IMPACT OF INFLATION ON ECONOMIC GROWTH: A CASE STUDY OF TANZANIA

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ABSTRACT

Like several other countries both industrialised and non-industrialised, one of the central objectives of macroeconomic policies in Tanzania is to promote economic growth and to keep inflation at a low level. However, there has been substantial debate on whether inflation promotes or harms economic growth. Motivated by this controversial, this study examined the impact of inflation on economic growth and established the existence of inflation growth relationship. Time-series data for the period 1990 -2011 were used to examine the impact of inflation on economic growth. Correlation coefficient and co-integration technique established the relationship between inflation and GDP and Coefficient of elasticity were applied to measure the degree of responsiveness of change in GDP to changes in general price levels. Results suggest that inflation has a negative impact on economic growth. The study also revealed that there was no co-integration between inflation and economic growth during the period of study. No long-run relationship between inflation and economic growth in Tanzania.

Keywords: Inflation, Economic growth, Co-integration, Dickey-Fuller, Phillip-Prron

INTRODUCTION

To attain sustainable economic growth coupled with price stability continues to be the central objective of macroeconomic policies for most countries in the world today. Among others the emphasis given to price stability in conduct of monetary policy is with a view to promoting sustainable economic growth as well as strengthening the purchasing power of the domestic currency (Umaru and Zubairu, 2012). The question on whether or not inflation is harmful to economic growth has recently been a subject of intense debate to policy makers and macro economists. Several studies have estimated a negative relationship between inflation and economic

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growth. Specifically the bone of contention is that whether inflation is necessary for economic growth or it is detrimental to growth. Basically the rate of economic growth depends primarily on the rate of capital formation and the rate of capital formation depends on the rate of savings and investment (Datta and Kumar, 2011). World economic growth and inflation rates have been fluctuating. Likewise, inflation rates have been dominating to compare with growth rates in virtually many years (Madhukar and Nagarjuna, 2011) and relationship between inflation and the economic growth continued to be one of the most macroeconomic problems. Similarly, Ahmed (2010) maintains that this relationship has been argued in various economic literatures and these arguments shown differences in relation with the condition of world economy order. In accordance with these policies, increases in the total demand caused increases in production and inflation too. However, inflation was not regarded as a problem in that period rather considered as a positive impact on the economic growth which was widely accepted. Amid these views, Phillips first introduced hypothesizes that high inflation positively affects the economic growth by lowering unemployment rates.

In 1970s, countries with high inflation especially the Latin American countries begun to experience a decrease in growth rates and thus caused the emergence of the views stating that inflation has negative effects on the economic growth instead of the positive effects. Evidence showing relationship between inflation and economic growth from some of the Asian countries such as India showed that the growth rate of Gross Domestic Product (GDP) in India increased from 3.5% in the 1970s to 5.5% in the 1980s while the inflation rate accelerated steadily from an annual average of 1.7% during the 1950s to 6.4% in the 1960s and further to 9.0% in the 1970s before easing marginally to 8.0% in the 1980s (Prasanna and Gopakumar, 2010). Likely, for the case of China, Xiao (2009) revealed that from 1961 to 1977, China's real GDP growth and real GDP per capita growth averaged at 4.84% and 2.68% respectively. Since 1978, China's economy grew steadily although growth rate fluctuated among the years. From 1978 to 2007, the growth rate of China's real GDP and real GDP per capita were recorded at 9.992% and 8.69% respectively. The experiences from East African countries, for example showed that Kenya had 5 years of very positive economic development with four consecutive years of growth above 4%. But average annual inflation of Kenya increased from 18.5% in June 2008 to 27.2% in March 2009, before falling marginally to 24.3% in July 2009. Uganda was one of the faster growing economies in Africa with sustained growth averaging 7.8 % since 2000 with the annual inflation rate decreasing from5.1% in 2006 to 3.5% in 2009. The average annual real GDP growth rate for Rwanda from 1990-1999 was -0.1 but from 2006 to 2009, Rwanda had an annual average growth rate of 7.3% (Stein, 2010). Since late 1970s, Tanzanian economy experienced many internal and external shocks. All sectors of the economy were affected by shocks, whose manifestations were, among others, large budget deficits and an imbalance between productive and non-productive activities. The signs closely associated with these were high rates of inflation, large balance of payments (BOP) deficits, declining domestic savings, growing government expenditure, falling agricultural

