ON THE RELATIONSHIP BETWEEN INFLATION AND UNCERTAINTY: AN APPLICATION OF THE GARCH FAMILY MODELS

Dr. Ahmed Mohammed Khater Arabi

Assistant professor, Department of Econometrics and Social Statistics, Faculty of Economic, University of Bakht Alruda, Alduiem, Sudan

CITATION: Arabi, A. M. K. A. (2014). On the relationship between inflation and uncertainty: an application of the GARCH family models. *International Journal of Social Sciences and Entrepreneurship*, *1* (12), 152-161.

ABSTRACT

This paper examines the relationship between inflation and inflation uncertainty in a dynamic framework for Sudan by using monthly data over the period July 1995–December 2012. The Generalized autoregressive conditional heteroscedasticity (GARCH) and the exponential generalized autoregressive conditional heteroscedasticity (EGARCH) models were used to capture the stochastic variation and asymmetries in the economic instruments. The results indicate a positive relationship between past inflation and current uncertainty. Furthermore Granger causality test shows that there is sufficient empirical evidence that higher inflation rate level will result in higher future inflation uncertainty and higher level of inflation uncertainty will lead to lower future inflation rate.

Key Words: *GARCH, EGARCH, inflation rate and uncertainty*

Introduction

Keeping inflation in low and stable rate is most vital responsibility of the central banks. Because policy actions to curb inflation typically take effect only after a long lag, the central banks needs to know in advance when inflation is likely to rise. Consequently, to understand where prices are headed and what policy steps are appropriate, policymakers turn to forecasts of inflation. Even though the positive relationship between inflation and inflation volatility is a well-established phenomenon, there is no consensus in the literature about the direction and the relationship between inflation and inflation uncertainty takes. Friedman (1977) suggests a positive correlation between the level of inflation and inflation uncertainty, with higher inflation leading to greater uncertainty and lower output growth. Ball (1992) formalizes Friedman's argument in the context of an asymmetric information game between the public and the policy maker. The empirical relationship between average inflation and inflation uncertainty has been studied extensively throughout the last three decades, with the results largely accepting the Friedman-Ball prediction. Thus, policies that lower average inflation lead to lower inflation uncertainty with apparent economic benefits. A variety of GARCH related models have been employed to account for time- varying inflation volatility. GARCH techniques are popular in empirical investigations of the inflation-uncertainty relationship, since the estimated conditional volatility can serve as a proxy for uncertainty.

The purpose of this paper is to investigate the dynamic relationship between inflation and inflation uncertainty and yield in general supportive evidence to the Friedman-Ball approach for various country cases for Sudan for the period July 1995 to December 2012. Exponential generalized autoregressive conditional heteroscedasticity (EGARCH) models are used to capture the stochastic variation and asymmetries in the inflation and inflation uncertainty.

The rest of the paper is organized as follows. The next section discusses the theoretical background and literature review concerning the inflation-uncertainty relationship. Section 3 presents an overview of the data and methodology. Sections 4 contain the empirical results and discussions. Section 5 provides conclusions and policy implications.

Theoretical Background and Literature Review

The idea that a rise in the level of inflation raises uncertainty about future inflation is central in Friedman's (1977) Nobel address. In the model by Ball (1992) there are two types of policymakers who stochastically alternate in power, and the public knows that only one type is willing to bear the economic costs of disinflation. When inflation is low both types of policy makers will try to keep it so, thus uncertainty concerning future inflation will also be low. On the other hand, when inflation is high uncertainty about the future monetary stance and the future path of inflation will be greater, since the public doesn't know how long it will be before a tough type comes along and disinflates. Thus, the public faces an inference problem when trying to distinguish between persistent changes in the objectives and transitory monetary control errors. An increase in uncertainty about money growth and inflation provides the policymaker with an incentive to create an inflation surprise to stimulate real activity leading to a positive correlation between uncertainty and optimal average inflation. In empirical investigations of the inflation-uncertainty relationship, a measure for uncertainty needs to be employed early studies use unconditional volatility measures; for instance Fischer (1981) employs the moving standard deviation of inflation. Such measures have a drawback in the sense that higher variability need not necessarily imply higher uncertainty. This will be the case, only if agents don't possess the relevant information to predict part of the increased variability. In survey-based studies, expected inflation and uncertainty are approximated using inflation forecasts of individual respondents. Johnson (2002) measures uncertainty as the standard deviation of individual forecasts within a calendar year, and as the average next-year forecast error and finds a strong positive link between past inflation and current uncertainty in line with the Friedman-Ball view.

