AN ANALISYS OF ECONOMIC GROWTH AND INFLATION IN SOUTH AFRICA

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ABSTRACT

A macroeconomic policy priority of both developed and developing economies is to sustain high economic growth together with low, one-digit inflation. It is against this background that this paper aims to explore whether there exists a relationship between inflation and economic growth in South Africa. The methodology employed in this study is the cointegration and Granger causality test. The study used four variables, GDP growth rate for economic growth, CPI for Inflation, INV for foreign direct investment inflow and GPOP for population growth. The time series data covers a period of 34 years, from 1980 to 2014. The result of the test shows no co-integrating relationship between economic growth and inflation for South Africa data. Further test was made to check the causality relationship between the variables by employing the VAR-Granger causality at two different lag periods. The results show the same at different lags. Hence, the study through the empirical findings shows the causality that run from inflation to economic growth and hence an indication of the relationship between Inflation and economic growth.

Keywords: Economic growth, Inflation, South Africa.

INTRODUCTION

A macroeconomic policy priority of both developed and developing economies is to sustain high economic growth together with low, one-digit inflation (Omoke, 2010). Asserting to this is Paldam (1969), states that two of the most important targets of economic policy are an increase in real growth and a decrease in the rate of inflation. The question of whether there is a conflict between these targets has often been discussed, both theoretically and in connection with policy-making.

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Classical economic theories emphasize the need for incentives to save and invest if the nation's economy is to grow, recalling the supply side theories, linking it to land, capital and labour. Keynesian and Neo keynesian theories deliver comprehensive models for linking inflation to economic growth under the AD-AS framework. Monetarism updated the Quantity theory, reemphasising the critical role of monetary growth in determining inflation, while Neo-classical and Endogenous Growth theories tend to associate inflation with growth through its impact on investment and capital accumulation (Gokal and Hanif, 2004).

Research on Asian and European countries show a negative relationship, between economic growth and inflation (Mortaza 2005, Erbaykal and Okuyan 2008). There are also studies which found no evidence of a relationship (Dorrance 1963 and Wai 1959). A study on thirteen Sub-Suharan Africa (SSA) countries, including South Africa amongst others, for the period 1969 to 2009 found a negative relationship (Fikirte, 2012). Regardless of this plethora of studies, the literature on inflation and economic growth in South Africa is insufficient, for a conclusion (Manamperi 2014, Odhiambo 2013, Hodge 2006 and Krogh 1967). The purpose of this paper is therefore to empirically examine the relationship between economic growth and inflation in South Africa.

This paper is organized as follows; section one is the introduction, section two reviews the empirical literature on economic growth and inflation; section three discusses the model and methodology, section four provides data and empirical evidence and finally section five provides the summary and concludes the study.

REVIEW OF RELATED LITERATURE

Ahmed and Mortaza (2005) empirically explore the relationship between inflation and economic growth in Babgladesh, using annual data set on real GDP and CPI for the period of 1980 to 2005, using co-integration and error correction models. Their results show that a statistically significant long-run negative relationship between inflation and economic growth for the country.

Erbaykal and Okuyan (2008) study the relationship between inflation and economic growth in Turkey within the framework of data covering 1987:1-2006:2 period. The study analyzed the causal relationship between inflation and economic growth in the framework of the causality test developed by Yamamoto (1995). Bound Test was used to examine the existence of the long term relationship between these two variables and the existence of a co-integration relationship between the two series was noted. Although no statistically significant long term relationship

was found with the formed ARDL models, a negative and statistically significant short term relationship has been found. The causality relationship between the two series in the framework of the causality test was examined. Though no causality relationship was found from economic growth to inflation, a causality relationship was found from inflation to economic growth. In other words, economic growth does not cause inflation but inflation instead causes economic growth.

Tan (2008) has investigated whether there is any trade-off between inflation and economic growth in Malaysia, Singapore, Thailand, the Philippines, Indonesia, Japan and South Korea. The purpose of the study was met by integrating the Phillips curve framework with Okun's theory. Quarterly data of these countries spanning from 1991 through 2006/7 were mobilized for the purpose. The results suggest a trade-off, though small, between economic growth and inflation in Singapore, South Korea and Thailand after the 1997/98 Asian financial crisis years whereas none in other countries.