produce and decreased utilization of industrial capacity which in turn hindered economic growth (Kilindo, 1997). With regard to Tanzanian economy, Ndyeshobola (1983) indicated that between 1964 and 1969 there was very low inflation (0.3% and 3.2%) on the average for the National Consumer Price Index (NCPI) and National Food Price Index (NFPI) respectively. After 1972, the NCPI rose by an average of 16% until 1975, (with peaks of 19% in 1974 and 25.9% in 1975). The NCPI in 1974 and 1975 seems to have been caused by the severe food problems prevailing during the second half of 1973. The NFPI reached as high as 35.0% in 1974 and 30.6% in 1975. Tanzania's economic growth has shown an erratic trend as it recorded an average GDP growth rate of about 3% between 1991 and 2000, the GDP growth rate in 1992 was only 0.584%, while the rates in 1996 and 2000 were 4.6% and 5.1% respectively (Odhiambo, 2011).

Between 1952 to 1970 economic growth rate of 5.2 percent was coupled with single digit rates of official inflation, with the exclusion of the period of 1966-70 when the rate of inflation was 11.7 percent. From 1965 to 1985 the rate of economic growth constantly declined as the rate of inflation continuously increased. Tanzania showed steady price stability in the 1950s and 1960s. Annual average rates of inflation were low, in a single digit, at about 4.5% and 9.3 % during 1950s and 1960s respectively. But the rates rose to 10.5% in 1973, before it reached 26.5% in 1975. During 1980-1985 the average highest rate of inflation, 27.3% was coupled with the lowest rate of economic growth of 0.9%. Moreover, studies revealed that, as the economy recovered during 1986-1990, the average rate of inflation decreased to 23.9% in turn average growth rate rose to 3.7 % (Shitundu and Luvanda, 2000). A central objective of Tanzania's macroeconomic policies is to promote economic growth and to keep inflation on a low level. However, in recent years there has been substantial debate on the relationship between inflation and economic growth. Some scholars, mainly those in favour of the Structural and Keynesian perspectives tend to believe that inflation is not harmful to economic growth whereas other scholars particularly those in favour of monetarist views, argue that inflation is harmful to economic growth. Some findings say that there is significant short-run relationship but not in the long-run (Datta and Kumar, 2011). Motivated by this economic controversial, this study investigated the impact of inflation on economic growth in Tanzania.

Objectives of the study

Specifically the study aimed at achieving the following objectives:

i.   To examine the impact of inflation on economic growth in Tanzania over the period 1990-2011

ii.   To measure the degree of responsiveness of Tanzanian economic growth (GDP) to changes in the general price levels (Inflation rate).

iii. To establish the relationship between inflation and GDP growth rate in Tanzania.

Justification of the study

This study is very important to macroeconomists, financial analyst, academicians, policy makers and central bankers officials in understanding the responsiveness of GDP to the change in general price level and thus come up with the relevant policies so as to keep prices at the reasonable rate that stimulate production. It is necessary to policy makers to clear doubt as many studies on the relationship between inflation and economic growth remains inconclusive, several empirical studies confirm the existence of either a positive or negative relationship between these two macroeconomic variables. For example, Mubarik (2005) found that low and stable inflation promotes economic growth and vice versa. Also the study carried by Shitundu and Luvanda, (2000) on the effect of inflation on economic growth in Tanzania concluded that inflation has been harmful to economic growth in Tanzania but they did not show the degree of responsiveness of GDP growth rate to changes in the general price levels. This study examined the impact of inflation on economic growth in Tanzania by showing the degree of responsiveness of change in GDP due to change in general price levels in Tanzania and thus filling the existing knowledge gap.

LITERATURE REVIEW

There is a huge survey of literature, which investigated theoretical and empirical aspects of relationship between inflation and economic growth. This section presents literature on the impact of inflation on economic growth.

Selected empirical literature review

A way back, Fischer (1993) used both cross-section and panel data that included both industrialised and developing economies to present a seminal contribution to the literature in exploring the possibility of a non-linear relationship between inflation and economic growth in the long-run. In his study, he found that the existence of significant negative association between inflation and economic growth. He also observed that inverse relationship dampens inflation rates after 40% in addition to establishing the existence of non-linearities in the inflation-growth nexus. Ghosh and Phillips, (1998) maintain that while there is no doubt about the fact that high inflation is bad for growth, there is less agreement about the effect of moderate inflation. Using panel regressions which allowed for nonlinearity specification, they found a statistically and economically significant inverse relationship between inflation and economic growth which holds robustly at all but the least inflation rates. They concluded that short-run growth costs of disinflation are only relevant for the most severe disinflations or when the initial inflation rate is well within the single-digit range. Quartey, (2010) using the Johansen co-integration methodology, investigated whether the revenue maximising rate of inflation is growth maximising in Ghana. He found that there is a negative impact of inflation on growth. Furthermore, the study found a revenue maximising rate of inflation at 9.14 percent over the period 1970-2006 using the Laffer curve. He further established that the rate of inflation that is growth maximising is not a single digit one. Barro, (1995) made an assessment on the effects of inflation on economic performance using data for around 100 countries

