

Modelling the Long Run Relationship Between Inflation and Economic Growth Using The Engel And Granger Approach (Evidence From Nigeria 1985 To 2013)

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Abstract: *The study examined the relationship between inflation and economic growth for the period 1985 to 2013 using empirical evidence from Nigeria. The Engel-Granger two-step cointegration procedures and Error Correction Model (ECM) were used as the method of estimation. The analyses of residuals of the OLS regression showed evidence in favour of cointegration between inflation and economic growth. Similarly, estimates from the error correction model provide evidence to show that the proxy for inflation and GDP series converge to a long-run equilibrium at a reasonably fast rate. The result points to the fact that the moderate inflation in the system can accelerate economic growth.*

Key words: *Economic Growth; Inflation; Error Correction; Long Run Relationship; Nigeria*

I. Introduction

It is commonly agreed amongst people in the financial world and public finance circle that the acceleration and sustenance of economic growth remains a major focus of several macroeconomic drives of policy makers. This is the case in both developed and developing economies. Maintaining a single-digit rate of inflation and a high and sustainable economic growth rate remains an ideal which every economy desires to attain.

There is, however, no agreement amongst scholars on the precise functional relationship that exists between inflation and economic growth. The impacts of inflation on respective economic units like individuals, business organisations e.t.c are identifiable. It favours borrowers at the expense of lenders, unfixed income earners at the expense of fixed income earners. The “menu cost” effect on firms Rotemberg (1983), Guerrero(2004) leaves the firms worse off as they have to incur a higher cost while adjusting to the new price regime or level.

On the first side of the argument are those who found no conclusive evidence (empirically) about the relationship between inflation and economic growth. Johansen (1967), Bhatia (1960) among others found neither positive nor negative relationship empirically between inflation and economic growth. Malla (1997), Fisher (1993) and De Gregorio (1993) among others concluded that a negative relationship exists between inflation and economic growth. They believe that the two are inversely related. On the third side of the lines of argument are those who believe that moderate inflation can accelerate economic growth. Dornbusch et.al(1996) believes that a positive relationship exists between inflation and economic growth especially in the short run. This is due to the fact that the producers are driven by a rise in price to produce more which would translate to economic growth.

In spite of the contention this has been generated over time and the seemingly countless volume of works done in this area in both developed and developing countries, there appears to be dearth of empirical works done on the effect of inflation on economic growth in Nigeria.

This paper therefore is set on establishing whether or not an empirical relationship exists between inflation and economic growth in Nigeria. The work is divided into five sections. Section one contains the introduction to the work, two contains the review of related literature, section three sets out the model and methodology, section four provides data analyses and empirical evidence while section five summarises and draws conclusion on the study.

II. Literature Review

There have been extensive theoretical and empirical research which examines the relationship between inflation and economic growth both in the context of developed and developing countries.

Tan (2008) ascertained whether there is any trade-off between inflation and economic growth in the founding members of ASEAN namely Malaysia, Singapore, Thailand, the Philippines and Indonesia and Japan and South Korea. The paper was set up in integrating the Phillips curve framework with Okun's theory. Quarterly data of these countries between 1991 through 2006/7 were employed.

The empirical results showed that a trade-off exists between economic growth and inflation in Singapore, South Korea and Thailand after the 1997/98 Asian financial crisis years while none in the other countries. Erbaykal and Okuyan (2008) examined the relationship between inflation and the economic growth in Turkey with a data framework covering 1987:1-2006:2 periods. The existence of the long term relationship between these two variables was examined using Bound Test developed by Pesaran et al. (2001), and the existence of a cointegration relationship between the two series was detected following the test result.

Whereas no statistically significant long term relationship was found with the formed models, a negative and statistically significant short term relationship has been found. The causality relationship between the two series was examined in the framework of the causality test developed by Toda Yamamoto (1995). Whereas no causality relationship was found from economic growth to inflation, a causality relationship was found from inflation to economic growth.