Faria and Cameiro (2001) investigate the relationship between inflation and economic growth for Brazil which has been experiencing persistent high inflation until recently. Investigating a bivariate time series model (i.e. vector autoregression) with annual data for the period between 1980 and 1995 the results suggest that although there exists a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long run.

Sarel (1995) examines the possibility of non-linear effects on economic growth. The study finds evidence of a significant structural break in the function that relates economic growth to inflation. The study was conducted to confirm the changing view, from the 1970s and 80s, that inflation had a negative effect on growth. It finds an evidence of a structural break (a situation which occurs when there is a sudden change in a time series or a relationship between two time series) that is significant. The break is estimated to occur when the inflation rate is 8 percent. Below that rate, inflation does not have any effect on growth or it may even have a slightly positive effect. When the inflation rate is above 8 percent, however, the estimated effect of inflation on growth rates is negative, significant, robust and extremely powerful. The results suggest that the existence of a structural break also suggests a specific numerical target for policy, which is to keep inflation below the structural break.

According to Gokal and Hanif (2004) Classical theorists laid the foundation for a number of growth theories. Adam Smith laid the foundation for classical growth model and developed a

supply side driven growth model. Smith considers saving as crucial for investment and hence growth. He also argues that profits decline because the competition of capitalists for workers will bid wages up. Fikirte (2012) states that there is no direct explanation in the Classical theories about inflation and its tax effect on profit level and output but The relationship between the two variables, (economic growth and inflation) is suggested to be negative, as specified by the reduction in firms profit levels through high wage costs.

Keynesians believe in the intervention of government to reach full production. They trust that intervention in the economy by government will boost investment and encourage demand to reach full production through expansionary policies (Fikirte, 2012). Gokal and Hanif (2004), states that the Keynesian model includes the Aggregate Demand (AD) and the Aggregate supply (AS) curves appropriately demonstrating the economic growth inflation relationship. AS curve is upward sloping rather than vertical in the short run thus, changes in AD affects both price and output. If the AS curve is vertical instead, it would mean that changes on the demand side of the economy affect only prices. This holds for the fact that many factors drive the inflation rate and the level of output in the short-run.

However Dornbusch, et al (1996) maintain that AD and AS yield an adjustment path, which shows an initial positive relationship between inflation and economic growth but eventually turns negative towards the later part of the adjustment path. The initial positive relationship between inflation and economic growth is because of the time inconsistency problem. Later on the relationship becomes negative, this outlines the phenomena of stagflation, that is, output decreases or remains the same when price rises.

According to Gokal and Hanif (2004) Neo-Keynesians originally emerged from ideas of the Keynesians with the major development of the concept of potential output, which is referred to as natural output. At this level of output, the economy is at its optimal level of production, which also corresponds to the natural rate of unemployment (NAIRU). NAIRU is the unemployment rate at which the inflation rate is constant and it is determined endogenously. The theory states that inflation depends on the level of actual output (GDP) and the natural rate of employment. The problem though in this theory is that, the precise level of potential output and natural rate of unemployment is unknown and tends to change over time. Therefore inflation also seems to act in unequal way, rising faster than it falls.

Milton Friedman developed Monetarism and its focus is on the long-run supply-side properties of the economy as opposed to short-run dynamics. He also highlighted several key long-run

properties of the economy, as well as the quantity theory of money and neutrality of money. The quantity theory of money linked inflation and economic growth by equating the total amount of spending in the economy to the total amount of money in existence. He argued that inflation is the product of an increase in the supply or velocity of money at a rate greater than the rate of growth in the economy (Gokal and Hanif, 2004).

However Fikirte (2012) has identified money supply as the only factor that determines price levels in an economy, arguing that the growth rate of money supply is managed by government intervention, to match it with the growth rate of output in the long run.

Monetarists also maintain that inflation will occur when money supply rises faster than the rate of growth of national income. Therefore monetarists argue that in the long-run, prices are affected by the growth rate in money although not having any real effect on growth. Inflation will result if the growth in the money supply is higher than the economic growth rate.

