑ *In* (1-λ_t)……………………………………………………………..(2)

Max-Eigenvalue test

λ_{trace} *(r,r + 1)* = - T ∑ *In* (1-λ_{t+1})………………………………………………………(3)

Where λ_{t+1} are the (k-r) small-scale estimated eigenvalues and for both tests, **λ** denotes the estimated coefficients, while T denotes the number of observations captured. The model above indicates the long-run relationship among the study variables. If the output of the model above indicates the existence of a co-integrating equation or long-run relationship among the study variables, the next step will be to estimate the VECM to capture the short-run dynamics of the study variables and the model below expresses the VECM procedure as follows:

$\Delta G_t = \beta D_t + \sum_{i=1}^{k-1} \Omega_i \Delta Y_{t-1} + \phi Y_{t-1} + \Omega_{k-1} Y_{t-k+1} + \pi_t$……………………………….(4)

Matrix Ω = α.β, where α denotes the matrix that consists of the short-run dynamics and β denotes the matrix consisting of the long-run coefficients or long-run equilibrium relationship. Lastly, the granger causality test is estimated to determine the causality among the study variables and to also confirm whether the change in any series is unidirectional or bidirectional.

4. Empirical findings

Table 1 represents the Augmented Dicky-Fuller unit root test results**.** Results reveal that all variables have p-values above 0.05 significance level, suggesting that the variables are non-stationary at levels (I(0)). For that reason, based on the assumption of no stationarity, the null hypothesis may not be rejected. This may imply the presence of a unit root within the series, with trend and without trend at levels. However, output suggests that at first differences, all variables have p-values below 0.05 significance level making them stationary. On this note, the null hypothesis of no stationarity is rejected at first difference or I(1) for LCPI, LGDP and LREPO. Therefore, the next step involves the use of the Johansen co-integration approach to test for long-run relationships or co-integrating vectors in order to establish whether variable are integrated in the long-run.

Table 1: Augmented Dickey-Fuller Unity Root Test

Variables	Level				First Difference		Order Of integration
	Intercept without trend		With trend		Without trend		
	t-stat	P-value	t-stat	P-value	t-stat	P-value	
LCPI	-2.0557	0.2630	-2.2719	0.4420	-3.2623	0.0215**	I(1)
LGDP	-1.8151	0.3698	-1.8157	0.6845	-5.0795	0.0001**	I(1)
LREPO	-2.4263	0.1391	-2.3690	0.3914	-4.2342	0.0013**	I(1)

*Note: [ ] * denotes P-value at 1% level of significance and ** at 5% significance.*

A lag order selection criterion was conducted to establish and obtain the optimal lag length for Johansen co-integration examination and the VECM. Having underscored that the variables are all integrated at first differences or I(1) order of integration, the study used four selection criterions, namely; HQ, AIC, FPE, and LR. Therefore, four (4) lags where suggested as the optimal lag length. For that reason, 6 lags are used in Johansen co-integration test as well as VECM, with intercept and no trend. Having established that variables are integrated at first differences and the selection of four lags as the optimal lag length, it is necessary to establish whether there exists a non-spurious and stable relationship with at least a single linear

combination between the regressors. Therefore, the Johansen co-integration test was conducted based on Trace statistic and Max-Eigenvalue statistics as reported in Table 2. Results indicate two co-integrating equations (r≤1) in trace statistic results at 0.05 and 0.1 significance levels. Additionally, Max-Eigenvalue revealed one co-integrating equation at 0.05 level of significance. Therefore, the null hypothesis of no co-integrating equation (r=0) is rejected for both Trace and Max-Eigenvalue tests. Henceforth, variables are co-integrated, simply implying that there exists a long-run relationship within the series.

Table 2: Johansen co-integration test results

H0: No. of CE(s)	Trace Test			Maximum Eigenvalue		
	Trace Statistic	T-critical value	P-values*	Max-Eigen Statistic	T-critical value	P-values*
None*	45.0186	29.7970	0.0004*	28.6566	21.1316	0.0036*
At most 1*	16.3619	15.4947	0.0369*	13.0390	14.2646	0.0774
At most 2	3.3229	3.8414	0.0683	3.3229	3.84146	0.0683