However, another strand of the literature argues that higher inflation uncertainty leads to a rise in the optimal inflation rate (Cukierman and Meltzer 1986; Cukierman 1992) with empirical evidence provided by Grier and Perry (1998) and Berument et al. (2005). Holland (1993, 1995) suggests that inflation uncertainty may lower the average inflation rate, provided that the central bank tries to minimize welfare losses arising from more inflation uncertainty. Berument et al. (2001) model inflation uncertainty in Turkey using the Exponential General Autoregressive Conditional Heteroskedastic (EGARCH) method for the period 1986–2000 using monthly CPI inflation. Their empirical findings indicate that the effect of positive shocks to inflation on inflation uncertainty is greater than that of negative shocks to inflation. In contrast, Nas and Perry (2000) examined the two-step approach to investigate the link between inflation and inflation uncertainty in Turkey from January 1960 to March 1998. They found that a strong statistical support that inflation significantly raised inflation uncertainty over the full sample period. Fernandez Valdovinos (2001) applied monthly data covering period of January 1965 to December 1999 in Paraguay with two-step approach to estimate inflation uncertainty. Once the measure of inflation uncertainty is obtained, they use Granger causality methods to test whether higher average inflation causes inflation uncertainty or vice versa. They point out that strong evidence supporting Friedman's hypothesis in all the European countries except for Germany and less robust evidence to support Cukierman, Meltzer and Holland's hypothesis. Kontonikas (2004) analyzed the relationship between inflation and inflation uncertainty in the United Kingdom from 1973 to 2003 with monthly and quarterly data. Different types of GARCH-Mean-Level (GARCH-M-L) models that allow for simultaneous feedback between the conditional mean and variance of inflation are used to test the relationship and they find positive relationship between inflation and inflation uncertainty, in line with Friedman-Ball causal link. Thornton (2007), using GARCH modeling, confirms Friedman-Ball hypothesis for all emerging markets, while Holland hypothesis gets support for Israel, Mexico, Colombia and Turkey. Nadia Saleem (2008), only work looking beyond the determinants, applies EGARCH to measure the volatility of inflation by using monthly data over a period of 1990-2007 and concludes that inflation is volatile in Pakistan and is significantly and positively related with inflation uncertainty. Hakan Berument & N. Nergiz (2005) this study examines the relationship between inflation and inflation uncertainty in the G-7 countries for the period from 1957 to 2001. The causality between the inflation and inflation uncertainty is tested by using the Full Information Maximum Likelihood Method with extended lags. The empirical results indicate that inflation causes inflation uncertainty for all the G-7 countries, while inflation uncertainty causes inflation for Canada, France, Japan, the UK and the US. Hassan H. and Sahar B. (2010) investigate the relationship between inflation and inflation uncertainty for the period of 1990-2009 by using monthly data in the Iranian economy. The study uses the Full Information Maximum Likelihood (FIML) method to address this issue. The estimates of the study gathered with the new set of specifications suggest that inflation causes inflation uncertainty, supporting the Friedman–Ball hypothesis. Sajid A. , Saud A. & Azad Haider (2012), examines relationship between Inflation and Inflation uncertainty for Pakistan using monthly data over 1957:1-2007:12. ARMA-GARCH model is applied to estimate conditional volatility of inflation. The empirical results support Friedman-Ball hypothesis for Pakistan as Granger-causality test reveals that inflation affects inflation uncertainty positively. Ahmad Jafari and Mohamadreza (2012) the study used the Full Information Maximum Likelihood (FIML) method to investigate the relationship between inflation and inflation uncertainty in five MENA countries. The results showed that there was an asymmetric relationship for MENA countries. Mohammad (2009) investigated the relationship between inflation and uncertainty using the Iranian data over the period 1959:03 – 2008:02. GARCH models were used to examine this relationship. Granger methods were employed to provide statistical evidence for the relationship between average inflation and inflation uncertainty. Threshold GARCH (TGARCH) models were considered to investigate asymmetry in the conditional variance of inflation. The Component GARCH (CGARCH) models were employed to decompose inflation uncertainty into a short-run and a long-run component by permitting transitory deviations of the conditional volatility around a time-varying trend. The findings are bi-directional causality, and increased inflation raises inflation. Abu Hassan (2007) this study is to explore the varying volatility dynamic of inflation rate in Malaysia for the period from January 1980 to December 2004. Results show that the EGARCH model gives better estimates of sub-periods volatility. Further analysis using Granger causality test shows that there is sufficient empirical evidence that higher inflation rate level will result in higher future inflation uncertainty and higher level of inflation uncertainty will lead to lower future inflation rate.

