Inflation and Inflation Uncertainty in Nigeria: A Test of the Friedman's Hypothesis

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This paper examines the relationship between inflation and inflation uncertainty in Nigeria. It attempts to test whether the Friedman's hypothesis – that a rise in the average rate of inflation leads to more uncertainty about future rate of inflation - holds for the country. The monthly inflation data spanning the period 1960:1 to 2014:07 was used. Inflation uncertainty was modeled as a time varying process using a GARCH framework. Exponential Generalized Autoregressive Heteroscedasticity (EGARCH) complemented by seasonal ARIMA (2, 0, 2) (0, 0, 1) was employed to model the inflation uncertainty. Given that inflation series display structural breaks, this was tested and found to be significant which was accounted for in the model. The EGARCH fitted our data better than the symmetric GARCH model. The bivariate Granger Causality test was performed on inflation and its uncertainty; it showed that inflation causes inflation uncertainty in Nigeria. The fitted EGARCH model found strong support for the Friedman's hypothesis.

Keywords: Inflation, Uncertainty, EGARCH, Friedman hypothesis

JEL Classification Numbers: C22, E31, E52

1.0 Introduction

One of the most significant costs of inflation is the uncertainty[2] it creates about future inflation. Inflation uncertainty clouds the decision making of consumers, entrepreneurs/businesses (ex-ante and ex-post) and reduces economic wellbeing. Uncertainty about future inflation can affect both business investments and consumer savings decisions. Understanding the costs of inflation requires that we understand the connection between the level

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[2] Uncertainty refers to situations in which the probability of the future events cannot be determined, while in the case of a risky event an explicit probability can be assigned. Future volatility in an economic variable is the sum of both predictable and unpredictable components (Moradi, 2006)

of inflation and uncertainty. The idea that high inflation leads to greater uncertainty was pioneered in the works of Okun (1971) and Milton Friedman in his Nobel lecture in 1977.

Various class of economic thinkers have investigated the welfare costs of inflation following Friedman (1977) postulation that a rise in the average rate of inflation leads to more uncertainty about the future rate of inflation. Inflation is deemed to have real cost via its effects on uncertainty which lowers welfare. Most importantly, in developing countries such as Nigeria which has no perfect indexation, the deadweight loss from inflation tax could be very huge. Furthermore, the pass through effect between inflation and inflation uncertainty have real impacts on the aggregate economic activities through investment, employment, financial markets and output levels which again lower welfare of the society (Moradi, 2006).

Discussions are ongoing on the cause of inflation uncertainty; some researchers opined that monetary policy is the key in the determination of inflation uncertainty since it originates from the uncertainty of the monetary policy regime, commonly termed "regime uncertainty". They argued that when there is high inflation, policy makers confront a dilemma, i.e., at one end, they want to bring down inflation, at the other end; they are scared that it may trigger a recession in the economy. Since the public is not aware of the direction of policy makers, it becomes highly uncertain of the future course of inflation. They further stated that the uncertainty rises further as a result of announcement of unrealistic stabilization programs by the governments in the face of increase in high inflation. However, Holland (1993a) thinks that inflation uncertainty arises due to the unknown size of the change in price level because of a certain change in money supply.

Ensuring price stability is one of the main objectives of the Central Bank of Nigeria and a study of this kind would give further insight into inflation dynamics in Nigeria to guide policy decisions.

The fundamental point of research in this area has been to test if a rise in the level of inflation raises uncertainty about future inflation. The thoughts around this relationship are that high inflation creates uncertainty about future monetary policy and makes monetary policy less stable (Ball and Cecchetti, 1999). However, Berument et al (2009) noted that there are no consensus in findings of studies on the relationship between inflation and inflation uncertainty. Although earlier studies by Ball (1992) found that higher inflation generates higher inflation uncertainty, other studies such as Cukierman and Meltzer (1986), found the relationship to be the other way round.

This study therefore, test whether or not the Friedman's hypothesis holds for Nigeria so as to offer policy recommendations that would reduce uncertainty about future inflation to ensure efficient allocation of scarce resources by policy makers. Given that the inflation series exhibited volatility clustering, the paper tested and addressed the presence of structural break as well as employed GARCH type models to examine the relationship between inflation and inflation uncertainty. A test of causality between inflation and inflation uncertainty[3] was also conducted.

The study is structured as follows; after this introductory section is the theoretical and empirical literature review in section 2. The description of the data and methodology forms section 3; section 4 provides estimation and analysis of the results; while section 5 concludes the study and offer policy implications.