*Note: * denotes rejection of the hypothesis at the 0.05 level*

The presence of co-integrating relationships between the variables LCPI, LGDP and LREPO insists that the long-run equilibrium in INFLA can be explained by LGDP and LREPO. Results in Johansen co-integration test sufficed the requirements of at least one single linear combination between the variables, indicative of a long-run relationship between the variables, the aforementioned is thus expressed in Equation (5) below:

$$LCPI = 0.574030 + 0.235003(LGDP) - 0.324521(LREPO)\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Equation (5) reveals that the long-run exhibits a positive relationship between inflation and Gross Domestic Product (GDP). This simply implies that any increase in South Africa's GDP leads to an increase in inflation. Accordingly, a one percent increase in GDP leads to a 0.23 percent increase in inflation. Notwithstanding, a significant negative relationship between inflation and the repo rate is identified in Equation (5). The latter suggests that a one percent increase in the repo rate induces a decrease in inflation by 0.33 percent. Provided that there exists a long-run relationship between the variables, the VECM is used to assess short-run disequilibrium adjustments towards reaching the long-run equilibrium or co-integration between the variables as indicated in equation (5) (Noumbissie and Mongale, 2014). Additionally, the error correction term (ECT) is further used to convey the speed of short-run dynamic adjustments towards long-run equilibrium (Magee, 2013). Therefore, it follows that conditions for explaining short-run adjustments towards reaching equilibrium in the long-run requires a significant t-value and a negative adjustment coefficient or ECT (Mukhtar and Rasheed, 2010). Results of the ECT are presented in Table 3 below. Accordingly, keeping in mind

that the ECT of the VECM needs to be negative and significant, the ECT of inflation and GDP as represented in Table 3 are the only equations which meet the adjustment requirements towards long-run equilibrium with negative coefficients; -0.214031 and -0.612538, and t-values of; -3.64557 and -2.55878, respectively. Further suggesting that the series LCPI and LGDP present evidence of error correction in the first co-integrating equation.

Table 3: Vector Error Correction Model

Error Correction:	D(LCPI)	D(LGDP)	D(LREPO)
CointEq1	-0.214031	-0.612538	-0.020495
	[-3.64557]*	[-2.55878]*	[-1.47163]
D(LCPI(-1))	-0.977292	-2.423391	-0.036923
	[-4.53647]*	[-2.75884]*	[-0.72253]
D(LCPI(-2))	-0.364500	-0.324970	-0.019667
	[-1.67464]	[-0.36616]	[-0.38091]
D(LCPI(-3))	0.040308	1.551270	0.107285
	[0.20587]	[1.94313]*	[2.30996]
D(LCPI(-4))	-0.345310	-0.280942	0.098121
	[-1.72157]*	[-0.34351]	[2.06225]
D(LGDP(-1))	0.249080	0.796165	0.020054
	[4.78898]*	[3.75420]*	[1.62544]
D(LGDP(-2))	0.126074	0.342351	0.017757
	[2.40712]*	[1.60308]	[1.42923]
D(LGDP(-3))	0.039985	-0.307456	-0.021417
	[0.85774]	[-1.61752]	[-1.93673]
D(LGDP(-4))	0.124794	0.021746	-0.030867
	[2.35569]*	[0.10067]	[-2.45631]
D(LREPO (-1))	-0.265279	1.856702	0.166077
	[-0.42132]	[0.72321]	[1.11194]
D(LREPO (-2))	-2.069248	-5.742123	0.093762
	[-3.14292]*	[-2.13896]*	[0.60035]
D(LREPO (-3))	1.368309	7.057335	0.036650
	[2.03331]*	[2.57200]*	[0.22959]
D(LREPOR (-4))	-0.656083	-1.287810	0.252356
	[-1.06910]	[-0.51466]	[1.73353]

In order to test the robustness of results, underscored in the study are diagnostic tests as indicated in Table 4. Results showed that the model successfully passed the test for heteroscedasticity and serial correlation. Therefore, the null hypothesis of the presence of heteroscedasticity and serial correlation are rejected. Diagnostic test results however revealed that the model failed the Jacque-Bera test or test for normality at 0.01 level of significance. Nevertheless, Kunda (2011:15) reassures that normality testing is highly sensitive to large data samples and it is therefore highly expectant to obtain a failed normality test for such data samples.

Large samples may also possess an "α-stable" distribution leading to inconsistent regression patterns over the period (Frain, 2007:3-15; Ruxanda and Botezatu, 2008:59). Henceforth, Hain (2010:93) highlights that stability testing using the AR root may be conducted to further assess the stability of the model as indicated in Figure 2. Figure 2 reveals that all AR roots are contained within the unit circle, meaning that the model is stable and robust.

Table 4: Diagnostic test results

Test	*H0*	*Probability*	*Decision*
LM Test	No serial correlation	0.2776	With a P-value above 5%, do not reject the H0. Therefore, there is no serial correlation in the model.
White (CT)	No heteroscedasticity	0.5388	With a P-value above 5%, do not reject the H0. Therefore, there is no heteroscedasticity in the model.
Jarque-Bera	Residuals are normally distributed	0.0000	With a P-value less than 5%, reject H0. Therefore, the results show that the data is not normally distributed.

