INFLATION IN SOUTH AFRICA 2000 - 2022: A NEW-KEYNESIAN APPROACH

https://doi.org/10.47743/jopafl-2024-32-10

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Abstract: Inflation is a daily monetary process that occurs over a period of time. Monetary policy is based on the Phillips Curve (PC) which is a tool used to describe inflation dynamics. The PC shows that inflation and unemployment have a negative relationship (Phillips, 1958). The study employed the Hybrid New Keynesian Phillips Curve (HNKPC) to investigate inflation dynamics in South Africa (SA). Additionally, the Autoregressive Distributed Lags (ARDL) model was used in the empirical analysis. The study aimed to find the hybrid curve in SA and to determine if monetary and fiscal variables affect inflation. Using quarterly data the study found the relationship between inflation and unemployment to be positive. As a result, no HNKPC existed in SA. In addition, fiscal and monetary variables influence inflation and therefore have a role to play in determining price levels in SA.
Keywords: inflation, PC, HNKPC, unemployment, SA, ARDL, ECM

Introduction

Inflation and unemployment are global phenomena and economically important. According to Wardhono, Nasir, Qori'ah, and Indrawati (2021) inflation occurs when the general price levels of an economy increase. In addition, Totonchi (2011) stated that the cause of inflation in developed countries is a rise in money supply, which means it is a monetary phenomenon. However, in developing countries various other factors lead to changes in inflation. These are related to fiscal imbalances and include growth in money and exchange rates among other factors.

In South Africa (SA), inflation targets are based on the Phillips Curve (PC). Particularly, Leshoro and Kollamparambil (2016) stated that the South African Reserve Bank (SARB) uses a PC when deciding on monetary policy objectives of inflation targeting. Blanco (2018) stated that SA has high unemployment levels and low economic growth, which renders the PC important. Therefore, testing for the PC is critical in SA as it presents policymakers with the opportunity to exploit the relationship between the variables of interest, namely inflation and unemployment.

As it is generally known, price stability is central to monetary policy worldwide, including SA (Vermeulen, 2015; Phiri, 2016). Inflation targeting was adopted in SA in 2002 and the main aim was to keep inflation between 3% and 6%. To achieve this, the repurchase rate is used. However, although targeting inflation has led to less persistence (Dossche and Everaet (2005) defined it as the tendency of inflation to slowly revert back to central bank's

inflation target in response to macroeconomic shocks), it still results in high unemployment levels, low economic growth and high real interest rates. According to Vermeulen (2015), SA's unemployment rate for the last 25 years has ranged around 20-25%. In addition, Statistics South Africa (StatsSA) (2023) indicate that although the unemployment rate has decreased in 2022, it still remained high at 30%. The SARB's (2023) quarterly bulletin states that economic growth has a low growth trend and has declined by 2% in the last two years. The International Monetary Fund (IMF) (2023) projected that inflation, real GDP and the unemployment rate will decline in 2023-2024. However, unemployment will still be above 30%. Therefore, Vermeulen (2015) suggested that employment should be targeted instead of inflation.

Botha, Khan and Steenkamp (2020) stated that the PC is important in modelling inflation dynamics. In addition, it captures how much economic slack affects inflation (Economic slack can be measured by unemployment or output gap). Also, SA's situation can be described by the fact that a persistently negative output gap has not translated into lower inflation after the financial crisis. Furthermore, global inflation has been relatively stable despite fluctuations in unemployment. As a result, questions about whether the PC has flattened and become a less useful monetary policy tool arose. However, after inspecting SA data, the authors concluded that the PC is still a relevant analytical tool. For this reason, this study explores inflation dynamics using the PC, more specifically, the NKPC.

Leshoro and Kollamparambil (2016) used a HNKPC and found no PC in SA. On the other hand, Fedderke and Liu (2018) found that the NKPC performed poorly due to its theoretical and empirical assumptions. Leshoro (2020) also found that no PC exists in SA, while Botha et al. (2020) found a PC relationship in SA. Lastly, Zobl and Ertl (2021) stated that little empirical evidence exists for NKPCs in developing countries, including SA. This study aims to fill the research gap and investigate the need for analysing inflation dynamics in SA. The PC relationship was examined using a new Keynesian approach. Therefore, the specific objectives for this study are (a) to establish the existence of the Hybrid New Keynesian Phillips Curve in SA, and (b) to determine the fiscal and monetary variables that significantly influence inflation in SA.

The rest of the paper is organised as follows. Section 2 provides the literature review. The methodology is presented in Section 3. The findings are discussed in Section 4, while the conclusion is presented in Section 5.