Solow (1956) and Swan (1956) developed one of the earliest neo-classical models, displaying diminishing returns to labour and capital separately and constant returns of both factors jointly. Investment (growth of capital (k)) is replaced with technological change as the primary factor explaining long-term growth, and its level anticipated to be determined exogenously thus independently of all other factors, including inflation (Todaro, 2000). Mundell's model argues that an increase in inflation immediately reduces people's wealth. This is shown on the premises that the rate of return on individual's real money balances falls, thus to accrue the desired wealth people save more by switching to assets, increasing their price, therefore driving down the real interest rate. Greater savings means greater capital accumulation and thus faster output growth (Mundell, 1963).

Endogenous growth theories consider economic growth to depend on one variable, the rate of return on capital. Variables, like inflation, decrease that rate of return, which in turn reduces capital accumulation and decreases the growth rate (Gokal and Hanif, 2004). Fikirte (2012) states that the endogenous growth model assumes that technological progress is endogenous, which is contrary to neo-classical growth theory. Further basic difference is that the neo-classical growth theory anticipates capital to have diminishing return while endogenous growth theory expects the marginal product of capital as constant. In the endogenous growth theory, the rate of return on capital including human capital and physical capital, determines the growth rate .A tax on either form of capital induces a lower return.

ECONOMETRIC METHODOLOGY

The study employs two econometric models the first model examining the short-run and long-run relationship between real GDP and CPI by applying the Johansen (1988) co-integration test and second applying the Granger causality test to determine the direction of causality between the two variables.

3.1Model specification

The primary model showing the relationship between economic growth and inflation is specified thus:

$$GDP = f(CPI + INV + GPOP) \quad \text{……..……..……..……} \quad (1)$$

$$GDP_t = \alpha_0 + \alpha_1 CPI_t + \alpha_2 INV_t + \alpha_3 GPOP_t + \varepsilon_t \quad \text{…….....} \quad (2)$$

Where

GDP denotes GDP growth rate used as a proxy for economic growth.

CPI is the Consumer Price Index used as a proxy for Inflation .

INV is the Investment rate used as a proxy for foreign direct investment inflow.

$GPOP$ is the Population growth rate.

α_0 is the constant term, $'t'$ is the time trend, and $'\varepsilon'$ is the random error term.

INV and GPOP are control variables.

3.2 Data Description and Sources

The study uses annual data covering the period from 1980 to 2014. All the variables are obtained from various issues of the World Bank Bulletin.

3.3 Estimation Technique

3.3.1 Unit root test

The first step involves testing the order of integration of the individual series under consideration. Researchers have developed numerous procedures for the test of order of integration. The most common ones are Augmented Dickey-Fuller (ADF) test due to Dickey and Fuller (1979, 1981), and the Phillip-Perron (PP) due to Phillips (1987) and Phillips and Perron (1988). The tests are conducted with and without a deterministic trend (t) for each of the series. The general form of ADF test is estimated by the following regression.

$$\Delta y_t = a^0 + a^1 y^{t-1} + \sum_{i=1}^{n} a\Delta y_t + e^t \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\Delta y_t = a_0 + a_1 y_{u-1} + \sum_{n=1}^{n} a_1 \Delta y_t + \delta_t + e_t \ldots\ldots\ldots (4)$$

Where:

y is a time series, t is a linear time trend, Δ is the first difference operator, α0 is a constant, n is the optimum number of lags in the dependent variable and e is the random error term; the difference between equations (3) and (4) is that the former includes just drift.whereas, the second equation includes both drift and linear time trend pp.

$$\Delta y_t = a_0 + a y_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

3.3.*2.* Cointegration test

The second step is the testing of the presence or otherwise of cointegration between the series of the same order of integration through forming a cointegration equation. The basic idea behind cointegration is that if, in the long-run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long-run equilibrium relationship, as the difference between them is stationary (Hall and Henry, 1989). A lack of cointegration suggests that such variables have no long-run relationship: in principal they can wander arbitrarily far away from each other (Dickey et. al., 1991). We employ the maximum-likelihood test procedure established by Johansen and Juselius (1990) and Johansen (1991). Specifically, if Yt is a vector of n stochastic variables, then there exists a p-lag vector auto regression with Gaussian errors of the following form:

Johansen's methodology takes its starting point in the Vector Autoregression (VAR) of order P given by

$$y_t = \mu + \Delta_1 y_{t-1} + - - - + \Delta p\, y_{t-p} + \varepsilon_t \ldots\ldots\ldots\ldots (6)$$

Where

Y_t is an nxl vector of varfibles that are intergrated of oder commonly denoted (1) and ε_t is an nxl vector of innovations.