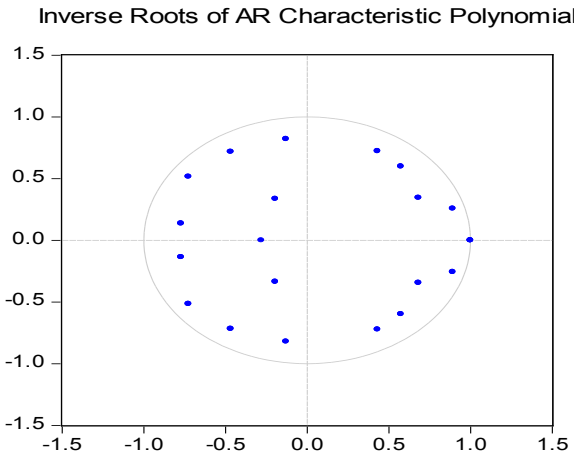

Fig. 2: AR Root test

Granger causality test results are indicated in Table 5. The results suggest a bi-directional causal relationship from LCPI to LGDP, and *vice versa.* This implies that short-run changes in South Africa's inflation cause changes in economic growth, accordingly, short-run changes in economic growth lead to changes in inflation. Results further indicate a uni-directional or one-way causality from LREPO to LCPI, short-run changes in the repo rate cause changes in the inflation. Lastly, causality test results suggest bidirectional causality from LREPO to LGDP, and LGDP to LREPO. Short run changes in the repo rate cause changes in economic growth, likewise, changes in economic growth lead to changes in the repo rate.

Table 5: Pairwise Granger Causality

Null Hypothesis	F-statistic	P-value
LGDP does not Granger Cause LCPI	17.14033	**0.0088***
LCPI does not Granger Cause LGDP	30.90182	**0.0000***
LREPO does not Granger Cause LCPI	11.7901	**0.0668***
LCPI does not Granger Cause LREPO	10.41506	0.1082
LREPO does not Granger Cause LGDP	16.05662	**0.0135***
LGDP does not Granger Cause LREPO	27.52716	**0.0001***

*Note: * indicates the rejection of the null hypothesis of no Granger causality at 5% significance.*

Variance decomposition results indicated in Table 6 further reveal that South Africa's inflation is predominantly affected by its own shocks, whereas shocks in GDP and the repo rate do not substantively affect the country's level of inflation. Although the shock effects of inflation on itself tend to be decreasing, the effect remains substantially high relative to GDP and the repo rate from the first quarter to the tenth quarter. In the first and second quarters, respectively 100 percent and 96 percent of movements in inflation are explained by its own shocks. Whereas, GDP and the repo rate only explain approximately 4.17 percent and 0 percent, respectively during the second quarter. During the tenth quarter, movements in inflation are still predominantly explained by its own shocks with 80 percent of the movements in inflation are explained by inflation shocks. Furthermore, GDP is shown to explain a relatively substantial change in inflation compared to the repo rate along the period. In essence, the repo rate and GDP have shown to have a relatively low percentage in explaining movements in inflation.

Table 6: Variance decomposition results of LCPI

Period	S.E.	LCPI	LGDP	LREPO
1	0.248482	100.0000	0.000000	0.000000
2	0.286115	95.82721	4.172364	0.000422
3	0.319622	92.07608	3.614647	4.309278
4	0.376575	94.22918	2.653779	3.117038
5	0.404673	91.19261	2.621772	6.185619
6	0.452935	87.60693	5.777390	6.615684
7	0.541857	85.47906	9.122114	5.398822
8	0.626159	82.27387	13.31242	4.413711
9	0.710945	79.94590	15.59956	4.454537
10	0.800554	79.48030	16.67378	3.845917

5. Discussion of results

Amongst the most crucial objectives of macroeconomic policy is the attainment of high output and low inflation in correspondence with the inflation-growth trade-off assumed within the precepts of the Philips Curve, as pertains to the short-term (Gokal and Hanif, 2004:8). The identified positive relationship between inflation and economic growth as projected in this study's short-run estimations, show that, at the first lag where growth serves as the dependent variable, past changes in South Africa's inflation significantly pose negative effects on its economic growth trajectories. The short-run results are further reinforced by the short-run Granger-causality results which revealed a bi-directional inflation-growth causal relationship. Moreover, the negative or trade-off relationship is further counteracted by the study's long-run findings of a positive inflation-growth relationship. The preceding findings stipulate that economic growth acts as stimuli for inflation rises in the long-run, any attempt at stimulating South Africa's economic growth would induce an increase in inflationary levels.