2.0 Review of Relevant Literature

2.1 Theoretical Background

Following Phillips (1958) postulation of an inverse relationship between money wage changes and unemployment (commonly referred to as the Phillips Curve), many economists corroborated his finding of a permanently stable negative relationship between inflation and unemployment. However, in the 1970s many countries began to experience the complete opposite of the Phillips curve with recorded high levels of both inflation and unemployment (stagflation). This prompted a number of criticisms from economists around the world including Milton Friedman.

Friedman was critical of the standard practice in the analysis of the Phillips curve of relating unemployment directly to price change without reference to the intermediate channel through wages. The assumed causal relation was believed to offer policy makers the option of a stable trade-off between a desired low level of unemployment and an acceptable level of inflation

[3] This is similar to testing the Friedman-Ball Hypothesis which states that high inflation leads to high inflation uncertainty.

required for a particular aggregate nominal demand. His main concern was the issue of the choice of the "right trade-off". He argued that the tendency for a rising inflation to reduce unemployment can be explained by what he term "unanticipated changes" in nominal demand.

Literature abounds on both empirical and theoretical relationship between the rate of inflation and inflation uncertainty. However, economic discuss around the world became entwined to studying this interrelation between inflation and inflation uncertainty following the works of Okun (1971) and Friedman (1976).

Okun (1971) noted importantly that "little is known about how people form their expectations about the variability and the trend of future inflation. Nonetheless, it seems reasonable to assume that, firstly, what the government does (and says) about inflation is one important influence on the inflationary expectations of the private sector; and secondly, an increase in expected inflation has some tendency to worsen the tradeoff and thus make a higher rate of actual inflation accompany any given unemployment rate".

Friedman (1977) postulated that a rise in the average rate of inflation leads to more uncertainty about the future rate of inflation which is detrimental to real economic activity and efficiency. Friedman's postulation of a negative effect of a highly volatile inflation rate on economic efficiency was based on two major reasons:

- Increased volatility in inflation makes long-term contracts costly because the value of future payments (in real terms) is uncertain; and
- It reduces the ability of markets to convey information to market participants on actual relative price movements

The critical question is: how does inflation uncertainty affects the economy as a whole. The answer follows from the simple anticipated rational behavior of economic agents in response to a rising inflationary trend. Golob (1994) noted that "Whenever expected inflation is a factor in an economic decision, uncertainty about inflation is also likely to be a factor". The author goes on to conclude that "this uncertainty has adverse economic consequences that potentially rise with inflation". Theoretically, the impact of inflation uncertainty on the economy is in two folds: ex-ante and ex-post. The ex-ante effect compels economic agents to make decisions different from what they would have made in anticipation of inflationary pressure. However, economic agents respond differently if the inflationary pressure differs from anticipated level, hence the term ex-post.

The ex-ante effects of inflation uncertainty on the economic manifest through three major channels. Firstly, undue speculation in the financial market as a result of inflation uncertainty leads to a general rise in long-term interest rates. This follows from investor’s perception of the growing risk in the nominal returns on long-term debts. The higher expected returns required by investors lead to a rise in long-term interest rates. The second channel of impact of inflation uncertainty on the economy is through the general uncertainty it creates about interest rates and other macroeconomic aggregates required for economic decision making. This general macroeconomic uncertainty may then lead to a reduction/deceleration in overall economic activities. The third channel of the ex-ante effect has to do with extra economic/financial cost of that business would have to take to hedge against inflation uncertainty.

One of the most visible ex-post effects (when inflation differs from expectation) is the issue of wealth transfer for holders of contracts whose payment are specified in nominal terms. The wealth transfer entails that one party to the transaction losses while the other party gains. An unexpected high inflation benefits holders of fixed-rate mortgages because future payments become less in real terms. However, employees and landlords losses because of the fixed nature of their wage and rent contracts. Depending on the level of the unexpected inflation, the ex-post effect can be felt in the entire economy.

Many scholars across the globe have carried out researches on inflation and its uncertainty. While some could not detect the relationship between inflation and its uncertainty some came up with different views on the causes, effects and impacts on the economy. Most of the research findings support the Friedman’s hypothesis that high inflation leads to higher inflation uncertainty. On the issue of the direction of causality between inflation and inflation uncertainty, there is however, diverse opinion from scholars. Ball (1992) postulated that low inflation offers the public some low level of uncertainty about the future policy, because the policy makers will commit to keep it low, therefore, making uncertainty about future inflation also low. However, given a high inflation, policy makers react differently to counter the high inflationary pressure and consequently, uncertainty about the direction of future monetary policy and the future path of inflation becomes higher. In a contrary view, Ungar and Zilberfarb (1993) argued that there is a possibility that a higher level of inflation will lead to a lower level of inflation uncertainty. The reason being that in the presence of higher inflation, an economic agent may invest more to obtain better prediction about inflation, therefore, leading to lower uncertainty about inflation.