Literature review

Theoretical literature

The theoretical premises of this study is the Hybrid New Keynesian Phillips Curve (HNKPC). However, it is worth mentioning the various versions of the PC. Starting with the traditional Phillips Curve (PC) originated in 1958 from A.W. Phillips. Phillips (1958) hypothesises was that there is a relationship between the rate of change in money wages, the unemployment level and its rate of change. Other versions are the New Classical Phillips Curve (NCPC), the Gordon's triangle model, the New Keynesian Phillips Curve (NKPC) amongst others. Gali and Gertler (1999) are the original authors who motivated the HNKPC, which is largely an empirical approach, and extended the NKPC. Their implementation of the curve includes Marginal Cost (MC) as opposed to the output gap. This is due to the fact that productivity gains are directly accounted for, whereas the output gap has measurement errors. However, the authors stated that MC and output gap share a

log-linear relationship, and inflation is negatively related with lagged output. In addition, the pricing behaviour of backward-looking firms is included in the specification. Therefore, firms that look to the past to predict inflation follow certain assumptions based on the rule of thumb. The first assumption states that firms do not deviate from the rule and behave optimally. Secondly, current inflation depends on the previous period's inflation rate. In addition, firms are unable to distinguish the inflation behaviour of competitors. Moreover, inflation is dependent on expected and lagged inflation and the lagged term captures inflation persistence. Lastly, the hybrid curve also includes the NKPC (i.e., the forward-looking behaviour of firms). Expanding on the same logic, Dupuis (2004) states that the hybrid curve was extended to include sticky prices, whereas the NKPC did not. Therefore, the Calvo model was adapted to include the price setting behaviour of forward-looking and backward-looking firms. Similarly, Gordan (2011) argues that the NKPC excluded the backward-looking behaviour of inflation. Hence the hybrid curve was developed by Gali and Gertler in 1999. Therefore, the HNKPC includes both future expected and past inflation (i.e., backward-looking and forward-looking). However, the author stated that the differences between the NKPC and its hybrid version are minimal due to some form of past inflation being a proxy for inflation.

Phiri (2015) agreed with Dupuis (2004) that the hybrid curve includes the backward-looking component of inflation. The hybrid curve also relates current inflation to expected future inflation, lagged inflation and MC. Moreover, the hybrid version of the curve creates price stickiness, includes inflation inertia and various forms of the PC, namely the NCPC and NKPC. Lastly, output gap or labour share variables can be used in the specification to provide satisfactory results. More to the point, Phiri (2016) stated that the hybrid curve fits South African data well when the output gap is used.

Empirical literature

This section covers empirical studies on inflation dynamics. In doing so, the dynamics of the inflation process will be uncovered. Studies from other continents, Africa and South Africa are reviewed.

Chowdhury and Sarker (2017) studied the NKPC relation for Russia, Brazil and India. The study used monthly data from 1994 to 2011 to test the stability of the NKPC using Generalised Moment of Methods (GMM). To account for regime switching, the Hamilton model was introduced. This was done for output gap estimations. The findings showed that inflation is very persistent for India and Russia. In addition, there are no volatile business cycles present in the output gap variables for all countries involved. Most importantly, the hybrid PC was found to be structurally unstable for all countries under study. Kim (2018) studied inflation dynamics in the US and European areas; the study was based on various forms of the PC. These were the forward-looking and backward-looking NKPC and the HNKPC. A Dynamic Stochastic General Equilibrium (DSGE) model was used in the empirical study to test if forward-looking behaviour is more important in the relationship between output and inflation. The empirical findings showed that only the hybrid curve performed well when studying inflation dynamics for both countries. Likewise, Salunkhe and Patnaik (2019) investigated inflation dynamics for the period 1996Q2 – 2017Q2 in India. They used various forms of the PC such as the traditional PC, purely forward-looking NKPC, HNKPC, extended backward-looking PC and extended HNKPC. The authors concluded that the extended backward-looking PC and HNKPC best fits India. In addition,

anchoring inflation is important and using the output gap best explains inflation dynamics in India. Therefore, monetary policy plays an important role in this regard.

Zobl and Ertl (2021) investigated both the NKPC and HNPKC in Central and Eastern Europe (CEE) who use inflation targeting regimes in monetary policy, namely, Poland, the Czech Republic, Hungary and Romania. In addition, the study explored the possibility of the NKPC flattening. GMM and Bayesian estimation methods were used on various variables for the period 2003 to 2019. According to the pure NKPC results, inflation expectations and external shocks are statistically significant and a determinate of inflation for CEE. Therefore, the NKPC exists for all countries under review. In addition, various economic slack variables such as output gap, capacity utilisation, labour share and short-term unemployment rates were tested in the PC specifications. The results showed that labour market variables were the most suitable proxies. When the pure-NKPC was compared to the HNKPC results, the hybrid model was rejected due to the fact that lagged inflation was already included in inflation expectations. Furthermore, when faced with using core or headline inflation, empirical testing of the NKPC showed that core inflation is the most preferred choice. The evidence suggested that the NKPC has not flattened, and non-linearity only exists for Hungary.

Abbas (2022) studied inflation dynamics using Monacelli's (2005) approach to the NKPC and GMM estimations. Inflation dynamics were studied using different business cycles and threshold effects of various inflation targeting countries. These were Australia, Canada, New Zealand (NZ), the United Kingdom (UK) and the US. The study tested both the NKPC, and its hybrid version. The findings showed that both the NKPC and HNKPC exists for these counties. However, it depends on the business cycle stage (i.e., expansion or contraction) and the current inflation regime (i.e., low or high inflation). For example, the NKPC is flatter when inflation is low, that is inflation responds asymmetrically in different regimes and business cycles for all countries involved. Secondly, the forward-looking behaviour of inflation dominates in expansionary periods. Thirdly, inflation is unresponsive to business cycles and price stability changes when nominal price rigidities exist in domestic and imported markets.