Saaed (2007) explored the relationship between inflation and economic growth in the context of Kuwait, using annual data set on real GDP and CPI for the period of 1985 to 2005. The estimated result of the relationship shows a long-run and strong inverse relationship between CPI and real GDP in Kuwait.

Mubarik (2005) estimated the threshold level of inflation for Pakistan using an annual data set from the period between 1973 and 2000. He employed the *Granger Causality* test as an application of the threshold model and finally, the relevant sensitivity analysis of the model. His estimation of the threshold model suggests that an inflation rate beyond 9-percent is detrimental for the economic growth of Pakistan. This in turn, suggests that inflation rate below the estimated level of 9-percent is favorable for the economic growth. Moreover, the sensitivity analysis performed for the robustness of the threshold model also confirms the same level of threshold inflation rate.

Ahmed and Mortaza (2005) empirically explored the relationship between inflation and economic growth in Bangladesh, using annual data set on real GDP and CPI for the period of 1980 to 2005, and the co-integration and error correction models. The empirical evidence demonstrates that there exists a statistically significant long-run *negative* relationship between inflation and economic growth for the country as indicated by a statistically significant long-run *negative* relationship between CPI and real GDP.

Sweidan (2004) examined whether the relationship between inflation and economic growth has a structural breakpoint effect or not for the Jordanian economy from the period between 1970 and 2003. He finds that this relation tends to be positive and significant below an inflation rate of 2-percent and the structural breakpoint effect occurs at an inflation rate equal to 2-percent. Beyond this threshold level inflation affects economic growth negatively.

Mallik and Chowdhury (2001) examined the short-run and long-run dynamics of the relationship between inflation and economic growth for four South Asian economies: Bangladesh, India, Pakistan, and Sri Lanka. Applying co-integration and error correction models to the annual data retrieved from the International Monetary Fund (IMF) *International Financial Statistics* (IFS), they found two motivating results. First, the relationship between inflation and economic growth is positive and statistically significant for all four countries. Second, the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates.

These results have important policy implications, that is, although moderate inflation promotes economic growth, faster economic growth absorbs into inflation by overheating the economy. Therefore, these four countries are on the turning point of inflation-economic growth relationship. Faria and Carneiro (2001) investigated the relationship between inflation and economic growth in the context of Brazil which has been experiencing persistent high inflation until recently. Analyzing a bivariate time series model (i.e., vector autoregression) with annual data for the period between 1980 and 1995, they found that although there exist a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long-run. Their empirical results also support the *super neutrality* concept of money in the long run. This in turn provides empirical evidence against the view that inflation affects economic growth in the long run. Shitundu and Luvanda (2000) used the Least Trimmed Squares (LTS) method, as introduced by Rousseeuw and Leroy (1987), which detects regression outliers and produces robust regression, to examine the impact of inflation on economic growth in Tanzania. The empirical results obtained suggest that inflation has been harmful to economic growth in Tanzania.

Malla (1997) conducted an empirical analysis using a small sample of Asian countries and countries belonging to the Organization for Economic Cooperation and Development (OECD) separately. After controlling for labor and capital inputs, the estimated results suggest that for the OECD countries there exists a statistically significant negative relationship between economic growth and inflation including its first difference. However, the relationship is not statistically significant for the developing countries of Asia. The crucial finding of this empirical analysis suggests that the cross-country relationship between inflation and long-term economic growth experiences some fundamental problems like adjustment in country sample and the time period. Therefore, inconclusive relationship between inflation and economic growth can be drawn from comparing cross country time-series regressions with different regions and time periods.

Barro (1995) explored the inflation-economic growth relationship using a large sample covering more than 100 countries from 1960 to 1990. His empirical findings indicate that there exists a statistically significant negative relationship between inflation and economic growth if a certain number of the country characteristics (e.g., fertility rate, education, etc.) are held constant. More specifically, an increase the average inflation by 10 percentage points per year reduces the growth rate of real per capita GDP by 0.2 to 0.3 percentage points per year. In other words, his empirical analysis suggests that the estimated relationship between inflation and economic growth is negative when some reasonable instruments are considered in the statistical process. Finally, he added that there is at least some reason to consider that higher long-term inflation reduces economic growth.

