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THE RELATIONSHIP BETWEEN GDP GROWTH RATE AND INFLATIONARY RATE IN GHANA: AN ELEMENTARY STATISTICAL APPROACH

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ABSTRACT

The study determines the relationship between GDP (Gross Domestic Product) growth rate and inflationary rate in Ghana from the period 1980 to 2012. The study employs the methods of scatter plot, correlation analysis and simple linear regression estimated using OLS (Ordinary Least Squares). All the three approaches proved that there is a strong negative linear relationship between GDP growth rate and inflation rate in Ghana. That is a 1% increase in inflation rate will cause GDP growth rate to decrease by 0.0864724%. However, a 1% decrease in inflation rate will cause GDP growth rate to increase by 0.0864724%. This value is statistically significant at the 5% level of significance. Therefore, policy makers should formulate and implement monetary, fiscal and physical policies that will continue to keep inflation rate downward to enhance economic growth and stability.

Keywords: GDP growth rate, Inflation rate, Scatter Plot, Correlation, Ordinary Least Squares

INTRODUCTION

The study determines the relationship between GDP growth rate and inflationary rate in Ghana from the period 1980 to 2012. The relationship between inflation and GDP growth rate has received much attention especially in the past decade and a half. Most empirical findings have established an inverse relationship between inflation and GDP growth rate.

The persistent rise in general prices of goods and services over time, impedes efficient resource allocation by obscuring the signaling role of relative price changes which is an important guide to effective decision making (Fischer, 1993). Inflation makes an economy's exports relatively expensive, affecting balance of payments negatively, hence reducing a country's international competitiveness.

Before World War II, inflation was said to behave like a "lazy dog", in that, it moves from one level to another only when there is a disturbance. During that time high inflation periods were followed by bouts of deflation without any upward or downward trends. It therefore reflected a positive relationship with economic growth (Haslag, 1997).

Theoretically, the aggregate demand (AD) and aggregate supply (AS) framework supported this positive relationship. As AD increases, general prices increase along with output. However, high prices established by OPEC (Organization of Petroleum Producing Countries) in the 1970s increased the general cost of production causing AS to shift inward, bring about the new concept of stagflation. This new concept of stagflation questioned the validity of the widely accepted Phillips curve relationship because it consists of high inflation, stagnating real output and high unemployment. Stagflation therefore questioned the validity of the positive relationship between inflation and economic growth.

In the short run, according to the Keynesian model, when the AS curve is upward sloping, inflation is positively related to economic growth. This is because changes in aggregate demand increases both price levels and output (Dornbusch et al., 1996). This model holds since many factors such as expectations, labour force, and fiscal or monetary policies and so on drive both the rate of inflation and output levels in the short run. The positive short run inflation growth nexus is believed to be due to the concept of time inconsistency problem – which each producer thinks the price rise is from his end alone but not the whole market. Blanchard and Kiyotaky (1997) believe that the positive relationship may be due to some forward contract entered into by producers which cannot be abrogated even with changes in the price levels. So that producers are obliged to deliver on their word by increasing production in order to deliver the agreed quantity.

The Keynesian model postulates that in the long run AS curve is vertical causing changes in AD to affect price but not output. The initial positive relationship between inflation and growth goes through an adjustment path of stagflation through to a negative relationship. This is to say that the economy does not move directly to higher inflation but follows a transitional path where inflation rises and falls. Hence an adjustment path of initial positive relationship turns negative towards the latter part of the path as a result of dynamic adjustment of the short run AD and AS curves. For inflation to be held steady at any level according to this theory, output must equal to the natural rate.

In contrast to the Keynesians, Monetarists focus on the long run supply side of the economy (Dornbusch et al., 1996). Led by likes of Milton Friedman, they focused on the long run properties of the economy. Popular among them are the Quantity theory of Money and Neutrality of Money.

In the Quantity theory of Money, Friedman was of the view that inflation was the product of an increase in supply or velocity of money (MS) at a rate greater than the rate of growth in the economy, that is, increase in MS > Economic growth rate = inflation.

In challenging the concept of Phillip Curve, monetarists argue that when general prices of goods and services double, wages also double. Individuals are therefore not affected by the price rise. This implies that employment and output are not affected at all by inflation because individuals anticipate price changes and being rational, incorporate its effects in their decisions or behaviour. In light of this inflation is harmless and the concept is termed Neutrality of Money. In conclusion monetarists believe that long run prices are mainly influenced by growth rates in money supply without any real effect on growth.