Similarly, Demir (2022) estimated the HNKPC for the US only. The author used GMM estimations and followed Gali and Gertler's (2000) approach to the HNKPC using quarterly data for two samples. These were 1960 to 2000 to compare results with Gali and Gertler and 1960 to 2019. Inflation dynamics for the US are explained using calculations of the natural unemployment and output gap, and the natural output rate is estimated using logs, Okun's Law, various statistical procedures and Hodrick-Prescott (HP) filters. The empirical results revealed a dominant forward-looking behaviour of inflation, same as in Gali and Gertler (2000). However, the second sample showed that output gap had a positive sign and was statistically significant. This was contrary to Gali and Gertler's result of an insignificant output gap. Therefore, based on the empirical results, it can be inferred that the NKPC was found for the US and can be used to explain inflation.

Kobbi and Gabsi (2017) studied the NKPC in Tunisia. The study employed a Smooth Transition Regression (STR) modelling technique on quarterly data for the period 1993 to 2012. The empirical study tested linearity using two versions of the NKPC, namely, the forward-looking NKPC and HNKPC. Based on the results, the linear specification of the PC does not describe the inflation process in Tunisia. Asymmetry or non-linearity was

consequently tested. In addition, the STR results indicate that the PC relation is dependent on whether the economy is in expansion or recession, that is, regime-switching.

In the same way, Belinga and Doukali (2019) studied the NKPC for Morocco. The authors used two methods to estimate the PC, namely, GMM and TJIVE (Tikhonov Jackknife Instrumental Variable Estimator). The results showed that a new Keynesian approach to inflation dynamics is encouraged. Moreover, inflation is more forward-looking in nature and using the output gap produces significant and accurate results. Therefore, the HNKPC is dominant for Morocco.

In contrast, few studies exist for Zimbabwe following a new Keynesian approach to inflation dynamics. However, Mukoka (2019) studied the PC for the country using yearly data and Ordinary Least Squares (OLS) methods. The hypothesis of this study is aimed at finding a negative relation between unemployment and inflation, and it was found that the coefficients of inflation and unemployment share the correct sign. This confirmed the presence of the existence of the PC for Zimbabwe. In other words, when unemployment increases by one unit, inflation will decrease by 9.6 units.

Likewise, Ayinde, Akanegbu, and Jelilov (2021) estimated a HNKPC for Nigeria. The study used quarterly data ranging from 2000 to 2018. GMM and maximum likelihood methods were used in the empirical analysis, and the study found that inflation expectations play an important role in the process of inflation. In addition, the output gap is not a factor that determines inflation in Nigeria. A labour share of income variable was proxied for marginal cost to test for robustness. The results were similar, concluding that forward-looking behaviour of inflation is dominant in Nigeria. However, marginal cost is not a significant driver of inflation. On the other hand, Adjei (2023) studied variations of the NKPC in Ghana. Using OLS regressions, the hypothesis was rejected as there was no evidence of the curve in the economy. Afterward, a structural break was confirmed and the period under study was broken into two subsets, namely, 1971-1992 and 1993-2020. Thereafter, estimations revealed that the PC had flattened in Ghana, implying that output had a smaller effect on inflation. and concluded that it does not exist. The variations included the expectations-augmented PC, accelerationist PC, the Lucas supply curve, HNKPC and the NKPC.

Phiri (2015) studied asymmetry in the PC for SA using an STR model. The use of this model was to capture non-linearity. The study used the NCPC, NKPC and HNKPC as well as extensions to each curve in the linear testing. Extensions to these curves included adding supply sock variables, using an output-based and marginal cost NKPC, and adding inflation inertia in the hybrid version. The empirical findings showed at least one non-linear relationship for each PC specification. In particular, the NCPC and NKPC were not applicable to SA. However, the marginal cost and output-based extensions of the HNKPC produced the best result for SA data. The authors concluded that monetary policy only has the ability to affect the economy on the demand side asymmetrically. In addition, this effect occurs via inflation expectations and inertia. Leshoro and Kollamparabil (2016) studied the existence of the PC in SA. The main objective was to find the PC in SA and whether inflation is determined by forward-looking or backward-looking components. as previous studies disagreed that the PC exists. The authors used HNKPC together with OLS and GMM methods. The OLS and GMM methods found no PC in SA, which means there was no trade-off between inflation and demand-side variables. In addition, OLS showed that

inflation is more forward-looking in SA, while the GMM methods found mixed results about whether inflation is forward-looking or backward-looking.

Chowdhury and Sarker (2017) empirically tested the HNKPC for SA using monthly data for a period of 17 years for the following variables: CPI, money supply, Real Effective Exchange Rate (REER) and Index of Industrial Production (IIP). The empirical estimator used in the study was GMM. The study found that output gap estimations revealed that inflation is very persistent in SA and forward-looking. Finally, the study revealed that the NKPC is unstable for the country.

Similarly, Fedderke and Liu (2018) studied inflation dynamics in SA using a range of PC models. These include the Gordon model, Gali model, NKPC, and HNKPC. The study covered quarterly data from 1970 to 2015. These different PC models were tested against a benchmark model, and the findings of the benchmark model were that inertia is present in SA. The Gordon model produced weak results of an output gap and inflation relationship. On the other hand, the Gali model found that the price level is a significant determinant of cost of production. In addition, results from the NKPC approach using OLS methods showed that wage costs had the strongest influence on inflation. Therefore, the output gap played no role. The GMM estimations provided poor results. In all these PC type models, the MC measure (unit labour cost) provided the most robust results of inflation dynamics.

