

An Econometric Evidence of the Interactions between Inflation and Economic Growth in South Africa

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Abstract

Little has been done on the relationship between inflation and economic growth, on contrary much empirical evidence commonly show failure to control the growth in real inputs. This paper used annual secondary data to examine the interactions between inflation and economic growth in South Africa during the period of 1980-2010. The Augmented Dickey-Fuller technique in testing the unit root property of the series is used while the hypothesis on the existence of a cointegrated relationship between inflation and economic growth is also tested using Johansen-Juselius co-integration technique. After confirming that a long run relationship between these two variables does exist, an extra effort was made to investigate the causality relationship by employing the Granger causality at two and four lag periods. The findings showed that uni-directional Causality is seen running from inflation to economic growth at both lag 2 and 4. Economic policy implications of findings are discussed and suggestions for future research direction are indicated in the paper.

Keywords: Inflation, Economic Growth; unit root; Cointegration; Granger Causality, South Africa

1. Background

South Africa has been widely applauded for its achievements in overcoming political, social, and economic challenges (such as bands from international trade) posed by the transition to a multi-racial democracy in 1994. However, nearly 20 years into the post-apartheid era, the transition is arguably not over. What lies ahead is the daunting task of ensuring that South Africa's rich natural and human resources are employed for the benefit of all. This implies that South Africa has to use these resources to promote economic growth for sustainable development by promoting sustainable livelihoods, improving social conditions, and alleviating poverty.

Even though South Africa is doing well and also happens to be the largest economy on the continent, the most persistent problem facing the country today is the absence of sustained economic growth which is very essential in alleviating poverty and improving living conditions of all citizens. In addition, like in most developing countries, one of common challenge facing South Africa economy is inflation. Generally speaking, inflation means a continuous increase of prices of goods and services. Recently, the inflation has plunged developing countries (such as Zimbabwe, Argentine to mention few) into long periods of instability. Central banks (South African Reserve Bank in this case) which often aspire to be known as "inflation hawks" often try to maintain a low rate of inflation through inflation targeting. However, this task of controlling inflation seems to be complicated in most cases. This is due probably to maintenance of different policies such as exchange rates stability, free capital movement and monetary policy autonomy known as impossible trinity. To show how inflation is undesirable in general, it was even declared "Public Enemy No. 1" in the United States by President Gerald Ford in 1974.

The fundamental objective of macroeconomic policies in both the developed and developing countries is to sustain high economic growth together with a very low inflation (Chimobi, 2010). The latter has negative consequences for the economic well-being of any country's citizens. In other words, high inflation rate is and could hardly be favourable to economic growth. From empirical point of view, many studies ((Caldor, 1959), (Sidrauski, 1967), (Yap, 1996), (Gokal and Hanif, 2004), (Chimobi, 2010); and (Levine, 2012)) confirm the presence of relationship between economic growth and inflation. Even though these attempted to establish this relationship, it must be mentioned that little research has been done on estimating the above mentioned relationship. This paper aims particularly to investigate if this relationship does exist in South Africa during the period between 1980-2010.

2. Objectives

The primary objective of this study is conducting an empirical investigation on the relationship between inflation and economic growth in South African. To achieve this primary objective, the following specific objectives have been developed:

- To determine the short-run or long-run relationship between inflation and economic growth,
- To establish the causal link between inflation and economic growth in South Africa,
- To suggest some recommendations to macroeconomic policymakers in general and South Africa in particular.

3. Methodology

To achieve the empirical findings, this paper follows the methodology used by Niyimbanira (2013). Firstly, this paper investigates the short-run and long-run relationships between economic growth and inflation by applying Johansen (1988) cointegration test and error correction model (ECM). Secondly, the study applies the Granger causality test to determine the direction of causality between the two variables.

3.1 Model Specification

Mathematical [1] and econometric [2] models showing the relationship between economic growth and inflation are as follows:

$$ECG = f(INF) \dots\dots\dots [1]$$

$$ECG = \alpha_0 + \alpha_1 INF + \varepsilon_t \dots\dots\dots [2]$$

Where

INF stands for inflation and ECG stands for economic growth; while α_0 is the intercept; ε the random error term and t stands for time trend.