There is now however, considerable evidence that even secular and presumable, predictable inflation has adverse effect on an economy's long run real activity. While few doubt that very high inflation is bad for growth, there have been mixed empirical studies presented, as to their precise relationship. The question then is what is the relationship between inflationary rate and GDP growth rate in Ghana?

Among the first authors to analyse the inflation – growth relationship included Kormendi and Meguire (1985) who helped to shift the conventional empirical wisdom about the effect of inflation on economic growth: from a positive one, as some interpret the Tobin (195) effect, to a negative one, as Stockman's (1981) cash-in-advance economy with capital, has been found. Kormendi and Meguire (1985) found a significant negative effect of inflation on growth. In pooled cross-section time series regressions for a large set of countries, Fischer (1993) and De Gregorio (1993) found evidence for a negative link between inflation and economic growth. This was also confirmed by Barro (1995, 1996) by empirically analysing

the effect of inflation on economic growth. What is then the situation in Ghana? What will be the impact of a 2% increase in inflation rate in Ghana have on it economic expansion?

Inflation in positive sense redistributes real income, encourages investment, encourages employment and increases government revenue. However, inflation discourages exports, hoarding of goods, high cost of living and so on and this makes us describe inflation as the public-enemy- one - number of every country.

Ghana has a long history of high rates of inflation. Inflation has been significantly reduced. From 40.5% in 2000, inflation has been steadily reduced to 9.1% as of April 2012. Inflation was relatively stable between 2005 and 2007 compared with what Ghana experienced from 2000 to 2004 (GSS, 2007). The overall inflation rate, estimated by using the consumer price indices, declined from 15.5% in 2005 to 10.7% in 2007 while the economy grew at a rate of 5.87% and 6.47% respectively. In 2006, inflation was 10.91%. It increased to 18.1% at the end of 2008 and fell to 8.61% at the end of 2010 and maintained the same record in 2011. Throughout the year 2012, inflation remained in the single digit band and ended the year 2012 at 8.8% while GDP growth rate was 7.1%. Inflation rate is expected to progressively decrease to 7.5% by 2014 year end. With the achievement of single-digit headline inflation, a debate has emerged in Ghana as to what extent inflation reflects the situation on the ground, in terms of national output. Consequently, the questions that come to mind are: (1) why is the government so interested in single digit inflationary rate? (2) What is the impact of inflation rate on the Ghanaian economy? To what extent is the impact of inflation rate on GDP growth rate in Ghana? Hence the urgency of this research paper.

OBJECTIVE OF THE STUDY

The main objective of the study is to determine the relationship between inflation and GDP growth rate in Ghana and then make some policy recommendations.

RESEARCH QUESTION

The question that this study seeks to find solution to is that what is the relationship between inflationary rate and GDP growth rate in Ghana? Since with the achievement of single-digit headline inflation, a debate has emerged in Ghana as to what extent inflation reflects the situation on the ground, in terms of the general performance of the economy.

HYPOTHESES

H_0: there is no negative relationship between inflation rate and GDP growth rate in Ghana.

H_1: there is a negative relationship between inflation and GDP growth rate in Ghana.

SIGNIFICANCE OF THE STUDY

This study is different from others because it uses some basic estimation techniques including scatter diagram, correlation analysis and simple linear regression analysis to determine the link between inflation rate and GDP growth rate in Ghana. Also, the study period spans from 1980 to 2012.

MATERIALS AND METHODS

In studying the relationship between inflation rate and GDP growth rate, we collected data and constructed a scatter plot. The aim of the scatter plot is to determine the nature of the relationship. The possibilities include a positive linear relationship, a negative linear relationship, a curvilinear relationship, or no relationship. In this study, we plotted the inflationary rate variable on the x-axis and the GDP growth rate on the y-axis. We believed

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that GDP growth rate can be determined by inflationary rate (Mendehhall et al., 1989; Oakshott, 2006)

After the scatter diagram was drawn, the next step was to compute the value of the correlation coefficient using the Pearson's product moment correlation coefficient given as:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

Where x = inflationary rate, y = GDP growth rate and n = the number of data pairs. Gretl was used to determine the value of the PPMC. In addition, we tested for the significance of the relationship r by using $t = r\sqrt{n-2}/\sqrt{1-r^2}$ with degrees of freedom equal n – 2 (Mendehhall et al., 1989; Oakshott, 2006). If the value of the correlation coefficient is significant, the next step is to determine the equation of the regression line, which is the line of best fit of the data.