Likewise, Leshoro (2020) studied inflation dynamics in SA using quarterly data for two separate time periods, namely, 1995-2014 and 2002-2014. In contrast to the other SA studies above, Leshoro (2020) incorporated fiscal policy in the inflation process. In addition, an augmented Gordon's model was used as a basis for the PC. By applying Vector Error Correction Model (VECM), the findings revealed that inflation was positively related to output growth, suggesting no PC in SA. Likewise, the coefficient on output gap was found to be statistically insignificant. The author concluded that the country's deficit, exchange rate and price of electricity are economically important. In addition, these variables significantly determine inflation rates in SA. Therefore, Fiscal Theory of the Price Level (FTPL) applies in SA, which means that fiscal and monetary policies have an effect on inflation.

From the literature reviewed, it can be concluded that the existence of the PC for each country depends on economic conditions. The results relating to SA are mixed and the latest study was reviewed in 2020. This study included an updated time period and sought to update the results of the PC for SA. Moreover, a vast majority of the literature has been done in other countries, specifically in the US and European countries. Most of the studies included in the literature review has made use of GMM methods. However, according to Nason and Smith (2008) using GMM to test for the hybrid PC does not produce reliable results due to weak identification or non-identification of the variables. In addition, GMM is not able to identify the HNKPC. As a result, this papers made use of an ARDL approach, and therefore fills a research gap of using a different estimation approach to studying inflation dynamics in SA. In doing so, the literature for SA is updated as well.

Research methodology

The study followed the theory of the PC developed in 1958, namely the PC reflects a negative relationship between inflation and unemployment. A new Keynesian approach was used together with the HNKPC originally developed by Gali and Gertler (1999), which

also includes inflation inertia. The hybrid curve accounts for monetary policy effects in the process of inflation for a longer time period, and as a result, current inflation is correlated with expected and past inflation. In addition, the NCPC and NKPC were included in the hybrid specification of the PC. Gali and Gertler (1999) represented the HNKPC as follows:

$$\pi_t = \lambda mc_t + y_f\ E_t\{\pi_{t+1}\} + y_b\pi_{t-1} \quad (1)$$

From equation 1 above:

$$\lambda \equiv (1 - \omega)(1 - \theta)(1 - \beta\theta)\emptyset^{-1} \quad (2)$$

$$y_f \equiv \beta\theta\emptyset^{-1} \quad (3)$$

$$y_b \equiv \omega\emptyset^{-1} \quad (4)$$

$$\text{And } \emptyset \equiv \theta + \omega[1 - \theta(1 - \beta) \quad (5)$$

In equations 1 to 5, MC instead of output gap is used. The coefficients of θ, ω and β represent price stickiness, backward-looking price setting behaviour and the discount factor irrespectively. When the coefficient of ω is zero, firms are forward-looking, and the model becomes the NKPC. Alternatively, when β equals one, the model represents the HNKPC and the sum of $y_f + y_b = 1$.

One of the hypotheses of the study was to determine if monetary or fiscal variables has a more significant impact on inflation. Therefore, inflation (CPI), the repurchase rate, money supply (M3), and the Real Effective Exchange Rate (REER) were included as proxies for monetary variables. Final consumption expenditure by government (i.e., government spending) and taxes were included as fiscal variables. In addition, unemployment rate, real GDP (RGDP) and unit labour cost (MC) were included. These variables are represented in the function below:

$$inflation = f(unemplomentrate, REER, RGDP, M3, government\ spending, taxes, repurchase\ rate, unit\ labour\ cost) \quad (6)$$

As a result, equation 6 above can be transformed into equation 7 below to include the expected sign of the variables:

$$CPI = c - unemployment\ rate + RGDP + M3 - REER + taxes - repurchase\ rate + government\ spending + unit\ labour\ cost \quad (7)$$

In equation 7, CPI is the dependent variable while unemployment rate, RGDP, M3, REER, government spending, repurchase rate and unit labour cost are the independent variables. In addition, a proxy for MC, the forcing variable is included, which is unit labour cost. The HNKPC equation thus shows that MC should have a positive sign with inflation (Equation 1). On the other hand, RGDP is added as a measure of output gap to determine if it has a stronger effect on inflation than MC. The expected sign indicates a positive relationship (Gordon, 2011). In addition, inflation and unemployment are expected to have a negative sign in the short run as indicated by the PC (Phillips, 1958). According to the quantity theory of money, money supply positively affects inflation (Mohr et al., 2018), and according to the authors, money supply causes inflation and therefore has a positive sign in the above equation.

Moreover, under the interest rate channel of monetary policy, when the repurchase rate is adjusted, it has ripple effects for other interest rates. AD, income and inflation are also affected when expansionary or contractionary policy is used (Mohr et al, 2018). Therefore, expansionary policy entails reducing the repurchase rate whereas contractionary policy

indicates when the repurchase rate is increased. Van De Merwe and Mollentze (2010) stated that as the repurchase rate is increased due to contractionary monetary policy, inflation will decline. The opposite is true for expansionary monetary policy. As a result, a negative relationship between inflation and the repurchase rate is expected. In the same way, under the exchange rate channel of monetary policy, exchange rates and inflation have a negative relationship. If the exchange rate appreciates, it results in lower inflation. On the other hand, a depreciating currency leads to a high inflation rate (Van De Merwe and Mollentze, 2010). According to the FTPL, inflation can be determined by government debt, spending, and taxes (Bassetto, 2008), but these variables have no direct relation to monetary policy. The study thus included government spending and taxes in the above equation. Mohr et al (2018) stated that fiscal policy uses government spending or taxes. Expansionary fiscal policy is when government spending is increased or when taxes are decreased. If such policies are implemented, the price level will increase. On the other hand, a decrease in government spending or an increase in taxes occurs under contractionary fiscal policy. As a result, inflation will decline. Therefore, government spending has a positive relationship, and taxes have a negative relationship with inflation.