Empirical evidence regarding the relationship between inflation and inflation uncertainty for Sudan is provided by a number of studies that employ alternative estimation methods, i.e. different measures of inflation and for different time periods. Khalafalla Arabi (2010) investigate the link between inflation and inflation uncertainty using variety of GARCH related models to account for time varying inflation volatility since the estimated conditional volatility can serve as a proxy for uncertainty, revealed that EGARCH was found to correctly specify and estimate the conditional variance of inflation with possibility of a simultaneous feedback relationship between inflation and uncertainty.

Research Data and Methodology

This study use monthly data of Sudan CPI inflation to investigate the relationship between inflation and inflation uncertainty covers period from July 1995 to December 2012. The data are obtained from central bureau of statistics. In applied econometric literature, ARCH class of models is used to model time varying conditional variance. In this study, inflation uncertainty is proxied as conditional variance. Figure (1) shows the volatility of consumer price index during the period analyzed and table 1 presents descriptive statistics of annual inflation. It is seen from figure 1 that there is a prolonged low volatility from year 1946 to year 1978 and also there exist a prolonged period of high volatility from year 1980 to year 2002

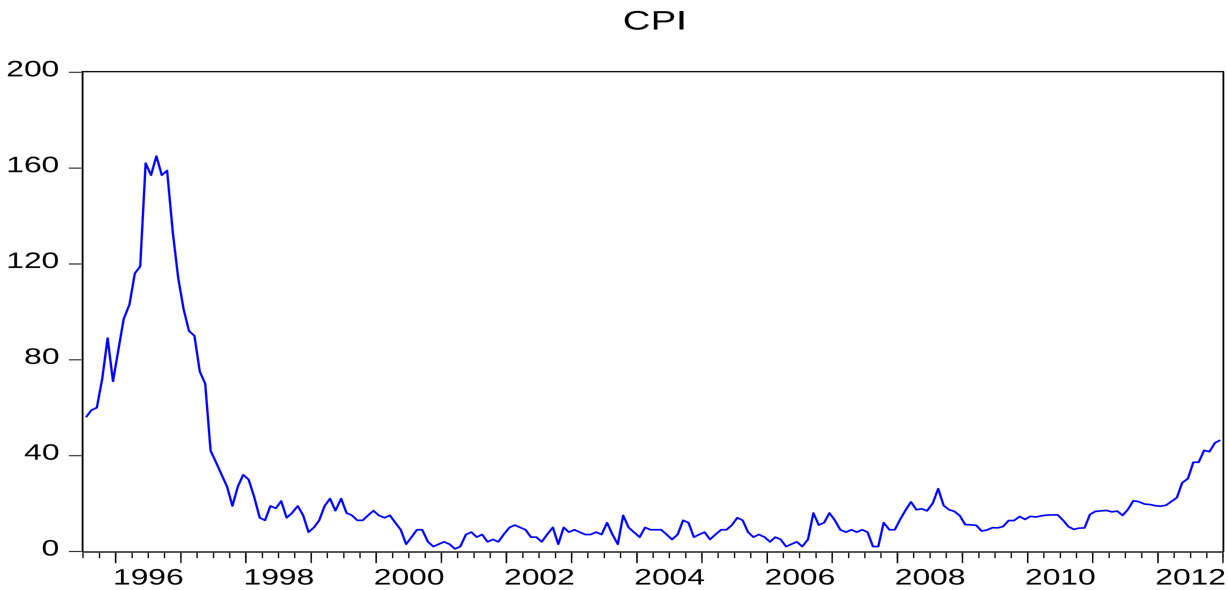

Figure 1: Volatility of consumer price index

According to table (1), the mean and standard deviation of inflation is approximately 23% and 31%, respectively. Maximum and minimum inflation rate during period analyzed is 165% and 1%, respectively. Skewness, Kurtosis and Jarque-Bera statistics indicate that inflation series is not distributed normally, and shows a distribution skewed to the right. Higher Jarque-Bera statistics also confirms that inflation series is not distributed normally.