over the period 1960-1990. His study reached to a conclusion that if a number of country characteristics are held constant, then the regression results suggested that an increase in average inflation of 10 percent per annum reduces the growth rate of real GDP by 0.2 to 0.3 percent per annum and lowers the ratio of investment to GDP by 0.4 to 0.6 percent. In addition, Barro (1996) conducted another empirical study using panel data of around 100 countries from 1960 to 1990. He revealed that for a given starting level of real per capita GDP, the growth rate is enhanced by lower inflation, higher initial schooling and life expectancy, lower fertility, lower government consumption, better maintenance of rule of law, and improvements in the terms of trade. Marbuah, (2010) investigated the relationship between inflation and economic growth to ascertain whether a significant threshold effect existed in the case of Ghana over the period 1955-2009. The study found evidence of significant threshold effect of inflation on economic growth with and without structural break. Specifically, the evidence showed both a minimum and maximum inflation threshold levels of 6% and 10% respectively. Moreover, the study found that adjusting for structural break in the model increases the effect of inflation on growth at a robust threshold level of 10% by a factor of 1.8 or approximately 81%.He concluded by recommending to continue pursuing the inflation targeting framework by keeping inflation targets below 10% for beyond 10% threshold, inflation can be detrimental to Ghana's growth prospects.

Hasanov, (2010) employed annual data set on growth rate of real GDP, Consumer Price Index Inflation and growth rate of real Gross Fixed Capital Formation to investigate whether there was any threshold effect of inflation on economic growth over the period of 2001-2009. Estimated threshold model indicated that there was non-linear relationship between inflation and economic growth in the Azerbaijani economy and threshold level of inflation for GDP growth was 13 percent. Inflation rate lower than 13 percent reflected statistically significant positive effect on GDP growth but this positive relationship became negative when inflation exceeded 13 percent. He added that, economic growth was expected to decline by about 3 percent when inflation increased above the 13 percent threshold. Umaru and Zubairu, (2012) suggested that all the variables in the unit root model were stationary and the results of causality revealed that GDP caused inflation and not inflation causing GDP. The results also revealed that inflation possessed a positive impact on economic growth through encouraging productivity and output level and on evolution of total factor productivity. Mallik and Chowdhury, (2001) found two results: First, the relationship between inflation and economic growth is positive and statistically significant for Bangladesh, Pakistan, India and Sri Lanka. Second, the sensitivity of growth to changes in inflation rates was smaller than that of inflation to changes in growth rates. The policy implication of these results was the fact that although moderate inflation promotes economic growth, faster economic growth absorbs into inflation by overheating the economy.

Frimpong and Oteng-Abayie, (2010) found a threshold effect of inflation on economic growth of 11 percent for Ghana over the period 1960-2008 though failing the test of significance at that level.

They also estimated a robust 11 percent threshold inflation level with close coefficients after dropping growth rate of aggregate labour force and money supply growth which were found to be insignificant in the OLS models. They further revealed that even at relatively lower threshold levels, inflation is still significant. But their study however, failed to check for sensitivity of the estimated coefficients across sub-samples of the full sample period to establish a new evidence of the threshold effect. The study thus concluded by highlighting the need to extend the context of analysis to deal with lower threshold levels in search of that evidence. On the other hand, Bick *et al.* (2009) empirically expanded the scope of Khan and Senhadji, (2001) by modelling a large panel-dataset of 124 industrialized and developing countries over the period from 1950 to 2004. Using a dynamic panel threshold model to shed light on the impact of inflation on economic growth, they found an inflation target of about 2 percent for industrialized countries and 17 percent for developing economies. Below the 17 percent threshold, the impact of inflation on economic growth remained insignificant, thus failing to support the growth-enhancing effects of inflation on economic growth in non-industrialized economies. Nell, (2000) examined the issue if inflation was detrimental to economic growth or not by using Vector Auto Regressive (VAR) technique. Data for the period from 1960-1999 was used and his empirical results suggested that inflation within the single-digit zone may be beneficial to economic growth, while inflation in the double digit zone tends to limit economic growth.