This VAR can be rewritten as

$$\Delta y_t = \mu + n_{yt-1} + \sum_{i-1}^{p-1} \tau_i \Delta y_{t-1} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots (7)$$

Where

$$\prod = \sum_{i-1}^{p} A_{i-1} \quad and \quad \tau_i = -\sum_{j=i+1}^{p} Aj$$

To determine the number of co-integration vectors, Johansen (1988, 1989) and Johansen and Juselius (1990) suggested two statistic test, the first one is the trace test (λ trace). It tests the null hypothesis that the number of distinct cointegrating vector is less than or equal to q against a general unrestricted alternatives q = r. the test calculated as follows:

$$\lambda\, trace\,(r) = -T \sum_{i=r+1} In\ \ (1-\lambda_t) \dots\dots\dots\dots\dots\dots (8)$$

Where

T is the number of usable observations, and the λ1,s are the estimated eigenvalue from the matrix.

3.3.3 Granger-causality test

After the testing of the Cointegration relationship, we test for causality between Growth and Inflation in South Africa. If the variables are co-integrated, an Error Correction term (ECT) is required to be included (Granger, 1988) in the following bivariate autoregression:

$$GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1t} GDP_{t-1} + \sum_{i=1}^{m} \alpha_{2t} CPI_{t-1} + \sum_{i=1}^{m} \alpha_{3t} INV_{t-1} + \sum_{i=1}^{m} \alpha_{4t} GPOP_{t-1} + \delta_1 ECT_{t-1} + \varepsilon_{1t} \dots 9$$

$$CPI_t = \beta_0 + \sum_{i=1}^{m} \beta_{1t} GDP_{t-1} + \sum_{i=1}^{n} \beta_{2t} CPI_{t-1} + \sum_{i=1}^{n} \beta_{3t} INV_{t-1} + \sum_{i=1}^{n} \beta_{4t} GPOP_{t-1} + \delta_1 ECT_{t-1} + \varepsilon_{1t} \dots 10$$

Where:

GDP is Gross Domestic product growth rate.

CPI is the Consumer Price Index used as proxy for inflation.

INV is the Investment rate used as a proxy for foreign direct investment inflow.

GPOP is the Population growth rate;

The term ECT_{t-1} is the error correction term derived from the long-run cointegrating relationship in equation 3. We note that the estimate δ1 and δ2 can be interpreted as the speed of adjustment. According to Johansen and Juselius (1987), the existence of cointegration implies the existence of the causality relation between the variables (Economic growth, Inflation, Investment and Population growth) under the constraint /δ1/ +/δ2/ > 0. If cointegration relationship between the variables GDPt, CPIt, INVt and GPOPt does not exist, the term ECT will be removed and the bivariate autoregression equation 9 and 10 becomes:

$$GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1t} GDP_{t-1} + \sum_{i=1}^{m} \alpha_{2t} CPI_{t-1} + \sum_{i=1}^{m} \alpha_{3t} INV_{t-1} + \sum_{i=1}^{m} \alpha_{4t} GPOP_{t-1} + \varepsilon_{1t} \ldots\ldots (11)$$

$$CPI_t = \beta_0 + \sum_{i=1}^{m} \beta_{1t} GDP_{t-1} + \sum_{i=1}^{n} \beta_{2t} CPI_{t-1} + \sum_{i=1}^{n} \beta_{3t} INV_{t-1} + \sum_{i=1}^{n} \beta_{4t} GPOP_{t-1} + \varepsilon_{1t} \ldots\ldots (12)$$

Rejecting (accepting) H0; $\alpha_{21} = \alpha_{22} =$ ---------- $= \alpha_{2m}$ in equation (9 and 10) or equation (11 and 12) suggests that Growth do (do not) Granger cause Inflation. On the other hand, rejecting (accepting) H_0; $\alpha_{11} = \alpha_{12} =$ ---------- $= \beta_{1m}$ suggest that Inflation do (do not) Granger Cause (have an effect) on Economic growth. These tests enable us to reveal the relationship of no causality, unidirectional causality of feedback causality between Money Supply and Inflation.