Bruno and Easterly (1995) examined the determinants of economic growth using annual CPI inflation of 26 countries which experienced inflation crises during the period between 1961 and 1992. In their empirical analysis, inflation rate of 40 percent and over is considered as the threshold level for an inflation crisis. They find inconsistent or somewhat inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crises are excluded from the sample. In addition, the empirical analysis suggests that there exists a temporal negative relationship between inflation and economic growth beyond this threshold level. The robustness of the empirical results is examined by controlling for other factors such as shocks (e.g., terms of trade shocks, political crises, and wars). Finally, they found that countries recover their pre-crisis economic growth rates following successful reduction of high inflation and there is no permanent damage to economic growth due to discrete high inflation crises.

Sarel (1995) mentioned that inflation rates were somewhat modest in most countries before the 1970s and after then rates started to be high. Therefore, most empirical studies conducted before the 1970s show the evidence of a positive relationship between inflation and economic growth and a negative relationship between the two beyond that time period due to the severe inflation hike.

III. Methodology

We adopt the Engle-Granger two-step method to examine whether a cointegrating relation exists between inflation and economic growth in Nigeria, as well as the short-run effect of changes in inflation on economic growth and the speed of error correction, if any, among the variables. The proxy used for economic growth is Gross Domestic Product(GDP). The Engle-Granger method involves following steps. The first step involves determining whether a set of data contain unit roots in the individual time series. Unit root tests are used to determine whether time series exhibit mean-reverting behaviour by showing their order of integration. If a pair of time series, such as *GDP* and *INF* are *I*(1) variables, then cointegration techniques can be used to model their long-run relationship. The Augmented Dickey-Fuller (from Fuller, 1976 and Dickey and Fuller, 1979) is used to examine the order of integration of *GDP* and *INF*. The ADF test is estimated thus:

$$\Delta Y_t = \alpha_0 + \beta t + \alpha_1 Y_{t-1} + \sum b_1 \Delta Y_{t-1} + \epsilon_t \dots\dots\dots (1)$$

The null hypothesis is that Y_t contains unit root, which implies that $\alpha_1 = 1$, against the alternative that the series does not contain unit root, which implies that $\alpha_1 < 1$. Dickey and Fuller (1981) provide cumulative distribution function of the ADF statistic. If the computed absolute value of the coefficient of α_1 is less than the ADF critical tau values, reject the null hypothesis that $\alpha_1 = 1$, in which case Y_t does not contain unit root. Otherwise accept the null hypothesis, in which case Y_t contains unit root.

Once the order of integration of the series (*GDP* and *INF*) are confirmed *I*(1), we estimate the long-run relationships, i.e., run regression on equation (2) and save the regression residuals. In order for the *GDP* and *INF* to be cointegrated, the estimated residual from the equation (1) should be stationary (i.e., $\mu_t \sim I(0)$). The residual-based unit root test is used to examine whether the residuals from equation (2) are stationary. If they are stationary, then the series are cointegrated. If the residuals are not stationary, there is no cointegration. Rejecting the null hypothesis of a unit root, therefore, is evidence in favour of cointegration (Engle and Granger, 1987; Lee, 1993). Residual-based test is estimated as follows:

$$\Delta \mu_t = \alpha_1 \mu_{t-1} + \epsilon_t \dots\dots\dots (2)$$

Where, $\Delta\mu_t$ are the estimated first differenced residual, μ_{t-1} are the estimated lagged residuals, α_1 is the parameter of interest representing slope of the line, ε_t are errors obtained from the regression.

The second step involves estimating an Error Correction Mechanism (ECM) by ordinary least square (OLS). ECM is based on the assumption that two or more time series exhibit an equilibrium relation that determines both short-run and long-run behaviour. It therefore models both short-run and long-run relations jointly.