An Autoregressive Distributed Lags (ARDL) model and an Error Correction Model (ECM) were used in the study. This approach was developed by Pesaran, Shin and Smith (2001) and includes a bounds test to cointegration to ascertain if long-run relationships exist in the model. In addition, the main attraction of the method is that the variables can have mixed integration orders, ranging from zero to one. However, variables should not be integrated for order two or higher. Most importantly, the authors mentioned that this model can be used in econometric analysis of the PC and is a linear equation. Additionally, the authors argued that the main feature of using this model is testing for long-run relationships which accommodate multiple processes of adjustment. For example, variables can be integrated of different orders and a single step equation can distinguish the long-run from the short-run. More specifically, the authors agree with Pesaran et al (2001) that an ARDL can be used when analysing the PC. Next, a detailed description of the steps followed in the model are provided.

The initial step for time-series analysis is to conduct unit root testing. This was done to determine the order of integration. This study used the Kwiatkowski-Philips-Schmidt-Shin (KPSS) tests. According to Nkoro and Uko (2016) the KPSS unit root tests the null hypothesis that the variable is stationary against the alternative hypothesis that the variable is not stationary. The null hypothesis is rejected if the calculated value of the KPSS is greater than the critical values.

The next step is to determine the optimal lag length through the VAR model. This is usually determined by the various criterion which include the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), the Hannan-Quinn Criterion (HQC), the Final Prediction Error (FPE), and the Bayesian Information Criterion (BIC). These criteria are successful in selecting the correct lag length; however, AIC and FPE provide the most correct results, with AIC being the more popular choice, especially in small samples of less the 120. Moreover, using AIC or FPE avoids the possibility of selecting a lower lag length. Following the determination of the optimal lag length, the next step is to determine the existence of the long run. According to Shittu et al (2012) and Nkoro and Uko (2016), cointegration is important when one wants to know if long-run relationships exist between variables. This is determined by using the F-statistic of the bound test to cointegration. The

null hypothesis is that there is no cointegration whereas the alternative hypothesis is that there is cointegration. When the calculated F-statistic is greater than both the upper I(1) and lower bounds I(0). The null hypothesis of no cointegration will be rejected. Alternatively, if the F-statistic is lower than the upper and lower bounds, the variables are not cointegrated.

The existence of the cointegration warrant the estimation of the Error Correction Model (ECM). Verbeek (2004) states that the ECM can be estimated using OLS methods, and the model shows how the explanatory variables causes the explained variable to change. As a result, the model gives an indication of when long-run equilibrium will be restored. Particularly, Shittu et al (2012) stated that the ECM is the solution to distinguishing between the short- and long-run in an ARDL model. Nkoro and Uko (2016) put it well by stating that the error correction term indicates the amount of time taken for equilibrium to be restored in the dependent variable.

Lastly, the diagnostic testing is done to ensure that the coefficients estimated are robust. In addition, various tests have been conducted, which include coefficient and residual diagnostic tests. Residual testing involves making sure that the error terms are independently and identically distributed. As a result, serial correlation and heteroskedasticity have been tested for. On the other hand, coefficient testing ensured that the coefficients of the model specified were stable. Thus, Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests have been carried out (Shrestha and Bhatta, 2018).

The data used in the study are quarterly secondary time-series data for the period 2000 – 2022. The variables were inflation (CPI), real gross domestic product (RGDP), money supply (M3), repurchase rate, real effective exchange rate (REER), government spending, unit labour cost, taxes and unemployment rate. CPI, RGDP, repurchase rate and M3 were sourced from the Federal Reserve Bank of St. Louis (FRED). Government spending, taxes, unit labour cost and unemployment rate data came from the SARB. REER data was sourced from the IMF, while RGDP and government spending were logged to allow for uniformity of data.

Empirical findings

Table 1 shows the results of the KPSS unit root test. This was done to ensure that the data was not integrated of order two or higher. The results revealed that the variables have mixed orders of integration, namely zero and one. This is for both intercept as well as intercept and trend. Thus, the mixture of stationarity levels (I(0) and I(1)) suggest an ARDL model can be estimated.

Table 1: KPSS unit root test results

Variable	Intercept		Trend and Intercept	
	Level I(0)	1st difference I(1)	Level I(0)	1st difference I(1)
CPI	0,0490***	0,0904	0,0476***	0,0889
UNEMPLOYMENT	0,6275*	0,2274	0,2713	0,0477***
REER	0,8078	0,0378***	0,0754***	0,0378
M3	0,6265*	0,1423	0,1017***	0,1399
LNRGDP	1,1503	0,4548**	0,2967	0,0726***
REPURCHASE RATE	0,8684	0,0820***	0,0939***	0,0371
UNIT LABOUR COST	1,2503	0,3531**	0,2118*	0,1049

LNGOVERNMENT SPENDING	1,2433	0,3815**	0,2977	0,0891***
TAXES	0,2651***	0,0372	0,0419***	0,0334

*Source: author's own compilation. Note: *** do not reject at 10%, ** do not reject at 5%, * do not reject at 1%*

The lag length criteria results are shown below in Table 2. The table shows the various lag lengths selected according to FPE, AIC, SC and HQ. According to FPE, AIC and HQ, eight lags should be used in the model. However, SC shows that one lag should be used. Based on these results, the model made use of AIC test results in estimating the relationships of inflation dynamics. This is due to the fact that AIC provides accurate results (Liew, 2004).