DATA AND EMPIRICAL RESULTS

4.1 Unit Root Test Analysis

This implicates testing for the stationarity of the individual variables using both the Augmented Dickey Fuller (ADF) and Phillips – Perron (PP) tests to find the existence of unit root in each of the time series. The results of both the ADF and PP tests are reported in Tables 4.1(Levels) and 4.2 (First Difference).

Inflation and population growth were not found stationary in levels. This can be seen by comparing the critical valise of both the ADF and PP test statistics with the critical values of the

test statistics at the 1%, 5% and 10% level of significance. Result from table 4.1 provides strong evidence of nonstationarity on CPI and GPOP. Therefore, the null hypothesis is accepted and it is sufficient to conclude that there is a presence of unit root in the variables at levels. GDP and FDI were found stationary in levels and result provides strong evidence of stationarity. Thus, the null hypothesis is rejected and it is sufficient to conclude that there is no presence of a unit root in the variables at levels.

Table 4.1 ADF and PP Stationarity test at Levels

Variables	ADF (Intercept)	ADF (intercept & trend)	PP (Intercept)	PP (intercept & trend)
GDP	-4.27 (0.00)***	-4.49 (0.00)***	-4.28 (0.00)***	-4.45 (0.00)***
CPI	-1.67 (0.43)	-2.72 (0.23)	-1.42 (0.55)	-2.71 (0.23)
INV	-4.26 (0.00)***	-5.65 (0.00)***	-4.26 (0.00)***	-5.74 (0.00)***
GPOP	-2.40 (0.14)	-3.28 (0.08)	-2.04 (0.26)	-2.63 (0.26)

Note: Significance at 1%, 5% and 10% level denoted by ***, ** and * respectively. Figures within parenthesis indicate P-values. Mackinnon (1991) critical value for rejection of hypothesis of unit root applied.
Source: Author's Estimation using Eviews 8.0.

As a result of the above result, CPI and GPOP were differenced once and both the ADF and PP test were conducted on them as shown in table 4.2. The coefficients compared with the critical values (1%, 5% and 10%) reveals that all the variables were stationary at first difference and on the basis of this, the null hypothesis of non-stationary is rejected and it is safe to conclude that the variables are stationary. This implies that the variables are integrated of order one, i.e. 1(1).

Table 4.2 ADF and PP Stationarity test at First Difference

Variables	ADF (Intercept)	ADF (intercept & trend)	PP (Intercept)	PP (intercept & trend)
DCPI	-4.88 (0.00)***	-4.78 (0.00)***	-7.72 (0.00)***	-8.86 (0.00)***
DGPOP	-4.41 (0.00)***	-4.34 (0.00)***	-4.27 (0.00)***	-4.16 (0.01)**

Note: Significance at 1%, 5% and 10% level denoted by ***, ** and * respectively. Figures within parenthesis indicate P-values. Mackinnon (1991) critical value for rejection of hypothesis of unit root applied.

Source: Author's Estimation using Eviews 8.0.

4.2 Cointegration Test Analysis

The result of the cointegration condition (that is the existence of a long term linear relation) is presented in Table 4.3 (Trace Statistics) and 4.4 (Maximum Eigenvalue) using methodology proposed by Johansen and Juselius (1990):

In the Cointegration tables, both test indicated no cointergration at the 5 percent level of significance, suggesting that there is no cointegrating (or long run) relationship between variables so the null hypothesis was accepted.

Table 4.3 Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.566761	42.22789	47.85613	0.1524
At most 1	0.285189	16.29747	29.79707	0.6912
At most 2	0.158761	5.889642	15.49471	0.7085
At most 3	0.016963	0.530366	3.841466	0.4665

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.566761	25.93042	27.58434	0.0802
At most 1	0.285189	10.40783	21.13162	0.7057
At most 2	0.158761	5.359276	14.26460	0.6960
At most 3	0.016963	0.530366	3.841466	0.4665

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

4.3 Granger Causality Test Analysis

Causality does not necessarily suggest exogeneity in the sense that the result gotten may not explain whether the relationship is positive or negative. However, economicgrowth and inflation, as widely suggested by many economist scholars in the literature reviewed are known to relate inversely, emphasising that, the economy does not grow well in the midst of high inflation. In any case the following result shown in the tables below reveals the direction of causality between growth and inflation at lag one (1) and lag two (2).