Inflation uncertainty can mislead consumers and businesses in decision making. Golob (1994), in his article pointed out the consequences of inflation uncertainty on the economy; how it causes high long term interest rate thereby reducing economic activity. This is supported by the findings of Elder (2004) in the study of effect of inflation uncertainty. He found that uncertainty about inflation has significantly reduced real economic activity.

Debates are still raging among economists whether inflation is good or not for an economy, however, there is a general consensus that inflation uncertainty has a negative effect on production and subsequently economic growth through various transmission channels. According to Fischer (1981), Golob (1993) and Holland (1993b), inflation uncertainty is seen as one of the core costs of inflation. It alters decisions concerning future savings and investments as a result of lower predictability of the actual value of future payments as well as prolongs the unfavorable impacts of these distortions on the efficiency of resource allocation and the level of real economic activity in the economy. Cukierman and Meltzer (1986) however, postulates that inflation uncertainty leads to higher average inflation due to opportunistic central bank behavior. Thus, Holland (1995) countered this argument due to the stabilization motive of the monetary authorities, he opined that as inflation-uncertainty increases due to rising inflation, the authorities respond by reducing money supply growth, so as to eliminate inflation uncertainty and the attendant negative welfare effects, thereby, supporting a negative causal effect of inflation uncertainty on inflation.

2.2 Empirical Literature

Chowdhury (2011) used maximum likelihood estimates from the GARCH model which reveals strong support for the presence of a positive relationship between the level of inflation and its uncertainty. The Granger causality results indicate a feedback between inflation and its uncertainty. The two results confirm the Friedman-Ball and Cukierman-Meltzer hypotheses in India.

Chowdhury and Sarkar (2013), in their work revisited the inflation and its uncertainty using evidence from some monthly time series data of OECD (Organization for Economic Co-operation and Development) countries by proposing a model called STAR (k)- ANSTGARCH(1,1)L(1) where the conditional mean as well as the conditional variance are based on consideration of two regimes for inflation- below and above a certain level of inflation. The authors subjected the consumer price indices of 13 OECD countries to X-12 ARIMA filter to make the series seasonally adjusted. The proposed model when compared was found to perform better than the benchmark model of AR (k)-GARCH (1, 1)L(1). They found that threshold levels of inflation exist in ten countries and the Friedman hypothesis holds for six (6) countries in high inflation regime while two countries were in low inflation regime and one in both regimes. Their paper though had a limitation of large span of data which could have caused a structural break in series which if disregarded could mislead the conclusion.

Alexakis and Apergis (1994) in the study of money demand equation included uncertainty of inflation; and observed that inflation uncertainty is well described by an ARCH model in terms of forecasting. Some papers that used the restricted models could not find more uncertainty; this is because the model was originally developed to analyzed financial data, where volatility often changes over time. Since inflation volatility also appears to change over time, researchers have adapted these models for analyzing inflation. The models typically constrain inflation to change slowly over time. Although researchers have found restricted uncertainty models to be useful for financial data, the assumptions may be inappropriate for inflation uncertainty (Golob 1994).

Valdovinos (2001) employed several AR-GARCH models to investigate the relationship between average Inflation and Inflation Uncertainty in Paraguay from 1965-1999, his findings indicates that higher levels of Inflation have been historically accompanied by more Inflationary Uncertainty.

Using GARCH model, Thornton (2006) used monthly data of South African Consumer Price index from 1957:01 to 2005:09 to examine the relationship between inflation and inflation uncertainty. The result supports Friedman`s hypothesis that high inflation leads to more variable inflation.

Kontonikas (2004) looked at the inflation and inflation uncertainty and the impact of the explicit targeting in the context of UK economy using the GARCH model and came up with the findings that there exist a positive relationship between past inflation and uncertainty about future inflation, in line with the Friedman-Ball causal link.

Conrad and Karanasos (2004) in their work used the ARFIMA-FIGARCH model which generates long memory in both the conditional mean and variance of inflation using monthly CPI data of the USA, Japan, and UK to examine the relationship between inflation and inflation uncertainty. Their findings indicated that inflation significantly raises inflation uncertainty as predicted by Friedman's hypothesis.

Rizvi and Naqvi (2010) examined the relationship between inflation and uncertainty in Pakistan using quarterly data from 1976:01 to 2008:02. They modeled Inflation to be determined by real growth rate and M2 growth rate and inflation uncertainty as time varying process using GARCH framework. The study analyzed asymmetric behavior of inflation uncertainty using GJR-GARCH and EGARCH models and then asymmetry and leverage effects employing news impact curves. The authors investigated the causality between inflation and inflation uncertainty using bivariate Granger-Causality test. They found strong evidence that the Friedman-Ball inflation uncertainty hypothesis holds for Pakistan.