Sergii, (2009) found that growth - inflation interaction was strictly concave with some threshold level of inflation. Inflation threshold level is estimated using a non-linear least squares technique, and inference made by applying a bootstrap approach. The main findings were that inflation rate above 8 percent tend to slow down economic growth while below 8 percent promotes economic growth. Espinoza *et al.* (2010) examined threshold effect of inflation on GDP Growth by using a panel data of 165 countries including Oil Exporting Countries and Azerbaijan over the period of 1960-2007. Their study found that for all country groups' threshold level of inflation for GDP growth was about 10 percent (with the exclusion of industrialized countries where threshold level was much lower). Estimated results suggested that inflation from higher than 13 percent decreases real non-oil GDP by 207 percent per year. Lastly, review of literature on money supply and exchange rate influence on economic growth and inflation. Mehari and Wondafrash, (2008) revealed that money supply had a direct impact on inflation. Mwase, (2006) indicated that currency appreciation is associated with a decrease in inflation rate, with one quarter lag.

METHODS OF DATA ANALYSIS

To achieve objectives of this study, the researchers used three methods of analysis, each for one objective. The study used reduced form regression equation (ILS) to investigate the impact of inflation on economic growth. Coefficient of elasticity was used to measure the degree of responsiveness of change in GDP growth rate due to change in general price levels. Co-integration

technique was applied to measure whether the two variables (inflation and economic growth) moved together in the long-run.

Reduced form regression equation

In order to investigate the impact of inflation on economic growth in Tanzania, the researchers modified the following model adopted from Khan and Senhadji, (2001) for the analysis of threshold level of inflation for Bangladesh.

$$GDP_t = \beta_0 + \beta_1 INFL_t + \beta_2 D(INFL_t - K) + U_t \qquad (1)$$

Where GDP stands for Gross domestic product, INFL= Inflation, U_t = error term, D= Dummy variable, and K is the threshold level of inflation (the rate of inflation at which structural break occurs). The model by Khan and Senhadji, (2001) was modified by the researchers so as to examine the impact of inflation on economic growth in Tanzania as follows:

$$GDP_t = \beta_0 + \beta_1 INFL_t + U_t \qquad (2)$$

Where, GDP= Growth rate of real Gross Domestic Product, INFL= Inflation, U_t= error term and $\beta_0 and \beta_1$ are parameters. After getting reduced form regression equation, the study established coefficient of elasticity by differentiating the equations with respect to Inflation (INFL).

Coefficient of elasticity as the measure of degree of responsiveness

This study employed the logarithmic techniques to measure the responsiveness of GDP to changes in general price level. Moreover, Ramanathan (2002) underlined elasticity with non-linear regression equation by using $\ln(Y) = \alpha + \beta \ln(X) + \varepsilon$ as an example. He interpreted β as elasticity. Kasidi, (2010) added that in the basic regression without logs, Y tends to change by β units for a one unit change in X. However, in the regression containing both logged dependent and explanatory variables Y tends to change by β percent for one percent change in X. That is, instead of having to worry about units of measurements, regression results using logged variables are always interpreted as elasticity. Therefore, for the purpose of getting elasticity in the linear reduced form regression equation, the formula adopted a model in Ramanathan, (2002):

$$Y = \beta_0 + \beta_1 X; \text{Where its elasticity becomes } \beta_1 X\!\!\Big/\!\!Y \qquad (3)$$

Where Y= GDP Growth rate and X=Inflation rate (INFL). When equation (2) is transformed into logarithm it becomes as:

$$LogGDP_t = \beta_0 + \beta_1 LogINFL_t; \text{where its elasticity becomes } \beta_1 \qquad (4)$$

Equation (4) measured the degree of responsiveness of change in Tanzanian GDP growth rate to changes in the general price levels.

Unit root test for stationary of data

The major purpose for conducting unit root test is that if we use the data without checking their stationarity properties, the results derived from the regression models would produce the so called spurious results (Datta and Kumar, 2011). Before estimating our modified model in the equation (2) it was very important to test out stochastic properties of the variables to be estimated. Habitually this task is realised by conducting unit root test. However, one of the weaknesses of unit root test is related to small number of observations and that a minimum number of 20 observations are required so as to get reliable results which can be made inference (Gujarati and Porter, 2009; Gujarati, 2004). The analysis was done using the Dickey-Fuller (DF) or more convenient ADF that is Augmented Dickey-Fuller and Phillips-Perron unit root test. The study proceeded with the estimation of the model in equation (2). The null hypothesis for the two tests was unit root or the time series was non-stationary (i.e. $\delta = 0$) while the alternative hypothesis states that there is no unit root or the time series was stationary (i.e. $\delta \neq 0$).The general form of DF and ADF is estimated by using the following models:

$$Y_t = \gamma Y_{t-1} + \varepsilon_t \qquad (5a)$$

If $\gamma = 1$, equation (5a) becomes a random walk, that is, a non stationary process. As a result of this there tends to be the so called unit root problem which means there is a situation of non stationarity in the series. However, if $\gamma < 1$, this means that the series Y_t is stationary. However, the unit root problem can be eliminated or stationarity can be achieved by differencing the data set (Wei 2006). The basic idea behind the ADF unit root test for non stationarity is to simply regress Y_t on its (one period) lagged value Y_{t-1} and find out if the estimated γ is statistically equal to one or not. In this case, equation (5a) can be further manipulated by subtracting Y_{t-1} from both sides and obtain:

$$Y_t - Y_{t-1} = (\gamma - 1)Y_{t-1} + \varepsilon_t \qquad (5b)$$

If equation (5b) is re-written as following:

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t \qquad (5c)$$

Where $\delta = (\gamma - 1)$, and Δ is the difference operator. Practically, instead of estimating equation (5a), the study estimated equation (5c) and tested for the null hypothesis of $\delta = 0$ against the alternative hypothesis of $\delta \neq 0$. If $\delta = 0$, then $\gamma = 1$ which means that there is a unit root problem and the series under consideration is non-stationary. The decision to accept or not to accept the null hypothesis of $\delta = 0$ was based on the Dickey-Fuller critical values of the $|\tau|$ tau statistic. The ADF test tends to include the lags of the first difference in the regression equation so as to make

the error term ε_t white noise and thus, the testing procedure for the ADF unit root test is applied to the following model:

$$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \varepsilon_t \tag{5d}$$

From equation (5d), α_0 is a constant, α_1 the coefficient on a time trend series, γ the coefficient of y_{t-1} which measures the unit root, ρ is the lag order of the autoregressive process, δ_j is a measure of lag length, $\Delta y_t = y_t - y_{t-1}$ are first differences of y_t, y_{t-1} are lagged values of order one of y_t, Δy_{t-j} are changes in lagged values, and ε_{it} is the white noise (Ssekuma, 2011).

In testing the unit root, the researcher employed ADF instead of DF test because the ADF took care of possible serial correlation in the error terms by including the lagged difference of the de pendent variable. Moreover, Phillips-Perron was used to test for the presence of unit root because it also take care of serial correlation in the error terms by using the non-parametric statistical method without addition of lagged difference terms (Hussain 2011). The Phillip-Perron test is based on the following model:

$$\Delta y_t = \varphi + \beta(t - T/2) + (\rho - 1)y_{t-1} + \chi \Delta y_{t-1} + \varepsilon_t \tag{6}$$

Co-integration test

Two variables are said to be co-integrated if they have a long-term, or long run equilibrium, relationship between them. If two variables, dependent and an independent, are individually non-stationary but their residual (combination) is stationary, those variables are co-integrated on the long run (Gujarati, 2004; Yang, 2000). In this case the researchers used the Johansen co-integration test to test co-integration since it is the only test which can estimate more than one co-integration relationship if the data set contains two or more time series as well as gives the maximum rank of co-integration (Ssekuma, 2011).

According to Hjalmarsson and Osterholm, (2007), the Johansen's methodology takes its starting point in the vector autoregression (VAR) of order ρ given by:

$$y_t = \mu + A_1 y_{t-1} + \ldots\ldots\ldots + A_\rho y_{t-\rho} + \varepsilon_t \tag{7a}$$

Where y_t is an $n\mathbf{X}1$ vector of variables that are integrated of order one, commonly denoted by I

(1), and ε_t is an $n\mathbf{X}1$ vector of innovations. This VAR can be re-written as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{\rho-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \qquad (7b)$$

$$\Pi = \sum_{i=1}^{\rho} A_i - I \quad \text{and} \quad \Gamma_i = -\sum_{j=i+1}^{\rho} A_j \qquad (7c)$$

If the coefficient matrix $\prod$ has reduced rank, $r \prec n$ then there exist $n\mathbf{X}r$ matrices α and β each with rank r such that $\prod = \alpha\beta^\bullet$ and $\beta^\bullet y_t$ is stationary. r is a number of co-integrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a co-integrating vector.