3.2 Data Description and Sources

To examine the inflation-economic growth relationship using econometric methodology. The economic growth data were collected from statistics South Africa; while Inflation was collected from South African Reserve Bank website. This paper uses annual data from 1980 to 2010 which make the sample size 31.

3.3 Estimation Technique

3.3.1 Checking for Stationarity

According to Niyimbanira (2013), when analysing time series data, it is very crucial to conduct unit root test to check if such time series are stationary or non-stationary. This test is very important because it helps the research to avoid the problem of spurious regression. For Harris (1995, p. 27) "if a variable contains a unit root then it is non-stationary and unless it is combined with other non-stationary series to form a stationary cointegration relationship, then regression involving the series can falsely imply the existence of a meaningful economic relationship." One of the most popular ways of testing for stationarity is usage of Augmented Dickey-Fuller (ADF) which was initiated by Dickey and Fuller in 1979 and amended in 1981. According to Chimobi (2010), "Augmented Dickey-Fuller test relies on rejecting a null hypothesis of unit root (the series are non-stationary) in favor of the alternative hypotheses of stationarity. The tests are conducted with and without a deterministic trend (t) for each of the series." Hence; ADF equation is as follows:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \alpha_i \sum_{i=1}^m \Delta y_{t-i} + \varepsilon \dots\dots\dots [3]$$

Where $\Delta y_t = (y_{t-1} - y_{t-2})$, $\Delta y_t = (y_{t-2} - y_{t-3})$ and so on and ε is the white noise term, while m stands for the lag length. The ADF test is comparable to the simple DF test, but the slight difference is that the first involves adding an unknown number of lagged first differences of the dependent variable to capture autocorrelation in omitted variables that would otherwise enter the error term.

3.3.2 Testing for Cointegration

In general, "a linear combination of two or more time series will be non-stationary if one or more of them is non-stationary, and the degree of integration of the combination will be equal to that of the most highly integrated individual series" (Dougherty (2011, p.504). This theory is described by Harris (1995, p.22) stating that "if a series must be differenced d times before it becomes stationary, then it contains d unit roots and is said to be integrated of order d , denoted $I(d)$." For Dickey and Fuller (1981) a lack of cointegration means that the long-run relationship between variables in equation does not exist. Therefore, to test for the long-run relationship between economic growth and inflation in South Africa, a Johansen-Jeselius maximum likelihood cointegration analysis was performed. There are two types of Johansen cointegration test, namely, trace and eigenvalue test. The null hypothesis for the trace test is the number of cointegration vectors $r \leq ?$, the null hypothesis for the eigenvalue test is $r = ?$. Just like a unit root test, there can be a constant term, a trend term, both, or neither in the model.

As mentioned above, this paper follow Niyimbanira (2013) where Johansen's methodology takes its starting point in the Vector Autoregression (VAR) of order INF given by:

$$y_t = \mu + \Delta_1 y_{t-1} + \dots + \Delta_p y_{t-p} + \varepsilon_t \dots \dots \dots [4]$$

Where y_t is an $nx1$ vector of variables that are integrated of order commonly denoted (1) and ε is an $nx1$ vector of innovations.

3.3.3 Granger Causality Test

Granger (1969) proposed an approach of determining causality in a time-series data. In the Granger-sense x is a cause of y , if it is useful in forecasting y_t . In this framework "useful" means that x is able to increase the accuracy of the prediction of y with respect to a forecast, considering only past values of y . After cointegration test for a long-run relationship, this paper test for causality between oil price and inflation in South Africa. Chimobi (2010:162) emphasised that "if the two variables are co-integrated, an Error Correction term (ECT) should be introduced in the model. Thus the relationship between economic growth and inflation is present by the following bivariate autoregression:

$$ECG_t = \alpha_0 + \sum_{i=1}^n \alpha_{1i} ECG_{t-i} + \sum_{i=1}^m \alpha_{2i} INF_{t-i} + \delta_1 ECT_{t-1} + \varepsilon_{1t} \dots \dots \dots [5]$$

$$INF_t = \beta_0 + \sum_{i=1}^m \beta_{1i} INF_{t-i} + \sum_{i=1}^n \beta_{2i} ECG_{t-i} + \delta_2 ECT_{t-1} + \varepsilon_{2t} \dots \dots \dots [6]$$