Balcilar and Ozdemir (2013) employed Granger causality tests within a conditional Gaussian Markov switching vector autoregressive (MS-VAR) model using monthly CPI data for G-7 countries (Canada, France, Germany, Japan, United Kingdom, and the United States) covering the period 1959:12–2008:10 to examine the relationship between inflation and inflation-uncertainty. The study found evidence in favour of the Friedman hypothesis for Canada and the United States.

Kwame (2012) used the monthly CPI and Treasury bill rate data to proxy inflation and interest rate respectively. He employed GARCH model to estimate the conditional variability of inflation with FIML technique in all the estimations with the use of two procedures to find out the relationship between inflation and inflation uncertainty. The result suggests a positive relationship between inflation and its uncertainty and that inflation uncertainty

Granger causes inflation. Also employing AR(3)-GARCH(1,2)-Mean model, Barimah and Amuakwa-Mensah (2014) used monthly CPI data from 1964:04 to 2012:12 to examine inflation and inflation uncertainty links in Ghana. They found overwhelming evidence that increased inflation significantly raised inflation uncertainty during the time period under review.

Hachicha and Lean (2013) in their study on the relationship between inflation, inflation uncertainty and output in Tunisia employed the GARCH-in-mean model with lagged variance equation for the analysis and found that recession in the economy was due to high inflation uncertainty triggered by lowering the level of interest rate by the Central Bank of Tunisia.

Hegerty (2012) used an Exponential GARCH and monthly CPI data from 1976 – 2011 to examine the relationship between inflation and inflation uncertainty in nine African countries (Burkina Faso, Botswana, Cote d'Ivoire, Ethiopia, Gambia, Kenya, Nigeria, Niger and South Africa) and found that the Friedman hypothesis holds true in all the countries. Valdovinos and Gerling (2011) also found that increased inflation raised inflation uncertainty by examining links between inflation and inflation uncertainty in WAEMU countries (Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo) using monthly CPI data for the period of 1994 to 2009.

Barimah (2014) also used EGARCH on monthly Inflation rates to estimate Inflation Uncertainty in Ghana. The study, as well strongly support both Friedman-Ball and Cukierman-Meltzer hypotheses.

In a recent study on inflation volatility in Nigeria Omotosho and Doguwa (2013), used three component of monthly CPI (core, food and headline) from 1996 to 2011 and investigated the dynamics of inflation volatility in Nigeria employing three GARCH type models i.e. symmetric GARCH, asymmetric TGARCH and EGARCH. The authors found that the asymmetric TGARCH (1, 1) was appropriate for explaining the dynamics of headline and core CPI volatilities in Nigeria. However, the symmetric GARCH (1, 1) was adequate for decomposing the volatility in food CPI. The study, however, was silent on investigating the relationship between inflation and inflation uncertainty (Friedman's hypothesis). The current study, however, validates the existence of the hypothesis in the case of Nigeria and accounted for structural breaks commonly associated with GARCH-type model.

3.0 Methodology

3.1. Data Set

In this study, Nigeria's CPI data from January, 1960 to July, 2014 was used. We measure inflation, inf, as the year-on-year change of the consumer price index (CPI), given as:

$$inf_t = 100 * \left(\frac{CPI_t}{CPI_{(-12)}} - 1\right) \tag{1}$$

Figure 1 show clearly that inflation in Nigeria has been very volatile with peaks above 40 per cent in 1984, 1988 and 1995, which recorded the highest of 85.0 per cent. There is actually no clear trend in inflation from the beginning of our sample period except for a short period between 2008 to July 2014 that shows relative stability hovering around 15 and 8 per cent. The series was tested for structural breaks and was found to be statistically significant with the breakpoint identified at July 1995.