According to the Granger representation theorem, for any set of $I(1)$ variables, error correction and cointegration are equal representations. In other words, if a number of variables, such as *INF* and *GDP*, are cointegrated there will be ECM relating the variables. The ECM is estimated thus:

$$\Delta GDP = \alpha_0 + \alpha_1 \Delta INF + \alpha_2 \mu_{t-1} + \varepsilon(t-1) \dots\dots\dots (3)$$

Where, Δ denotes the first difference operator, α_1 is the inflation coefficient, α_2 is coefficient of the one period lagged value of the error term from the cointegrating regression in equation (2), and ε_t is a random error term.

The α_1 measures the short-term effect of inflation on GDP. The α_2 , which is the error correction term, captures the rate at which Total Credit adjusts to the equilibrium state after a shock. The coefficient of α_2 should be negative in sign for the series to converge to long-run equilibrium. Negative and statistically significant α_2 coefficient is regarded as a convincing evidence and confirmation for the existence of cointegration found in the cointegrating regression (Engle and Granger, 1987). More so, the size of α_2 is an indication of the speed of adjustment towards equilibrium. Small coefficient of α_2 , tending to -1, indicate that the speed of adjustment is fast; Larger values, tending to 0, indicate that adjustment is slow; and positive values would imply that the series diverge from the long-run equilibrium path.

IV. Data Analysis And Interpretation Of Results

4.1 Interpretation of results

From the results presented in table 1, the overall regression is statistically significant (F-test) and can be used for a meaningful explanation of the relationship between Inflation and economic growth with GDP as proxy. Inflation exerts a positive and significant influence on GDP. The co-efficient of determination R^2 with a value of 0.5419354 implies that approximately 54% of the change in GDP is explained by INF. The remaining 46% is explained by factors outside the model. The constant has little or no significance hence no cause for concern though it is positive and statistically insignificant. It however implies that the Dependent Variable (TCR) will be greater than zero if the predictor or regressor's expected value is placed at zero. The OLS is a show of short run relationship and the DW statistics which is approximately close to 2 means that there is no autocorrelation.

4.2 Testing for Unit roots

Table 2 presents results of unit root tests performed on logarithmic levels of GDP AND INF as well as their first differences. It can be observed from the ADF that both GDP and INF does not contain unit root at conventional significance levels (i.e CAP = $I(1)$ and TCR = $I(1)$). These results indicate that the series requires achieve stationarity at the natural log series; they are $I(0)$ variables. Hence, we can conduct cointegration tests on the variables.

4.3 Testing the Long-run Relationship

Tables 3 and 4 show the estimated results of the Engle-Granger cointegration test and the results of the residual-based test.

It is clear from the results that we cannot reject cointegration (i.e. long-run relation) between GDP and INF.

From the residual-based unit root test performed on the residuals and presented in Table 4, it can be seen that the test statistic (-3.56492) is less than the 5% critical tau (t) value (-3.08179). Since the computed t value is less than the conventional critical tau values, we reject the null hypothesis of no cointegration in favour of the alternative. This result, therefore, indicates evidence of long-term relationship between GDP and Inflation in Nigeria.

The speed of this pre-shock adjustment will however depend on error correction mechanism.

4.4 Estimating the Error Correction Mechanism (ECM)

This section presents the results of the ECM. The model of the ECM is of the form of equation 3 and the estimates of the short-run and long-run movements, as well as the error correction term, which proxies speed of adjustment, are provided in the Table 5. It can be observed that short-run changes in Inflation have a positive and statistically significant impact on short-run changes on GDP. This suggests that inflation affects economic growth in the short-term in Nigeria.

Table 5 also shows useful long-run information. The equilibrium adjustment coefficient (-0.70340) enters with a correct sign (negative). This suggests that GDP and Inflation series converge to long-run equilibrium; deviations from this equilibrium relationship as a result of shocks will be corrected over time.