It can be shown that for a given r, the maximum likelihood estimator of β defines the combination

of y_{t-1} that yields the r largest canonical correlations of Δy_t with y_{t-1} after correcting for lagged

differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of $\prod$ matrix: the Trace Test (TT) and maximum eigenvalue test are shown in equations (7d) and (7e) respectively.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \qquad (7d)$$

$$J_{max} = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (7e)$$

Where T is the sample size, and $\hat{\lambda}_i$ is the ith largest canonical correlation. The TT tests the null

hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vectors. The maximum eigenvalue test, on the other side, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of $r+1$ co-integrating vectors.

DATA ANALYSIS, INTERPRETATION AND DISCUSSION

The study analyzed Unit root tests, co-integration test, and empirical impact of inflation on economic growth by using reduced form regression equation. Analysis of sensitivity of economic growth (GDP) on inflation as well as relationship between inflation and economic growth were put

forward quantitatively. Data analysis followed chorological order of the objectives stated above starting stationarity test by applying Unit root test results.

UNIT ROOT TEST RESULTS

Before testing for co-integration, researchers conducted unit root test on the variables under study to establish the stationarity properties of the data. Augmented Dickey-Fuller tests and Phillips Perron tests were employed on each of the two time series variables. The results for the two tests are presented in Table 1 and 2.

Table 1: Results: unit root test (level variables)

	Augmented Dickey-Fuller		Phillips-Perron	
Variable	Test Statistics	Critical value at 5%	Test Statistics	Critical value at 5%
GDP	-1.572	-3.000	-1.645	-3.000
INFL	-1.607	-3.000	-1.629	-3.000

Table 2: Results: unit root test (First Difference)

	Augmented Dickey-Fuller		Phillips-Perron	
Variable	Test Statistics	Critical value at 5%	Test Statistics	Critical value at 5%
GDP	-4.126	-3.000	-4.130	-3.000
INFL	-4.161	-3.000	-3.912	-3.000

Table-1 and 2, results of the unit root tests revealed that GDP and inflation were non-stationary without lag. The computed absolute values of the tau statistics ($|\tau|$) do not exceed the ADF (or MacKinnon) critical tau values, implying that we cannot to reject the null hypothesis ($\delta = 0$) that there was unit root or the time series was non-stationary. The same applied to Phillips-Perron test whereby the computed absolute values of the tau statistics ($|\tau|$) do not exceed the ADF (or MacKinnon) critical tau values. On the other hand, Table-2 showed that both variables became stationary after first difference as the computed absolute values of the tau statistics ($|\tau|$) exceeded the ADF (or MacKinnon critical tau values, which led the researchers to accept the null hypothesis ($\delta = 0$). However, the test at first difference was performed with no constant (no intercept) meaning that the process under null hypothesis is a random walk without drift, meaning that the time series data observed a difference stationary process (DSP).

Co-integration test

Two variables are said to be co-integrated if they have a long-term, or long run equilibrium, relationship between them. If two variables, dependent and an independent, are individually non-stationary but their residual (combination) is stationary, those variables are co-integrated (Gujarati,

2004). If two time series variables are integrated of order one, I (1), there could be a linear combination between them which may be integrated of order zero, I (0) (Green 2002). To establish co-integration, the test was conducted by using Johansen co-integration test. Table 4.3 presented the results of the test.

Table 3: Results: Johansen tests for co-integration

Trend : constant Sample: 1992-2011				Number of observations = 20 Lags = 2	
Maximum rank	Parms	LL	Eigenvalue	Trace statistic	5% critical value
0	6	-110.81099	-	10.0768*	15.41
1	9	-106.89296	0.32416	2.2408	3.76
2	10	-105.77256	0.10599		

Results in Table-3 revealed that the researchers cannot reject the null of having no rank (that is, the first significant values where trace statistics is less than critical value at 5 percent was found at maximum rank of zero. The results suggested that there is no co-integration. This is because the Johansen's test for co-integration is based on maximum likelihood estimation and two statistics: maximum eigenvalues and a trace statistics, and that if the rank is zero means there are no co-integration relationship. The rank is one there is one, if it is two there are two (Parlow, 2010). These results are in line with the results found by Chimobi, (2010) in the study of the relationship between inflation and economic growth in Nigeria. The inclusion of lags is often necessary in order for the regression model to be able to predict the future, that is, to predict what will happen in the period (*t*) based on knowledge of what happened up to (*t-1*) (see Ernst *et al*., 2005). Due to the absence of co-integration researcher did not run an Error Correction Model.