Table1: Summary of Descriptive Statistics for monthly INF, July 1995- December 2012

	CPI
Mean	23.21905
Median	13.00000
Maximum	165.0000
Minimum	1.000000
Std. Dev.	31.89256
Skewness	2.847285
Kurtosis	10.89602
Jarque-Bera	829.2839
Probability	0.000000
Sum	4876.000
Sum Sq. Dev.	212581.3
Observations	210

The complete general model used for inflation series π_t in this paper, is given bellow in equation

$$\inf_t = \omega + \sum_{i=1}^{k} \alpha_i \inf_{t-i} + \sum_{j=1}^{s} \beta_i \epsilon_{t-j} + \sigma_t \varepsilon_t - - - - - - - - - - - - - - - (1)$$

Where: $\epsilon_t = \eta_t \sigma_t$ *and* $\eta_t \sim D(0,1)$which may also contain the lagged values of endogenous variable and an inflation volatility measureσ_t^2, ϑ is an inflation volatility premium coefficient to capture the volatility-in-mean effect and $\alpha, \beta_1, \ldots\ldots \beta_k$are the other parameters of interest. The variance equation the ARCH (q) is written as:

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

the GARCH(p,q) model can be written as

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 \text{ and}$$

Persistence of shocks to volatility is given by $\alpha_i + \beta_j$ above model is a pair of equations, equation (3)-standard ARMA process-, is conditional mean equation and equation (4) represents uncertainty (conditional variance).

The EGARCH (p, q) model can be written as

$$ln\sigma_T^2 = \omega + \sum_{i=1}^{p} \beta_i \ln\sigma_{t-i}^2 + \sum_{i=1}^{q} \alpha_i \left|\frac{\epsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\epsilon_{t-k}}{\sigma_{t-k}},$$

Where the order of the p and the distributional assumption will affect the intercept term ω, σ_{t-i} and σ_{t-k} are the conditional variance of the previous time period, $\sigma_{t-1}, \epsilon_{t-i}$ *and* ϵ_{t-k} are the conditional variance's error terms of the previous time period ϵ_{t-1} and α_i, β_i *and* γ_k are coefficients.

Empirical Models and Results

It is important to check the series for stationarity using the Augmented Dickey Fuller (ADF) and Philips Perron (PP) tests, the results are reported in table (2) that inflation rate is stationary I(0) over the period.

Table 2: unit root test

	Unit root test	
	ADF (level)	PP (level)
Test statistics	-6.093109	13.48696
Critical value : 5%	-3.463576	-3.461783
Lag length (automatic – based on SIC maxlag	14	14

Table 3: AR(6)-GARCH(1,1) and AR(6)-EGARCH(1,1) Models

	AR(6)-GARCH(1,1)			AR(6)-EGARCH(1,1)	
Mean equation					
variable	Coefficient	P value	variable	Coefficient	P value
constant	7.685735	0.6020	constant	15.07613	0.0000
inf_{t-1}	1.086936	0.0000	inf_{t-1}	0.966377	0.0000
inf_{t-6}	-0.059416	0.0000	inf_{t-6}	-0.044569	0.1066
Variance equation					
Constant	148.3079	0.0000	constant	0.005050	0.9044
ϵ_{t-1}^2	0.110319	0.0000	$\left\|\epsilon_{t-1}/\sigma_{t-1}^2\right\|$	0.149080	0.0066
σ_{t-1}^2	1.001144	0.0000	$\epsilon_{t-1}/\sigma_{t-1}^2$	0.055098	0.0234
			$ln\sigma_{t-1}^2$	0.951323	0.0000
AIC	6.285906		AIC	5.588169	
SIC	6.383497		SIC	5.702027	
F-statistics	0.006808	probability 0.9343	F-statistics	0.003571	probability 0.9524
Ob*R-squared	0.06876	probability 0.9339	Ob*R-squared	0.003607	probability 0.9521