Table 2: Lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1328,5860	NA	548,0695	31,8473	32,1077	31,9520
1	-671,9744	1156,8870	0,0006	18,1423	20,7467*	19,1892
2	-564,1340	166,8959	0,0003	17,5032	22,4516	19,4924
3	-448,9317	153,6031	0,0002	16,6889	23,9813	19,6204
4	-286,3989	181,8819	0,0000	14,7476	24,3841	18,6214
5	-193,8657	83,7205	0,0001	14,4730	26,4535	19,2890
6	-57,3973	94,2282	0,0000	13,1523	27,4768	18,9106
7	159,5282	103,2979*	0,0000	9,9160	26,5845	16,6166
8	543,0050	100,4344	0,0000*	2,7142*	21,7266	10,3570*

Source: author's own compilation

Table 3: Cointegration results

Sample Size	F-static			6,5634		
	10%		5%		1%	
80	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Asymptotic case	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000
	1,8500	2,8500	2,1100	3,1500	2,6200	3,7700

Source: author's own compilation

Table 3 presents the results for cointegration test. The findings show that the calculated F-statistic is greater than both lower and upper bounds. Thus, the null hypothesis of no cointegration was rejected. This means that there is cointegration in the model and at least one variable shared a long-run relationship with inflation.

Table 4: Long- run dynamics of ARDL

Variable	Coefficient	t-Statistic	Probability
CPI(-1)	0,2613	2,7774	0,0070
CPI(-2)	-0,1694	-1,8157	0,0737
CPI(-3)	0,1152	1,2862	0,2026
LNGOVERNMENT SPENDING	6,3756	2,3953	0,0193
LNGOVERNMENT SPENDING(-1)	-2,1539	-0,9738	0,3335
LNGOVERNMENT SPENDING(-2)	8,9075	3,9773	0,0002
LNGOVERNMENT SPENDING(-3)	-1,9188	-0,8282	0,4104
LNGOVERNMENT SPENDING(-4)	-11,6402	-4,2731	0,0001

LNRGDP	0,9340	0,2414	0,8099
M3	0,0301	0,6958	0,4889
REER	-0,0142	-1,6302	0,1075
REPURCHASE RATE	0,5587	4,2521	0,0001
REPURCHASE RATE(-1)	-0,5919	-4,8838	0,0000
TAXES	-0,0084	-1,4399	0,1544
UNEMPLOYMENT	0,1195	2,6390	0,0102
UNEMPLOYMENT(-1)	-0,1183	-2,4902	0,0151
UNIT LABOUR COST	0,0048	0,2126	0,8322
C	-6,5307	-0,1911	0,8490
SUMMARY STATISTICS R-squared = 0.7178 Adjusted R-squared = 0.6493 F-statistic (Prob) = 10.4735 (0.0000) Durbin-Watson stat = 2.2397			

Source: author's own compilation

The long-run dynamics of inflation in SA is represented in Table 4 above. As can be seen, unemployment has a positive relationship with inflation. This contradicts theory since in the long run, there is no relationship between inflation and unemployment (Szentmihályi and Világi, 2015). On the other hand, the coefficient of lagged unemployment becomes negative. Both unemployment and lagged unemployment are statistically significant as the probabilities are less than 5%. Furthermore, inflation and RGDP share a positive but insignificant relationship. This positive relationship is supported by Gordon (2011).

Moreover, government spending bears a positive coefficient. This is correct as theory dictates that spending should increase due to expansionary fiscal policy, leading to a rise in inflation rates (Mohr et al., 2018). Furthermore, the probability value indicates that the variable is statistically significant, especially when lagged by two and four quarters. In addition, the relationship between inflation and M3 is found to be positive but statistically insignificant. Moreover, according to Mohr et al (2018), the quantity theory of money implies that as money supply increases, price levels will increase. This means that a positive relationship exists. Furthermore, the findings that government expenditure and M3 share positive correlations with CPI, corroborates the findings of Fedderke and Lui (2018). Taxes are negatively related to inflation since it is generally known that a decrease in taxes due to expansionary fiscal policy leads to a rise in inflation (Mohr et al, 2018). However, the probability value is more than 5%, making it insignificant.

Similarly, exchanges rates (REER) have a negative relationship with inflation. This has been theoretically proven by the exchange rate channel (Van De Merwe and Mollentze, 2010). According to the authors, exchange rates and inflation move in opposite directions. If the currency appreciates, the result would be lower price levels and vice versa. However, the probability value of 0,1075 indicates that it is statistically insignificant. When compared with unemployment, repurchase rates shares a positive relationship with inflation which is opposite to theory. According to the interest rate channel, if the repurchase rate is increased, prices will decline. Alternatively, a drop in the repurchase rate results in an increase in inflation (Van De Merwe and Mollentze, 2010). However, when the repurchase rate is lagged by one quarter, the coefficient becomes negative. In addition,

irrespective of the coefficient of the repurchase rate, the variable is statistically significant according to Table 4. On the other hand, inflation and unit labour cost are positively related, but the probability indicates that unit labour cost is an insignificant variable. Most importantly, lagged inflation is significant in the short run. This indicates that inflation is persistent. However, the coefficients vary from positive to negative.