Where ECG is the economic growth and INF is the inflation. The term ECTt-1 is the error correction term derived from the long-run cointegrating relationship in Equation 4. It should be noted that the estimate δ_1 and δ_2 can be interpreted as the speed of adjustment. However, Equation 5 and 6 would become 7 and 8 respectively if long run relationship between economic growth and inflation does not exist. In other words, the term ECT will be removed and bivariate autoregression Equation 5 and 6 become:

$$ECG_t = \alpha_0 + \sum_{i=1}^n \alpha_{1i} ECG_{t-i} + \sum_{i=1}^m \alpha_{2i} INF_{t-i} + \varepsilon_{1t} \dots \dots \dots [7]$$

$$INF_{Ot} = \beta_0 + \sum_{i=1}^m \beta_{1i} INF_{t-i} + \sum_{i=1}^n \beta_{2i} ECG_{t-i} + \varepsilon_{2t} \dots \dots \dots [8]$$

4. Results and Discussion

4.1 Unit Root Test at Levels

Unit root test is about testing for stationarity of the individual variables using Augmented Dicker Fuller (ADF). To conduct all required tests, this paper used EViews software version 7. Results for ADF tests are presented in Table 1 and 2. These results in Table 1 and 2 reveal that the null hypothesis for individual variables (being non stationary) cannot be rejected, suggesting that inflation and economic growth are not stationary at their levels. In other words, there is enough evidence to conclude that both inflation and economic growth have unit root. If the variables are not stationary at their levels, the next step to test for stationarity using the first-difference of such variables (Niyimbanira, 2013). Thus, this paper proceeds with ADF tests for the first-difference of economic growth and inflation.

Table 1. ADF Stationary Test at level (Inflation)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.422430	0.5581
Test critical values:	1% level -3.670170	
	5% level -2.963972	
	10% level -2.621007	

Table 2. ADF Stationary Test at level (Economic Growth)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.008919	0.0043
Test critical values:	1% level -3.670170	
	5% level -2.963972	
	10% level -2.621007	

*MacKinnon (1996) one-sided p-values.

4.2 Unit Root Test at First Difference

The results of unit root at first difference are presented in Table 3 and 4. These results indicate that the estimated t-statistics are greater than critical t-values at the 1%, 5% and 10% levels of significance. This implies that variables are stationary at the first-difference. Thus, there is statistical evidence to conclude that inflation and economic growth become stationary in their first differences. This further imply that the variables are integrated of order one.

Table 3. ADF Stationary at First Difference (Inflation)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.380725	0.0001
Test critical values:	1% level -3.689194	
	5% level -2.971853	
	10% level -2.625121	

*MacKinnon (1996) one-sided p-values.

Table 4. ADF Stationary at First Difference (Economic Growth)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.278547	0.0000
Test critical values:	1% level -3.679322	
	5% level -2.967767	
	10% level -2.622989	

*MacKinnon (1996) one-sided p-values.

4.3 Testing for Cointegration

The findings for trace and maximum eigenvalue cointegration tests are presented in Table 5 and 6. These findings show that all variables in the model, despite initially being individually nonstationary, are cointegrated. For such information, this paper finds that there is a unique long-run relation between the inflation and economic growth and both variables share a common trend. Cointegrating equation shows a positive long-run relationship between the variables. Hence, this paper concludes that the positive long-run relationship between inflation and economic growth in South Africa does exist. According to Engle and Granger (1987) there is a need to further subject the variables to error correction test which helps to estimate how the observed model moves toward the long run equilibrium whenever it has been pushed away.