Due to the linear relationship between GDP growth rate and inflationary rate, our linear model was specified as: $GDPGR_t = b_0 + b_1 NFLR_t + U_t$ where;

$GDPGR_t$ is the dependent variable and denotes GDP growth rate at time t.

$INFLR_t$ is the independent variable and denotes inflationary rate at time t.

b_0 and b_1 denote the parameters or constants, b_0 is the intercept and b_1 was the derivative of the GDP growth equation with respect to inflation rate.

U_t denotes the error term normally distributed with a zero mean and a constant variance.

The values of b_0 and b_1 were obtained by using the ordinary least squares estimation technique by the help of an econometric package called gretl.

The value of the R^2 is used to determine how strong or weak the GDP growth rate regression equation is. If R^2 value lies between 0.8 and 1, then we can conclude that the regression equation is strong. However, if the value of the R^2 lies between 0 and 0.5, then we can say that the regression equation is a weak one. In addition, the value of the R^2 is used to determine by how much the change in the independent variable(s) explain the changes in the dependent variable, called the explained variation. The unexplained variation is given as ($1 - R^2$) which takes care of the other factors that are not included in the GDP growth rate regression equation (Shim & Siegel, 1995).

The value of the F statistic was used to ascertain the overall significance of the GDP growth rate equation in terms of inflation. We compared the value of the F statistic ($F = \frac{R^2/k}{(1-R^2)/[n-(k+1)]}$) with the value of the critical value of F ($F_{\alpha, k-1, n-k}$ where k = number of parameters and n = number of observations) at a given significance level usually 5% (Shim & Siegel, 1995). If the value of the F statistic is greater than the critical value of the F, then we conclude that the overall GDP growth rate equation is statistically significant or otherwise.

The statistical significance of the parameters of the GDP growth rate equation was established. In testing for the statistical significance of the parameters, we used the t-test. Using the t-test, the t- critical value was compared with the t-statistic at a given significance level (5%). If the t-statistic is greater than the t-critical value, then, the parameter in question is statistically significant or otherwise. The t-critical value is given by $t_{\alpha/2,n-k}$ (n = number of

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observations and k is the number of parameters) where n-k is the degree of freedom and α is the level of significance . The critical value of t was obtained from the t distribution table (Koutsoyiannis, 2006; Gujarati & Porter, 2009; Wooldridge, 2006).

Finally, we determined whether our GDP growth model was affected by autocorrelation (detected using the Durbin Watson statistic (DW)) and heteroscedasticity (examined using spearman rank correlation coefficient).

The data used for this study was secondary data collected from the Ghana Statistical service (GSS).

RESULTS

Scatter Diagram Method

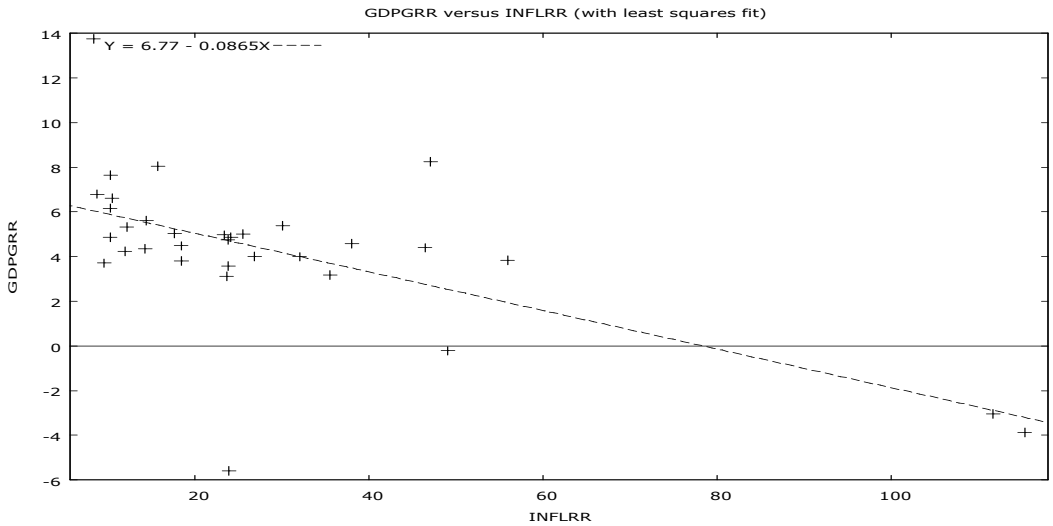

Figure 1. A scatter Diagram Showing the Relationship between GDP Growth rate and Inflation Rate