Table 5: Error Correction Model

Variable	Coefficient	Standard Error	t-Statistic	Probability
ECT(-1)	-0,7929	0,0921	-8,6065	0,0000
D(CPI(-1))	0,0542	0,0891	0,6083	0,5447
D(CPI(-2))	-0,1152	0,0782	-1,4737	0,1445
D(LNGOVERNMENT SPENDING)	6,3756	1,6222	3,9303	0,0002
D(LNGOVERNMENT SPENDING(-1))	4,6516	1,7319	2,6858	0,0088
D(LNGOVERNMENT SPENDING(-2))	13,5591	1,6656	8,1406	0,0000
D(LNGOVERNMENT SPENDINGC(-3))	11,6402	1,7666	6,5889	0,0000
D(REPURCHASE RATE)	0,5587	0,0886	6,3074	0,0000
D(UNEMPLOYMENT)	0,1195	0,0376	3,1762	0,0021
SUMMARY STATISTICS R-squared = 0.7187 Adjusted R-squared = 0.6902 F-statistic (Prob) = 25.2294 (0.0000) Durbin-Watson stat = 2.2397				

Source: authors own compilation

The error correction results are shown in Table 5 below. The table also shows the short-run relationships of the model; government spending shares a positive sign with inflation in the short run. In addition, government spending and inflation are positively correlated in the long run as shown above in Table 4. This positive sign is correctly predicted since an increase in spending increases inflation (Mohr et al, 2018). In addition, the variable is statistically significant, especially when lagged up to three quarters. Furthermore, the relationship between the repurchase rate and inflation remains positive and significant in the long and short run. In conclusion, monetary and fiscal policies affect inflation (Leshoro, 2020) due to their significance.

Similarly, the coefficient of unemployment is positive and statistically significant. However, this is opposite to theory which states that a negative relationship exists (Phillips, 1958). Therefore, it can be concluded that the PC does not exist in SA, agreeing with Leshoro and Kollamparabil (2016). A positive relationship suggests that the triangle model of inflation exists. Furthermore, lagged inflation becomes insignificant. Most importantly, the error correction term reveals that it will take approximately 79% every quarter for variables to converge to long-run equilibrium. In addition, the DW statistic shows no problem of autocorrelation, and the ECM is statistically significant as indicated probability of the F-statistic. Finally, the adjusted R^2 reveals the model has an explanatory power of about 69%.

Table 6: Heteroskedasticity

F-statistic	0,6576
Obs*R-squared	12,1193

Scaled explained SS		6,3170
Prob. F(17,70) 0,8324	Prob. Chi-Square(17) 0,7929	Prob. Chi-Square(17) 0,9908

Source: author's own compilation

The Breusch-Pagan-Godfrey test was used to test for heteroskedasticity. Table 6 shows that the null hypothesis of homoscedasticity could not be rejected since the probability values of 0.8324 is greater than the 5% significance levels.

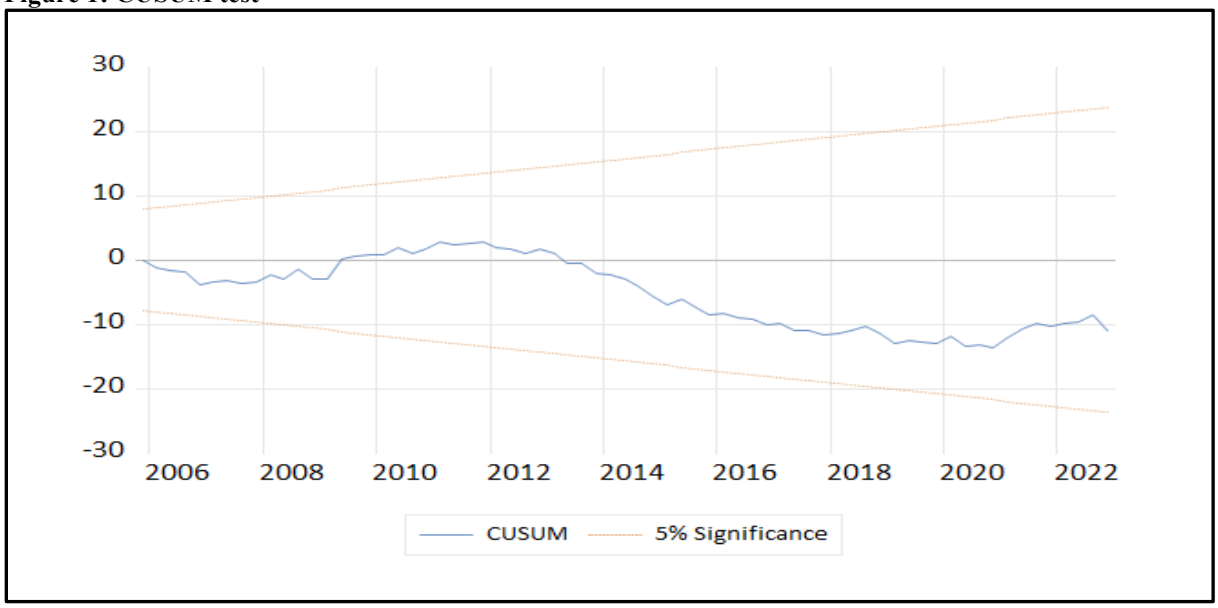
Table 7: Serial correlation

F-statistic	1,1971
Obs*R-squared	11,7740
Prob. F(8,62) 0,3156	Prob. Chi-Square(8) 0,1616