Table 5. Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.500454	23.07367	15.49471	0.0030
At most 1	0.096599	2.946076	3.841466	0.0861

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-value

Table 6. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.500454	20.12759	14.26460	0.0053
At most 1	0.096599	2.946076	3.841466	0.0861

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

4.4 Vector Error Correction Estimates

A long-run relationship between two variable or more variable is given by cointegration test as shown in sub-section 4.3. However, this doesn't shed any light on short-run dynamics. In other words, according to Dougherty (2011:510) "some short-run forces that are responsible for keeping the relationship intact, and thus that it should be possible to construct a more comprehensive model that combines short-run and long-run dynamics." The results shown in Table 7, show that error correction is negative and significant, indicating that the model adjusts to correct the equilibrium error. The absolute value of 1.9450 indicates that about 194.50 percent of the discrepancy between the long-term and short-term is corrected within year. The fact that the absolute value of ECT is greater than 1, it means that the speed of adjustment to restore equilibrium is less than year. Half-life formula $\left(\frac{\ln 0.5}{-1.9450} = 0.3564\right)$ reveals that the system adjusts to the equilibrium within 0.3564 year which is about 4 months. Coefficients of lags for both variables are not statistically significant at 5 percent level of significance. This suggests that previous changes in both variables do not have short-run effects on economic growth.

Table 7: VEC Results

Error Correction:	D(EG,2)
CointEq1	-1.945007 (0.44216) [-4.39888]
D(EG(-1),2)	0.374015 (0.33314) [1.12269]
D(EG(-2),2)	0.047291 (0.20136) [0.23486]
D(INF(-1),2)	-0.020432 (0.18195) [-0.11230]
D(INF(-2),2)	-0.024402 (0.17644) [-0.13831]
C	0.216625 (0.43716) [0.49553]

4.5 Model consolidation Test and the Overall Goodness of Fit

According to Niyimbanira (2013:110) "the overall goodness of fit of the model can be analyzed by seeing the coefficient of determination or the value of R square and R square adjusted for the degrees of freedom." The R squared value of the model used in this paper was 0.8457 which means that 84.57% of variation in the dependent variable that is inflation is caused by variation in the independent variable which is inflation in this case. The adjusted R square value confirms this result. In addition, to confirm this goodness of fit to check for heteroskedasticity is also needed. "This generally means that the variance of the error term is not constant over time. In other words the independent variables are affected by the variation in error term" (Niyimbanira, 2013:110). The results show that heteroskedasticity does not exist in the model as the probability of chi square came out to be greater than 0.05 (0.6517 in this case).

4.6 Granger Causality Test Analysis

According to Gokal and Hanif (2004) many studies which examine causality commonly use Granger Causality tests. This is because this method does not only test the correlation between two variables (as is tested by traditional approaches such as OLS regression), but also specifies the direction of causality. Table 8 below reveals the test results which show that the null hypothesis that inflation does not Granger Cause Economic growth is rejected at the five percent level of significance. At the same time, the null hypothesis that Economic growth does not Granger cause inflation is accepted. Hence, the results suggest that Granger causality runs one way, from inflation to economic growth in South Africa, also referred to as uni-directional causality.

Table 8. Pairwise Granger Causality Tests (2)

Null Hypothesis:	Obs	F-Statistic	Prob.
D(INF) does not Granger Cause D(EG)	28	2.90030	0.0753
D(EG) does not Granger Cause D(INF)		0.70487	0.5045

5. Implication of the Study and Recommendations

From the findings discussed in section 4 above, this paper is one of very few supporting the intuitive belief that faster sustainable growth can only occur in a climate where the inflation monster is tamed. In other words, one can confirm that it is "more costly for a low inflation country to concede an additional point of inflation than it is for a country with a higher starting rate." Hence, this paper encourages all macroeconomic policy makers to develop more efforts to keep inflation under control which sooner or later pays off in terms of better long-run economic performance.

6. Conclusion

This paper demonstrated one of the major concerns of macroeconomists of finding out the existence of the relationship between inflation and economic growth. The results of the study revealed that with usage of ADF test variables were found stationary which means they were integrated of order one. Findings from cointegration have shown that the long-run relationship between inflation and economic growth does exist in South Africa and are in line with other studies conducted in other countries. Furthermore, the causality between the two variables ran one-way from inflation to economic growth. Meaning that type of inflation which exist in South Africa is cost-push inflation. Further studies should include other variables in the model because this paper used only one explanatory variable (inflation) which was assumed to be one of the determinants of economic growth. Therefore, finding out which unit of production costs rise that puts pressure on price level upwards and simply passed on to consumers in the form of higher prices would be interesting for a future research.

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