Correlation Method

Table 1. Shows the Correlation Analysis between GDP Growth Rate and Inflation Rate

GDPGR	*INFLR*	
1.0000	-0.6233	GDPGR
	1.0000	INFLR

Correlation coefficients, using the observations 1980 - 2012

5% critical value (two-tailed) = 0.3440 for n = 33

corr(GDPGRR, INFLRR) = -0.62329460

Under the null hypothesis of no correlation:

t(31) = -4.43787, with two-tailed p-value 0.0001

Simple Regression Method

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Table 2. OLS estimates using the 33 observations 1980-2012 Dependent variable: GDPGR

Variable	*Coefficient*	*Std. Error*	*t-statistic*	*Critical value of t*	*p-value*
const	6.77386	0.740582	9.1467	2.04	<0.00001
INFLR	-0.0864724	0.0194851	-4.4379		0.00011

Unadjusted R^2 = 0.388496; Adjusted R^2 = 0.36877; F(1, 31) = 19.6947; Durbin-Watson statistic = 1.819

Table3. The Effect of Inflation on GDP Growth Rate in Ghana

An increase in inflation rate by (%)	*Will cause GDPGR to change by (%)*	*A decrease in Inflation rate by (%)*	*Will cause GDPGR to change by (%)*
20	-1.7294	20	+1.7294
40	-3.4589	40	+3.4589
60	-5.1883	60	+5.1883
80	-6.9178	80	+6.9178
100	-8.6472	100	+8.6472

Author's computation, 2013

DISCUSSION

From figure 1 it can be seen that there is a negative linear relationship between GDP growth rate and inflation rate in Ghana. This implies that as inflation rate increases, GDP growth rate in Ghana decreases. Therefore, from the scatter plot, we can conclude that there is a negative linear relationship between GDP growth rate and inflation rate in Ghana (i.e GDPGR = 6.77 - 0.0865INFLR).

From table 1, the value of the correlation coefficient between GDP growth rate and inflation rate is -0.6233. The sign of the correlation coefficient indicates that there is a negative relationship between GDP growth rate and inflation rate in Ghana. The degree of the association (0.6233) is a moderate one. It is statistically significant since the absolute value of 4.43787 > 2.04. Therefore, the correlation coefficient strongly confirms that there is a significant inverse relationship between GDP growth rate and inflation rate in Ghana.

From table 2, the value of the R^2 is 0.36877 representing about 36.877%. This suggests that the GDP growth rate regression equation has a weak fit, statistically. In terms of economic explanation, it means that about 36.877% of the total variation in GDP growth rate is explained by inflation rate. It is statistically significant since the absolute value of 4.43787 > 2.04. The remaining is approximately 63.123%. This implies that the other factors that can influence GDP growth rate and not included in the model account for 63.123%. Overall, the GDP growth rate regression equation in terms of inflation rate is statistically significant at the 5% significant level since the test value of F (19.6947) is greater than the critical value of F (4.17). The GDP growth rate equation is acceptable for Ghana since DW (1.819) is greater than the value of the R^2 (0.36877). In addition, there is no problem of autocorrelation since the value of the DW which is 1.819 lies between 1.5 and 2.5 (Shim & Siegel, 1995). Again, there is no problem of heteroscedasticity since the value of the spearman's rank correlation

coefficient between the absolute value of the error values and inflation rates is -0.0074. This value is less than 0.5 which indicates the absence of heteroscedasticity.

If there is no public enemy number one (inflation) in the macroeconomic environment of Ghana, the GDP growth of Ghana will be 6.77386%. It is statistically significant since test value of t (9.1467) is greater than the critical value of t (2.14).