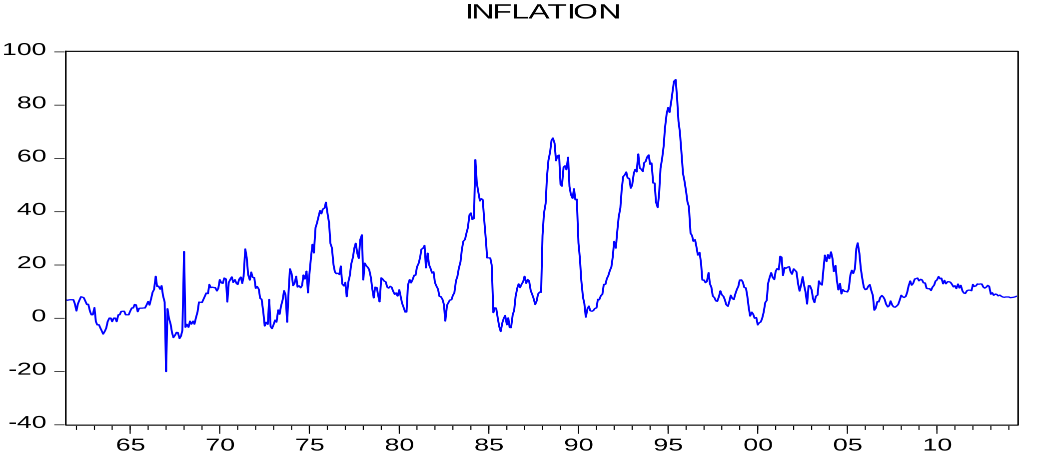

Figure 1: Graphical Representation of Inflation

3.2 Model Estimation

As stated earlier, the study employs GARCH or GARCH-type models as a measure of inflation uncertainty that support the dynamic link between inflation and inflation uncertainty. Given the volatility in inflation series, the study fits both the symmetric GARCH and asymmetric Exponential GARCH (EGARCH) models to investigate the relationship between inflation and inflation uncertainty.

We specify the mean equation for this study as follows:

$$inf_t = \mu + \varepsilon_t \tag{2}$$

However, because of the presence of structural break and seasonality in the inflation data we fitted the proposed Box *et al*.(1994) seasonal ARIMA (2,0,2) (0,0,1) [12] model which was selected and illustrated as follows:

$$(1 - \theta_1 L - \theta_2 L^2) inf_t = (1 + \omega_1 L + \omega_2 L^2)(1 + \Theta_1 L^{12})\epsilon_t \tag{3}$$

The functions θ and ω are the standard autoregressive (AR) and moving average (MA) polynomials of order p and q in variable L. Furthermore, Θ is the seasonal moving average (MA) polynomial of the order P and Q in variable L.

Using the properties of operator L, it follows that equation (3) can be expressed as:

$$inf_t = \alpha_0 + \gamma DUM_t + \theta_1 inf_{t-1} + \theta_2 inf_{t-2} + \omega_1 \epsilon_{t-1} + \omega_2 \epsilon_{t-2} + \Theta_1 \epsilon_{t-12} + \omega_1 \Theta_1 \epsilon_{t-13} + \omega_2 \Theta_1 \epsilon_{t-14} + \epsilon_t$$

where ϵ_t is a Gausian white noise with zero mean and constant variance and . γ is the coefficient of dummy for the structural break

In order to explore the symmetric and asymmetric properties of inflation in Nigeria, we estimated two conditional variance models, i.e. the symmetric and asymmetric models.

For estimating a time-varying volatility of a series, Engel (1982) developed an ARCH (q) model stating the conditional variance of a series forecast error as a function of the lagged value of one-period squared error as follows:

$$\phi_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-1}^2 \qquad (4)$$

Where ϕ_t^2 denotes the conditional variance at time t, α_0 is a constant term, α_i are the ARCH parameters and ε_{t-1}^2 is the lagged value of the squared error. According to Engel (1982), for conditional variance of inflation to be a time-varying measure of inflation uncertainty (presence of ARCH), at least one of the $\alpha_i \geq 0$, where $(i = 1,2, \dots \dots, q)$. By stating the constraint $\sum_{i=1}^{q} \alpha_i < 0$ we ensure that the ARCH process is covariance stationary. Nonetheless, proof of long lag processes of squared residuals in the ARCH specification indicates that shocks have persistence effects on inflation uncertainty. To address this issue, Bollerslev (1986) proposed an alternative generalised ARCH approach, called GARCH[4], expressing the conditional variance as a function of the lagged values of both the conditional variance and the squared error as follows:

$$\phi_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \phi_{t-1}^2 \qquad (5)$$

Where $\alpha_0 \geq 0$, $\alpha_1 \geq 0$ and $\beta \geq 0$ for GARCH (1, 1), while $\alpha + \beta < 1$ is necessary for covariance stationary.

β is the GARCH parameter and ϕ_{t-1}^2 stands for the one period lag of the fitted variance from the model.

Following Nelson (1991) who extended the GARCH model to account for asymmetric effect in volatility, we intend to use the asymmetric EGARCH model since the behavior of inflation uncertainty could be asymmetric. The EGARCH model is preferred to the TARCH[5] model due to it many advantages which include the ability to capture the asymmetric effects of good news and bad news on volatility, which is critical in modeling inflation and inflation uncertainty. It also relaxes the non-negativity constraints imposed on GARCH parameters.