These results fulfil the positive growth-inflation relationship governing the precepts of the structuralists, who accentuate that inflation is essential for growth (Bain and Howells, 2009). Moreover, these findings resonate with results established by Mallik and Chowdhury (2001), Majumder (2016) and Makuria (2014), in the context of Ethiopia, and selected South Asian countries. The stipulated positive relationship between inflation and economic growth contradicts the findings of a negative relationship revealed by Mokgola (2015) and Munyeka (2014) in the South African case, with findings of the former being non-significant. The study's findings are also contrary to the findings by Ahmed and Mortaza (2005), Enu *et al*. (2013), Kiliç and Arica (2014), Salian and Gopakumar (2008) in the context of Bangladesh, Ghana, 23 upper-middle income countries and India, respectively. According to Gokal and Hanif (2004:8), despite the short-run trade-off, no permanent trade-off occurs between inflation and output as for inflation to be kept steady at any level, the level of output needs to equal the natural rate (Y*) thus for inflation to decline output must be below the natural rate. Khan (2014:106) also accentuates that variations in the growth-inflation relationship relies significantly on country specific factors or characteristics which range from the level of income, institutional and macroeconomic developments. Khan (2014:106-107) further makes an important assertion that dissimilar growth-inflation nexus amongst various countries are consequent to economies made up of heterogeneous financial development, trade openness or capital accumulation.

Moreover, the current study revealed that South Africa's long-run consists of a significantly negative relationship between the level of inflation and the SARB's repurchase rate or repo rate. In practice, efforts by the SARB to increase (decrease) the repo rate induces a decrease (increase) in South Africa's level of inflation. Such a notion according to these findings mirrors the core function of the inflation targeting framework undersigned within expansionary and contractionary policies. These results are consistent with the findings of a negative repo rate-inflation correlation by Kandel *et al*. (1996). The findings are also consistent with the study by Umoru and

Oseme (2013) as it pertains to the case of Nigeria, and subsequent results underpinned by Asghapur *et al*. (2014) in the context of selected developing countries. Also, no short-run adjustments or relationship between South Africa's repo rate and its level of inflation was revealed in the study. However, further confirmatory results based on the Granger causality test revealed that in the short-run, no causality exists at both 0.01 and 0.05 significance level, existing uni-directional causality only occurs from the repo rate to inflation at 0.1 significance level. This suggests that attempts by the SARB, through effective repo rate usage, negligibly impact changes in South Africa's level of inflation in the short-run. Such an assumption is also reinforced by variance decomposition results which show that changes in inflation are mostly explained by shocks in inflation itself with minimal explanatory effect from both economic growth and the repo rate, especially the repo rate. Nevertheless, the effect of the repo rate is revealed to be relatively higher in the long-run than economic growth, although both at low levels.

6. Conclusion

Maintaining price stability is the main concern of central banks worldwide. In a developing country such as South Africa, a policy dilemma has emerged with high inflation levels accompanied by subsequently low GDP growth rates. Within this scenario, monetary policy still seeks to reaffirm its position in the financial and economic markets through policy adjustments by its utilisation of the repo rate as its primary tool. To further understand the mechanisms behind the dilemma involving the interplay between South Africa's repo rate, inflation rate and GDP, the objective of this study was to establish the effectiveness of the use of the repo rate in controlling and managing inflation. The study thus analysed the short-run and long-run relationships between the aforementioned macro-economic variables. Findings showed that the long-run relationship holds between the repo rate, inflation rate and GDP. The suggested positive long-run relationship between inflation and GDP upholds the undertakings of the classical economic theory. The revelation of a negative relationship between inflation and the repo rate also assures the active application of the quantity theory of money.

Future potential research may include an extension of this model to include other variables such as income levels, institutional quality, trade openness and capital accumulation. Also research could be conducted in assessing other significant policy tools which may be utilized by the SARB in influencing supply specific inflationary pressures led by the cost-push phenomena. In addition, the inflation targets of the reserve bank may be investigated. From the literature review it was found that emerging economies may require higher inflation target if compared to established economies. The research attempted to fill a gap in the research on emerging economics to determine the debatable relationships between inflation, economic growth and the repo rate. South Africa is seen as a proxy for emerging countries and finding of this study could be applied to other emerging economies. The main implications from the research is that, although a long-run relationship

exists amongst the variables, the impact of for example a change in the repo rate on inflation is relatively low. On the short run changes in the repo rate did not even had an effect on the inflation or economic growth rate.

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