The impact of inflation on economic growth

To estimate the impact of inflation on economic growth the study applied regression techniques as explained above. To quantify the extent of the impact, the researchers measured impact of inflation on economic growth using linear regression equation as illustrated below. Results for regression equation with and without lags are presented in equation 1(a) and 1(b) respectively. Lags were included in order for the regression model to be able to predict the future, that is, to predict what will happen in the period (*t*) based on knowledge of what happened up to (*t-1*) (see Ernst, Nau and Bar-Joseph, 2005).

$$GDP_t = 18.24506 - 0.48105141 INFL_{t-1} \tag{1a}$$

$$(10.55) \qquad (-4.72)$$
$$R^2 = 0.5400$$

$$GDP_t = 18.84073 - 0.5358219 INFL_t \tag{1b}$$

$$(12.26) \qquad (-5.95)$$
$$R^2 = 0.6394$$

The estimated equation (1a) uncovered that the impact of inflation on Tanzania GDP can be interpreted that as the general price level (inflation) goes up by one percent (1%), economic growth (GDP) goes down by 48.105%. The coefficient of determination (R^2) = 0.54 implied that 54% of the variations in economic growth (GDP) have been explained by inflation and about 46% was captured by other factors which have substantial influence on GDP but were excluded from the model. This is because the economic growth does not only get influenced by inflation but also by other factors such as higher initial schooling and life expectancy, lower fertility, lower government consumption, better maintenance of rule of law, and improvements in the terms of trade (see Barro, 1996). Since the large percentage of variations in GDP was explained by inflation, this means that inflation has strong contribution to economic growth (GDP) of Tanzanian economy. Moreover, the summary of the results showed that the impact of inflation on economic growth is statistically significant at 5 percent level for its absolute t-values was greater than two (Gujarati, 2004). The regressor inflation has the sign that accord with prior expectations, that is, inflation has a negative impact on economic growth. The estimated equation (1b), on the other hand, indicated that the impact of inflation on Tanzania GDP can be interpreted that a decrease in GDP by 53.582% was a result of an increase in the general price by 1%. The Coefficient of Determination (R^2) = 0.6394 implied that about 64% of changes in economic growth (GDP) have been explained by inflation and only 36% was captured by other factors which were not included in the model.

A slight difference in results from the estimated equation (1a) and (1b) precipitated the researchers to make conclusion based on equation (1b) results. This is because the Coefficient of Determination (R^2) in estimated equation (1b) is relatively higher compared to that of equation (1a). The implication of this is that, the impact to GDP in equation (1b) has been explained by inflation by large percentage than that of equation (1a). Moreover, the absolute values of *t* statistics are relatively larger in equation (1b) than that of estimated equation (1a) implying that the impact of inflation on economic growth is statistically significant at 5 percent level. These results agreed with various theories of inflation and economic growth (Monetarists) as well as other previous researchers such as (Barro, 1995; Ghosh and Phillips, 1998; Quartey, 2010). These statistically significant results indicated that persistent increase in the general price has a negative impact on economic growth in Tanzania.

The degree of responsiveness of GDP to inflation

The study applied regression equation to determine the degree of responsiveness of GDP to changes in the general level of prices as illustrated below. Results for regression equation is presented in equation (2) below:

$$\ln GDP_t = 1.848391 - 0.8047261 \ln INFL_t \qquad\qquad (2)$$

$$(18.31) \qquad (-8.90)$$
$$R^2 = 0.7983$$

Prognostication of the log-log results produced very interesting results to the question about responsiveness of GDP to general price changes. The elasticity coefficient of GDP to inflation rate is inelastic due to the fact that inflation rate is a very important macroeconomic variable to the changes of GDP. The result showed that Tanzanian GDP is inelastic on inflation because the value of estimated coefficient $\hat{\beta}_1$ (-0.8047261) is less than one. The result was also statistically significant at 5 percent level. From these results the study concluded that the degree of responsiveness of change in GDP due to changes in the general price levels in Tanzania is inelastic to the tune of -0.8. Also $R^2 = 0.7983$ is very strong indicating that about 79.83% responsiveness of GDP has been explained by changes in the general price levels.