We can express the variance equations of the seasonal ARIMA (2, 0, 2) (0, 0, 1)[12]-EGARCH (1, 1) with dummy as follows:

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[4] GARCH is Generalized Autoregressive Conditional Heteroscedasticity

[5] TARCH stands for Threshold Generalized Autoregressive Conditional Heteroscedasticity

$$\log(\phi_t^2) = \alpha_0 + \rho DUM_t + \beta_1 \log(\phi_{t-1}^2) + \beta_2 \left|\frac{\varepsilon_{t-1}}{\phi_{t-1}}\right| + \beta_3 \frac{\varepsilon_{t-1}}{\phi_{t-1}} \tag{6}$$

It should be noted from (6) above that ρ is the coefficient of the dummy for structural break, β_1 is the GARCH coefficient and ϕ_{t-1}^2 is the one period lag of the variance from the fitted model while, β_2 captures the impact of conditional shocks on the conditional variance. β_3 measures the asymmetric effect of inflation on inflation uncertainty. A significant positive β_3 coefficient is an indication of leverage effect—inflation uncertainty is affected more by a positive change in the rate of inflation than by a negative change of equal magnitude. This interaction is analogous to that of Friedman.

We report in Section 4 the estimation results of the two equations.

4.0 Data Analysis and Presentation of Results

Table 1 provides descriptive statistics of inflation, showing high volatility in the variable; despite the smoothing inherent in the calculation of Year-on-Year rate. We reject the null hypothesis of normality under Jarque-Bera statistics. The non-normal distribution of the data is also apparent from the values of its skewness and kurtosis, which are higher than the normal benchmarks of 0 and 3, respectively.

Table 1: Descriptive Statistics of Inflation

Mean	16.85
Median	12.08
Maximum	89.56
Minimum	-20.0
Std. Dev	17.54
Skewness	1.66
Kurtosis	5.61
Jacrque-Bera	474.93
Probability	0.00
Sum Sq. Dev	196086.0

This empirical study uses inflation data sourced from the Central Bank of Nigeria statistics database, covering the period January 1960 to July 2014 as the dependent variable for the mean model estimated.

4.1 Stationarity Tests

The Augmented Dickey Fuller (ADF) and Philips Perron (PP) tests were used to test for the stationarity properties of the data. The Zivot-Andrews breakpoint unit root test was undertaken to establish the existence of structural break in the series. The summary of the results is given in Table 2.

Table 2: Unit Root Test Results

INFLATION	Test Statistic	Critical Value	AIC	SIC	DW Stats
ADF	-3.19	-2.87*	5.48	5.58	2.00
PHILIPS PERRON	-3.73	-2.87*	5.68	5.69	2.05
ZIVOT-ANDREWS BREAKPOINT	-5.73	-4.93*			

*Note: * indicates significance at 5% level*

Both tests rejected the null hypothesis of presence of unit root. We thus, conclude that the behavior of the series over time is stationary. From the unit root test results, both the ADF and PP test rejects the null hypothesis at 1% level of significance. Furthermore, the Zivot-Andrews breakpoint test revealed the presence of structural break in the series as shown in the critical value (see figure 2). The structural break point is July 1995 which coincides with the strengthening of demand management policies by the government which considerably moderated inflationary pressures.

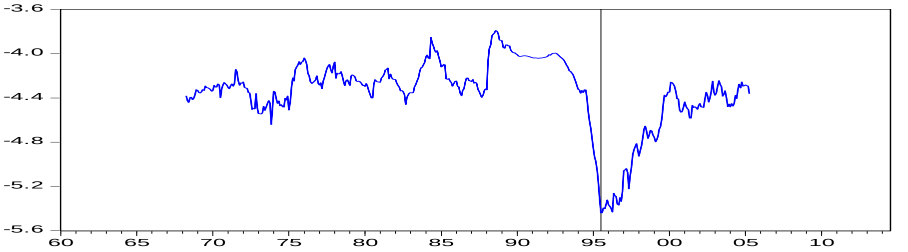

Figure 2: Zivot-Andrews Breakpoint Test

4.2 Test for ARCH Effect

It is important to conduct Engle (1982) test for ARCH effects to ensure that the data suits this class of models. Table 3 presents the result of the ARCH effect test.

Table 3: ARCH Effect Test Result

Model	F-Statistics Test		Chi-Square Test	
	F-Statistics	Prob.	Obs*R-squared	Prob. Chi-Square
Inflation	105.7242	0.0000	90.8995	0.0000

The F-statistic in table 3 above is significant, suggesting the presence of ARCH effect in the Nigeria's inflation data and hence, the appropriateness of GARCH type models. In addition, the plot of the residual graph presented below further establishes the presence of ARCH effect.