In addition, there is a negative relationship between GDP growth rate and inflation in Ghana. A 20% increase in inflation rate will cause GDP growth rate to decrease by 1.7294%. Also, a 100% increase in inflation rate will cause GDP growth rate to decrease by 8.6472%. However, a 20% decrease in inflation rate will cause GDP growth rate to increase by 1.7294%. And, a 100% decrease in inflation rate will cause GDP growth rate to increase by 8.6472%. This implies that if the general price level rises in Ghana people's real income falls which leads to a fall in their personal consumption expenditure, increasing their cost of living and then lowering their standard of living. Exports of goods and services become very expensive, decreasing exports and encouraging imports, which affect our balance of trade and payments account negatively. In addition, cost of production increases leading to a fall in the production of goods and services. Hence a there will be a reduction in Ghana's GDP growth rate when there is an increase in the general price level of goods and services. The reserve is also true. It is statistically significant since 4.4379 > 2.04 at the 5% level of significance. This means that inflation rate is a major factor that influences economic expansion in Ghana. Therefore, it can be concluded that, in Ghana, there is a negative relationship between GDP growth rate and inflation rate in Ghana.

POLICY RECOMMENDATION

The study found that there is an inverse relationship between GDP growth rate and inflation rate in Ghana. Therefore policy makers should continue to formulate and implement monetary, fiscal and physical policies that will continue to drive inflation rate downward to enhance economic growth and stability in Ghana.

CONCLUSION

The study was to determine the relationship between GDP growth rate and inflationary rate in Ghana for the period 1980 to 2012. The study employed the methods of scatter plot, correlation analysis and simple linear regression estimated using OLS. All the three approaches proved that there is a strong negative linear relationship between GDP growth rate and inflation rate in Ghana. That is a 1% increase in inflation rate will cause GDP growth rate to decrease by 0.0864724%. This implies that if there is increase in the general price level it will cause real income to fall, increase cost of living, decrease standard of living, and decrease our exports, increase imports, increase balance of payments deficits and finally the national out. Therefore, policy makers should formulate and implement monetary, fiscal and physical policies that will continue to keep inflation rate downward to enhance economic growth and stability. Also, the exchange rate environment should be stabilised.

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APPENDIX

Year	*GDPGR*	*INFLR*	*GDPGR**	*INFLR**
1980	-0.23	51.33	-0.2197	49.03112
1981	-3.18	116.91	-3.03758	111.674
1982	-5.85	25.01	-5.588	23.88989
1983	-4.05	120.73	-3.86862	115.3229
1984	8.64	49.27	8.253046	47.06338
1985	5.09	10.73	4.862038	10.24944
1986	5.2	24.43	4.967111	23.33587
1987	4.79	39.81	4.575473	38.02706
1988	5.63	31.48	5.377853	30.07013
1989	5.09	25.25	4.862038	24.11914
1990	3.33	37.18	3.180861	35.51484
1991	5.28	18.47	5.043528	17.6428
1992	3.88	9.99	3.706229	9.542584
1993	4.97	24.9	4.747412	23.78482
1994	3.27	24.73	3.123549	23.62243
1995	4.02	58.54	3.839959	55.91821
1996	4.6	48.62	4.393983	46.44249
1997	4.2	28.08	4.011897	26.8224
1998	4.69	19.27	4.479952	18.40697
1999	4.43	12.5	4.231596	11.94017
2000	3.74	24.93	3.572499	23.81348
2001	4.18	33.54	3.992793	32.03787
2002	4.55	14.92	4.346222	14.25179
2003	5.25	26.71	5.014872	25.51376
2004	5.58	12.74	5.330092	12.16942
2005	5.87	15.08	5.607104	14.40462
2006	6.93	10.96	6.619631	10.46914
2007	6.46	10.73	6.17068	10.24944
2008	8.43	16.46	8.052451	15.72282
2009	3.99	19.3	3.811302	18.43562
2010	8.01	10.79	7.651261	10.30676
2011	14.39	8.73	13.74552	8.339015
2012	7.12	9.16	6.801121	8.749757

Source: Ghana Statistical Service (GSS)

To correct for autocorrelation $\hat{GDPGR} = b_0 + \rho GDPGR_{t-1} + b_1 INFLR_t - b_1 \rho INFLR_{t-1} + vt$

$GDPGR^* = GDPGR_t\sqrt{1-\hat{\rho}}$ and $INFLRt^* = INFLR_t\sqrt{1-\hat{\rho}}$