The relationship between economic growth and inflation

To quantify the extent to which Inflation is related to GDP, the study estimated variables (GDP and inflation) and correlation coefficient. The results for estimated variables and correlation coefficients are provided in equation (3) and (4) below:

$$GDP_t = 18.84073 - 0.5358219 INFL_t \qquad\qquad (3)$$

$$(12.26) \qquad (-5.95)$$
$$R^{2=}0.6394$$

The results showed that there was negative relationship between inflation and economic growth in Tanzanian economy in the period of study. The results implied that as the general level of prices increases, the GDP decreases. This means that an increase in the general price level (inflation rate) by 1% results in a decrease of GDP by 18.305%. This could imply that an increase in the general price level was harmful to economic growth. In addition, the study decided to regress Inflation against GDP in order to know the nature of relationship when Inflation was dependent variable and GDP was independent variable. The results for the estimation of Inflation are provided in equation (4) below:

$$INFL_t = 27.75812 - 1.193227 GDP_t \qquad\qquad (4)$$

$$(11.09) \qquad (-5.95)$$
$$R^2 = 0.6394$$

The results of the estimated equations indicated that there was a negative relationship between GDP and inflation in Tanzania. The estimated coefficients are highly statistically significant at 5 percent and negative for both regressions implying that both GDP and Inflation affected each other negatively. Moreover, equation (4) implied that an increase in GDP by 1 percent resulted in a decrease of the general price levels by about 1.19. The relationship between the two variables only

existed in the short-run because the Johansen co-integration test revealed that the first significant values where trace statistics is less than critical value at 5 percent was found at maximum rank of zero. This could mean that inflation is harmful to economic growth and economic growth helps to reduce inflation in the country.

CONCLUSION OF THE FINDINGS

The main objective of this study was to examine the impact of inflation on economic growth in Tanzania. Annual time-series data for the period of 1990-2011 were employed. The diagnostic tests carried out for all variables were all satisfied, that is, no serial correlation and heteroskedasticity were observed, implying that the estimates are reliable and therefore can be relied upon.

The methodology employed in this study included the regression analysis to examine the impact, stationary test was carried out using the Augmented Dickey-Fuller technique and Phillips-Perron (PP) test. The results of unit root suggested that both variables in the model were stationary after first difference. The results from regression analysis revealed that inflation has the negative impact on economic growth of Tanzania. This indicated that inflation is harmful to economic growth of Tanzania. The same results were found by (Quartey, 2010) in Ghana. Correlation coefficient and co-integration technique were employed to establish the relationship between inflation and GDP. The results of co-integration test using Johansen co-integration test showed that over the period of 1990-2011 there was no co-integrating relationship between inflation and economic growth. That is, no any statistically significant long-run relationship between inflation and economic growth in Tanzania. Only a negative and statistically significant short term relationship was found. These results are consistent with other previous studies such as (Ahmed, 2010; Chimobi, 2010; Carneiro and Faria, 2001). Moreover, the study found that the degree of responsiveness of GDP to changes in the general price levels is large. The study concluded that the degree of responsiveness of change in GDP as a result of change in the general price levels is inelastic to the tune of -0.8.

POLICY IMPLICATIONS AND RECOMMENDATIONS

This study found out that an increase in the general price level (inflation) has been detrimental to sustainable economic growth in Tanzania. These results have important policy implications for both domestic policy makers and development partners, implying that controlling inflation is a necessary condition for promoting economic growth. Thus, policy makers should focus on maintaining inflation at a low rate (single digit). Stability in inflation rate is an important factor as the results from the findings indicated that about 64 percent of the variations in GDP have been explained by inflation. This could imply any fluctuation in country's general price level has a significant impact on economic growth. In this regard the study concluded that all factors which cause an increase in the general price levels such as energy crisis, exchange rates volatility, and

increase in money supply, poor agricultural production and so forth should be addressed with the appropriate policies so as to foster economic growth.

Since the double-digit inflation rate in Tanzania was mainly due to energy crisis and poor agricultural produce, the government should use other sources of power such as gas as an alternative to hydro-electricity. Constant availability of power is of great important for production since the more the country produces the less the prices of goods and services hence higher economic growth. Similarly agricultural produce may be increased by improving infrastructure, provision of labour force, training to farmers as well as strategies like loan provision schemes with affordable interest rates and establishment of permanent markets for their products should be undertaken. The elasticity coefficient of GDP to inflation rate is inelastic due to the fact that inflation rate is a very important macroeconomic variable to the changes of GDP. To policy makers this could implies that even if there are other factors which influence economic growth such as inflows and outflow of FDI, human capital, investment, technological progress, financial systems, geographical position of the country as well as government policies like better maintenance of rule of law, less non-productive government consumption and better public investment in high-return avenues (see Hussain, 2011; Kasidi, 2010). Thus to attain and sustain high economic growth (GDP) policy makers in Tanzania should strive to keep inflation rate at a possible minimum rate.

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