Following the result in table 4.7, the null hypothesis that CPI does not Granger Cause GDP is rejected and it is safe to conclude that unidirectional causality run from Inflation to Economic growth at lag one (1). In the result shown in table 4.8, the null hypothesis that CPI does not Granger Cause GDP is rejected, further confirming a unidirectional causality from Inflation to GDP at lag 2.

CONCLUSION

The objective of this paper is to explore whether there exists a relationship between inflation and economic growth in South Africa's economy.

The methodology used in this study is the cointegration and Granger causality test. In its econometric analyses the study used four variables, GDP denotes GDP growth rate used as a proxy for economic growth, CPI as a proxy for Inflation, INV as a proxy for foreign direct investment inflow and GPOP as a proxy for population growth to examine the relationship. The time series data covers a period of 34 years, thus from 1980 to 2014. A stationarity test was carried out using the Augmented Dickey-Fuller test (ADF) and Phillip-Perron test (PP) and stationarity found at first difference at 1% and 5% level of significance. Thus, the null hypothesis was rejected and it is sufficient to conclude that there is no presence of a unit root in the variables at levels. However all the variables were stationary at first difference and on the basis of this, the null hypothesis of non-stationary is rejected and it is safe to conclude that the variables are stationary.

The Johansen-Juselius co-integration technique employed in this study proved to be superior to the Engle and Granger (1987) approach in assessing the co-integrating properties of variables, especially in a multivariate context. The test found no cointegrating vectors, thus according to Omoke (2010) there is no need to further subject the variables to error correction test which has lead us to examine the causality between growth and inflation

Further tests were made to check the causality relationship that exists between the variables by employing the VAR-Granger causality at two lag periods. The results showed the same at different lags. The null hypothesis that CPI does not Granger Cause GDP was rejected and concluded that there was unidirectional causality run from Inflation to GDP at lag one (1). At lag two (2) the null hypothesis that CPI does not Granger Cause GDP was rejected, further confirming a unidirectional causality from Inflation to GDP.

The study did not go beyond testing whether the relationship between inflation and growth was negative or positive; although, various studies as revised in the literature have come out with the outcome that high inflation is and has never been favourable to economic growth. The fact that causality runs from inflation to economic growth is an indication of a relationship showing that Inflation indeed has an impact on economic growth.

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APPENDIX

Table 4.7 Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause GDP	34	8.36446	0.0069
GDP does not Granger Cause CPI		5.31849	0.0280
INV does not Granger Cause GDP	34	0.00945	0.9232

GDP does not Granger Cause INV		3.04658	0.0908
GPOP does not Granger Cause GDP	34	0.95333	0.3364
GDP does not Granger Cause GPOP		0.19949	0.6582
INV does not Granger Cause CPI	34	0.01032	0.9198
CPI does not Granger Cause INV		9.65256	0.0040
GPOP does not Granger Cause CPI	34	0.47560	0.4956
CPI does not Granger Cause GPOP		1.59365	0.2162
GPOP does not Granger Cause INV	34	1.01734	0.3210
INV does not Granger Cause GPOP		1.34342	0.2553

Table 4.8 Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause GDP	33	7.06181	0.0033
GDP does not Granger Cause CPI		1.65440	0.2094
INV does not Granger Cause GDP	33	0.58899	0.5616
GDP does not Granger Cause INV		2.20843	0.1287
GPOP does not Granger Cause GDP	33	0.97367	0.3901
GDP does not Granger Cause GPOP		0.51924	0.6006
INV does not Granger Cause CPI	33	4.16261	0.0261
CPI does not Granger Cause INV		5.38457	0.0105
GPOP does not Granger Cause CPI	33	0.38525	0.6838
CPI does not Granger Cause GPOP		1.19201	0.3186
GPOP does not Granger Cause INV	33	0.45327	0.6401
INV does not Granger Cause GPOP		0.69510	0.5074