It can also be observed that α_2 tends to one, indicating that the speed of adjustment to equilibrium is fast. It follows that about 70.3% of the deviation from equilibrium path is corrected per annum. The ECM results therefore confirm the long-run relationship between GDP and inflation observed from the residuals of equation 2

V. Conclusion

This paper analyses the relationship between inflation and economic growth. The economic motivation being the desire to find out the extent to which inflation impacts on economic growth. GDP was used as a proxy for economic growth. A review of empirical and theoretical basis for the work was done. The research methodology concentrated on the use of the ordinary least square regression using the first difference of the series from the natural log transformed series. The Engel and Engle-Granger two steps cointegration method was also used

The regression results confirm the existence of a significant relationship between inflation and GDP indicating that inflation explains about 54% variation in GDP (economic growth). The analyses of residuals from our cointegrating regression indicate evidence of cointegration between Inflation and economic growth. Similarly, estimates from the error correction model provide evidence to show that inflation and GDP series converge to a long run cointegrating equilibrium at a reasonably fast rate. The ECM results also shows that short run changes in inflation have a positive and statistically significant impact on short-run changes in GDP, suggesting that inflation impacts on economic growth.

It should be borne in mind that the study did not consider if the relationship between inflation and growth was negative or positive; however, various studies as reviewed in the literature has come out with the result that high inflation is and has never been favourable to economic growth. There are however key theoretical underpinnings that moderate inflation rates accelerate economic growth. Hence it will be good to maintain the fact that the empirical findings just indicate that inflation impacts on economic growth.

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Table 1 Ordinary Least Square (OLS) Results ($\Delta GDP = B_0 + B_1 \Delta INF + e_t$)

Endogenous Variables	Exogenous variable		R ²	Adj.R ²	F-Stat
	CONSTANT	ΔINF			
ΔGDP	0.1757288 (0.5217985)	0.0435318* (0.00000050)	0.5419354	0.458651	6.5074* (0.013648)

Note: Probability values are stated in parenthesis and * means significant at 5% level of significance. (DW Stat 1.7208)

(Source: Author's Computation)

Table 11: Unit Root Test Results (ADF)

Variables	Critical values 10%	Critical value 5%	Critical value 1%	Computed value
GDP	-2.68288	-3.08179	-3.96343	-3.91411*
INF	-2.61815	-2.95912	-3.65745	-3.61133*

Lag length on ADF chosen by Akaike Criterion. **indicates significance at 1% level of significance.

Source: (Author's Computation)

Table 3: ESTIMATION OF THE LONG RUN RELATIONSHIP
($GDP = \alpha_0 + \beta INF + \mu_t$)

Variables	Co-efficient	Std Error	Significance	D.W Stat
Constant	-0.71056	0.463	0.050523	1.1271
INF	-0.65648	0.376	0.0970253	

Source: (Author's Computation)

Table 4: Residual Based Unit Root Test ($\Delta \mu_t = \alpha \mu_{t-1} + \epsilon_t$)

Variables	Crit. Value 10%	Crit. Value 5%	Crit. Value 1%	Test statistic
Residuals(μ_t)	-2.68288	-3.08179	-3.96343	-3.56492*

Lag length on ADF chosen by Akaike Criterion. **indicates significance at 1% level of significance and * indicates significance at 5% level.

Source: (Author's Computation)

Table 5: ERROR CORRECTION MECHANISM
($\Delta GDP = \alpha + \alpha_1 \Delta INF + \epsilon_{t-1}$)

Variable	Co-efficient	Std Error	T-Stat	Significance
A	0.175728	0.26558	0.66168	0.52179855
α_1	0.043532	0.495276	0.8789	0.03154057
α_2	-0.7034	0.1960122	-3.58859	0.00425416*

R² (0.54192), Adjusted R² (0.45865), DW (1.5750 approx 2)

Lag length on ADF chosen by Akaike Criterion. **indicates significance at 1% level of significance and * indicates significance at 5% level.

Source: (Author's Computation)