Source: author's own compilation

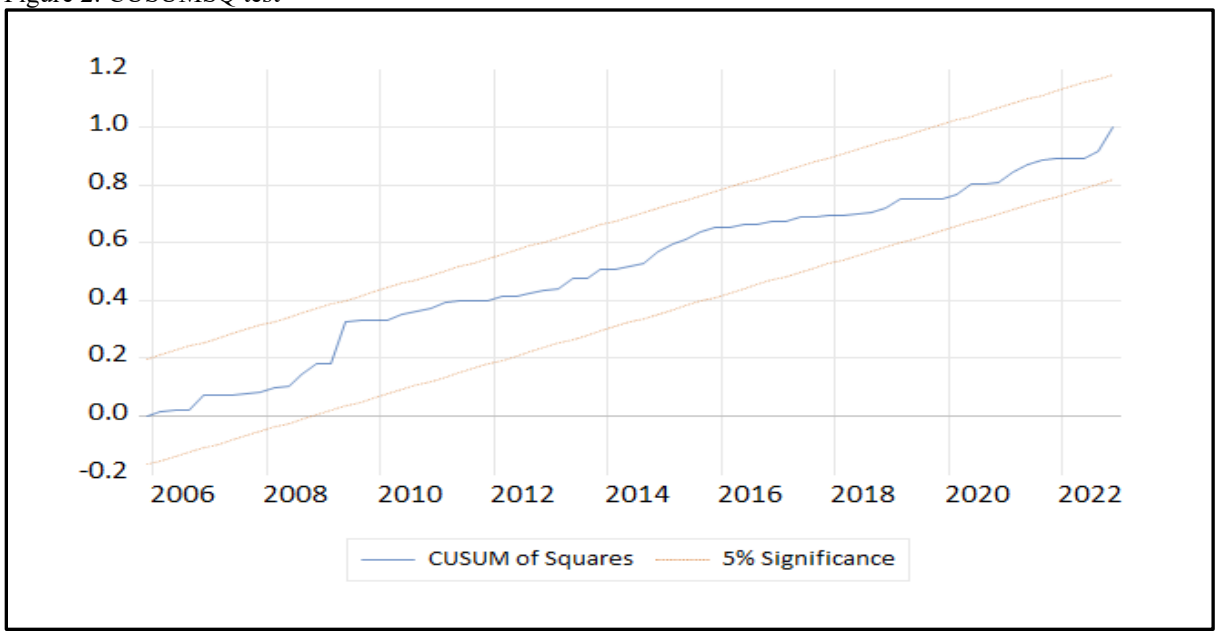
Table 7 revealed that the null hypothesis of no serial correlation could not be rejected. Specifically, the probability value of 0.3156 is greater than 5% level of significance (based on the Breusch-Godfrey LM test).
The CUSUM and CUSUMSQ graphs (Figures 1 and 2) show the stability of the model and coefficients in the long run. Figures 1 and 2 below show that the blue line falls within the bandwidth of the 5% significance level. Therefore, the regression and model is stable and constant over the sample period.

Figure 1: CUSUM test



Source: author's computations

Figure 2: CUSUMSQ test



Source: author's computations

Conclusion

This research study aimed to investigate inflation dynamics in SA using the new Keynesian approach. This approach is based on the assumption that inflation should be influenced by inflation persistence (i.e., lagged inflation) and inertia. The HNKPC was utilised as it included more than one type of PC, and the empirical study applied an ARDL model together with an ECM to fulfill the objectives and prove or disprove its hypotheses. The basic hypothesis of the study was to determine if a HNKPC existed, and to identify the other factors that influence inflation. Consequently, a secondary hypothesis was included to investigate if both monetary and fiscal factors play a role in determining inflation in SA. For this purpose, quantitative research methods were employed using quarterly data for the period 2000 - 2022.

The study found that inflation and unemployment move in a positive direction both in the short and long run, and the relation becomes negative when unemployment is lagged. This could indicate that the triangle model exists in SA. RGDP and unit labour costs had the correct signs but were statistically insignificant in affecting inflation. Lagged inflation was significant in both the short and long run, proving that a new Keynesian approach was the correct route to take. In addition, government spending, the repurchase rate and unemployment were the only variables to affect inflation in both the short and long run. These variables all proved to be significant, and the results indicated that the HNKPC does not exist and that monetary and fiscal variables play a pivotal role in inflation dynamics.

Inflation and unemployment are two very important variables. Both affect people's livelihoods, buying power and economic growth. Unemployed people cannot fight the cost of inflation, and it is important to find the correct balance between the two. Policies aimed at keeping both inflation and unemployment as low as possible should be implemented since this affects economic growth. In addition, both monetary and fiscal policies should be considered when studying inflation dynamics and the PC. The scope of these variables

should also be widened when studying inflation dynamics. Most importantly, inflation is a continuous process; policies should regularly be updated to achieve better results and alternative theories should be considered when analysing inflation.

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