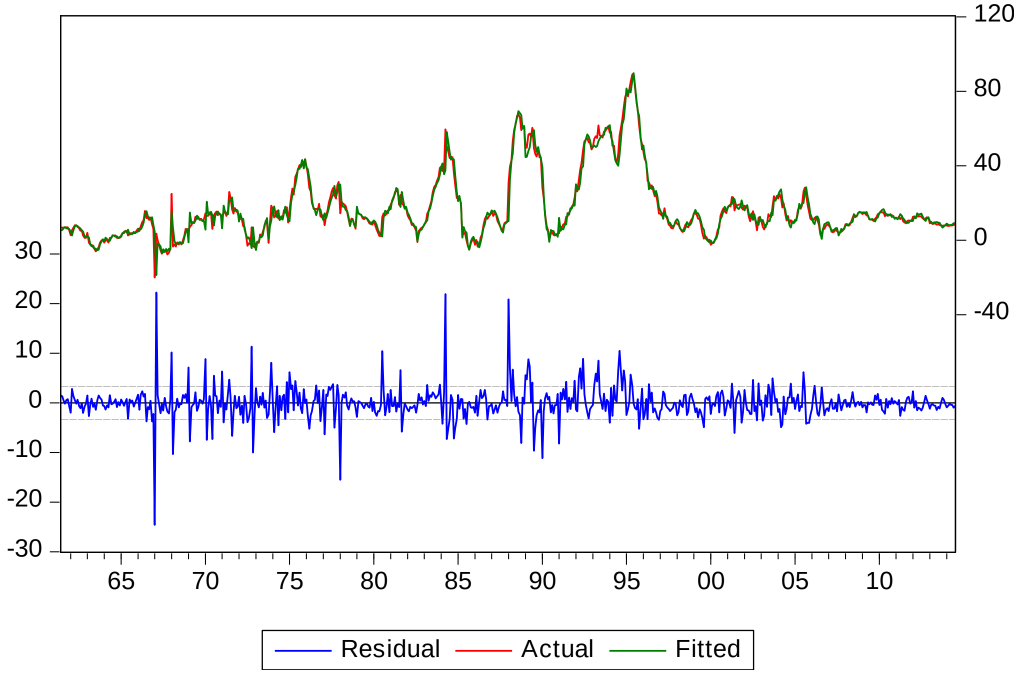

Figure 2: Residual graph

4.3 Presentation of Results

4.3.1 Conditional Mean Equation

The results of the mean model for inflation whose optimal number of lags was obtained based on minimum value of AIC[6], for the autoregressive and moving average terms. Thus, we arrived at SARIMA (2, 0, 2) (0, 0, 1) [12] model to estimate mean inflation as specified in equation (3) above:

Regression results for the mean equation (3) are presented in equation (7) as follows:

[6] Akaike Information Criterion

$$inf_t = 20.2573 - 1.8815DUM_t + 1.8764\mu_{t-1} - 0.8780\mu_{t-2} - 0.9021\upsilon_{t-1} + 0.1327\upsilon_{t-2} - 0.7925\upsilon_{t-12} \quad (7)$$

All the coefficients are found to be statistically significant. The F and DW statistics suggests that the equation is well specified. However, the coefficient of the dummy of structural break in the model is highly significant.

4.3.2 Estimation of the Inflation Uncertainty Models

The measure of inflation uncertainty was obtained by deriving the GARCH variance series from the estimated volatility model, which is the conditional variance of unanticipated shocks to inflation process.

The squared residual of the mean model was examined for the presence of ARCH effect using Breusch-Pagan-Godfrey test and the null hypothesis of homoscedasticity was rejected. Thus, we concluded that there was ARCH effect in the squared residuals and hence, presence of time varying volatilities. The results of the test are presented below:

Table 4: ARCH LM Test for Heteroskedasticity in the Squared Residual of the Mean Model

Series	***F-Statistics Test***		***Chi-Square Test***	
	F-Statistics	*Prob.*	*Obs*R-squared*	*Prob. Chi-Square*
Inflation	*9.6179*	*0.0020*	*9.5045*	*0.0020*

The test result is a confirmation that the mean model can be used for the estimation of inflation uncertainty in Nigeria.

The SARIMA in the EGARCH equation which was selected based on the minimum AIC value is as presented below:

$$Inf_t = 15.6147 - 1.6166 * DUM_t + 1.8314\mu_{t-1} - 0.8349\mu_{t-2} - 0.8323\upsilon_{t-1} + 0.0993\upsilon_{t-2} - 0.7582\upsilon_{t-12} \quad (8)$$

Equation (8) is well specified. However, the coefficient of the dummy for structural break is not statistically significant, suggestive that structural change did not impact inflationary dynamics during the period.

The uncertainty models estimated as reported in table 6 showed that the EGARCH model has the best fit for inflation uncertainty in Nigeria.

Table 5: Highlight of the Estimates of Inflation Uncertainty Models

	GARCH	EGARCH
α_0	4.0959	0.2605*
α_1	0.3882*	
β	0.3259*	
β_1		0.7620*
β_2		0.4275*
β_3		0.0440*
GARCH Persistence ($\alpha_1 + \beta$)	0.7141	
EGARCH Persistence (β_1+β_2)		1.1895
R-Square	0.9648	0.9647
AIC	5.1071	5.0706
DW-Statistics	2.0368	2.0339

*Note: * indicates 5% significance levels.*

Results from table 6 confirms that the EGARCH model is the best fitted for inflation uncertainty based on it minimum AIC value. The coefficients are statistically significant at the 5 per cent level. The asymmetric term (β_3) is highly significant and positive. This implies that positive shocks exert greater impact on inflation uncertainty than negative shocks, indicative of the presence of leverage effect. The inference is that when there is an unexpected rise in inflation, inflation uncertainty would increase more than when there is an unanticipated fall in inflation. In other words, the point estimates of the coefficients imply that, if ε_{t-1} rises by 1 unit implying a positive shock to inflation, the conditional variance (inflation uncertainty) will increase by 0.4715 (β_3+β_2). However, a 1 unit decline in ε_{t-1} will induce a change in inflation uncertainty by -0.3835 (-β_3+β_2). This interaction strongly supports the Friedman's hypothesis. The persistence parameter is around 1.1895, which is higher than unity, indicating that the impact of any positive shock to inflation will diminish very slowly overtime.

We conducted ARCH LM test on our correctly fitted uncertainty model to confirm if the standardized residual of the model is free from ARCH effect.

Table 6: Serial Correlation Test on the Uncertainty Model for Any ARCH Effect

Model	F-Statistics Test		Chi-Square Test	
	F-Statistics	Prob.	Obs*R-squared	Prob. Chi-Square
Inflation (EGARCH)	0.0176	0.8944	0.0177	0.8942

The result as presented in Table 7 reveals that there is no longer presence of ARCH in the preferred uncertainty model and can thus, conclude that the model was adequately specified.

4.4 Causality Test between Inflation and Inflation Uncertainty

In order to determine the causality between inflation and its uncertainty, we carried out Granger causality test up to 12 lags between inflation and inflation uncertainty. The result is reported in Table 8.

Table 7: Granger Causality Test (P-values of Wald Statistics)

Lags	Inflation does not cause Inflation Uncertainty	Inflation Uncertainty does not cause Inflation
1	0.0057	0.2545
2	1.E-08	0.1329
3	6.E-08	0.2903
4	2.E-07	0.6844
5	5.E-07	0.9140
6	2.E-06	0.8936
7	3.E-06	0.8475
8	6.E-06	0.8868
9	2.E-05	0.9151
10	4.E-05	0.9448

In Table 8, the P-values for the null hypothesis that inflation does not cause inflation uncertainty and then inflation uncertainty does not cause inflation were given in the first and second columns, respectively. The result is consistent for all the lags and the null that inflation does not cause inflation uncertainty was rejected, therefore supporting the Friedman(1977) and Ball(1992) postulations. Furthermore, the result did not corroborate the Cukierman-Meltzer hypothesis that inflation uncertainty causes inflation except for lag 1 which stated otherwise.

5.0 Conclusion and Policy Implication

This research work has elicited some interesting outcomes about inflation dynamics in Nigeria. Given that all inflation series display structural breaks, the phenomenon was tested and found to be significant which was accounted for in the model. We modeled the time varying properties of inflation uncertainty in Nigeria as conditional variance and discovered that asymmetric EGARCH model fitted better than symmetric GARCH model based on the selected information criterion. The asymmetric parameter was found to be positive and highly significant, which proposes that unanticipated price decreases have less destabilizing impact than unanticipated price increases of equal magnitude. This conclusion supports the Friedman's hypothesis that the study sets out to test for Nigeria. Furthermore, the Granger causality test conducted indicated that high inflation Granger causes inflation uncertainty, which strongly agrees with the Friedman (1977) and Ball (1992) postulations. There was no sufficient evidence in support of the Cukierman-Meltzer hypothesis, as revealed by the causality test results.

The policy implication of these findings is for the monetary authorities to continuously aim at achieving and sustaining low average inflation rate consistent with targeted economic growth, in order to reduce the negative consequences associated with uncertainty. There is need for the Central Bank of Nigeria to always thinker with money supply growth whenever inflation is high so as to reduce its impact. In discussing the negative consequences, Conrad and Karanasos (2005) argue that greater uncertainty – which many have discovered to be negatively correlated to economic activities, is part of the cost of inflation. Finally, the evidence against Cukierman-Meltzer hypothesis supports the stabilization hypothesis put forward by Holland (1995). Since we have established causality running from high inflation to higher inflation uncertainty, Nigeria would need stabilization programmes, particularly in agriculture[7] during periods of high inflation so as to bring down the welfare cost of inflation.

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[7] Since agriculture carries the highest weight in the CPI basket.

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