The presence of leverage effects in the EGARH model is confirmed by the negative estimate |RES|/SQR[GARCH](1) that is -0.149, so the impact is symmetric. The residuals analysis is also carried out. Q-stat on residuals and squared residuals accepts the null show that the residuals are free from serial correlations and conditional heteroscedasticity. Furthermore the LM-ARCH test, for distinct lags, shows that no ARCH is left in residuals. However, AR(6)-GARCH(1,1) model has smaller values of AIC and SC as compared to AR(6)-EGARCH(1,1) model. Thus, AR(6)-EGARCH(1,1) model seems adequate for estimating both the conditional mean and conditional variance of Sudan's inflation rate. However, in this paper the focus of discussion is on the conditional variance (volatility) estimation. The coefficients of $\epsilon_{t-1}/\sigma_{t-1}^2$ and $\ln\sigma_{t-1}^2$ measure the asymmetric effect and persistency of inflation uncertainty, respectively. The results show that both parameters are positive and statistically significant at the 0.01 level. In this study, the positive and significant value of $\ln\sigma_{t-1}^2$ coefficient implies that positive shocks have greater impact on inflation uncertainty as compared to negative shocks.

Conclusions and Recommendations

This is second attempt to study inflation-inflation uncertainty nexus for Sudan. GARCH modeling is employed on monthly data over a period of 1995:7-2012:12 to estimate inflation-uncertainty. The results support Friedman-Ball hypothesis. The study comprehend positive association between level of inflation and inflation uncertainty i.e. higher inflation rate causes higher rates of uncertainty, and conclude that this renders the credibility of disinflation program to be established. The work will help the policy makers to formulate policies to control inflation so that uncertainty can be minimized. Moreover, based on findings of our work, and in concurrence with Friedman hypothesis, we can conclude that a stable inflation will result in degenerating inflation uncertainty which in turn can improve economic performance of Sudan. AR(6)-EGARCH(1,1) model seems adequate and best fitted model for estimating both the conditional mean and conditional variance of Sudan's inflation rate.

References

Ahmad Jafari, Mohamadreza Abdollahi and Saman (2009) Inflation and Inflation Uncertainty: Evidence from MENA, Universal Journal of Management and Social Sciences, vol. 2, No. 1; January 2012

Abu assan, Tan Yan , Maarof (2007) On the Relationship between Inflation Rate and Inflation Uncertainty: An Application of the GARCH Family Models. Sains Malaysiana 36(2)(2007): 225-232

Ball, L., 1992. Why does higher inflation raise inflation uncertainty? Journal of Monetary Economics 29,371-378.

Berument H, Kilinc Z, Ozlale U (2005) The missing link between inflation uncertainty and interest rates.Scottish J Political Econ 52: 2–241

Berument H, Metin-Ozcan K, Neyapti B (2001) Modeling inflation uncertainty using EGARCH: an application to Turkey. http://www.econturk.org/Turkisheconomy/kivil2.pdf

Cukierman A (1992) Central bank strategy, credibility and independence: theory and evidence. MIT Press,Cambridge.

Cukierman A,Meltzer A (1986) A theory of ambiguity credibility and inflation under discretion and asymmetric information. Econometrica 54:1099–1128

Fernandez Valdovinos, C. 2001. Further evidence Friedman's hypothesis: The case of Paraguay. Cuadernos de economia V38 N115

Friedman, M., 1977. Nobel lecture: inflation and unemployment. Journal of Political Economy 85, 451-472.

Grier K, Perry MJ (1998) On inflation and inflation uncertainty in the G7 countries. J Int Money Financ17:671–689

Hakan Berument & N. Nergiz (2005) Inflation and inflation uncertainty in the G-7 countries. Available online at www.sciencedirect.com. Physica A 348 (2005) 371–379

Hassan H. and Sahar B. (2010), Inflation and Inflation Uncertainty in Iran: An Application of GARCH-in-Mean Model with FIML Method of Estimation, *International Journal of Business and Development Studies Vol. 2, No. 1, (2010) pp.131-146*

Khalafalla Arabi (2010) Association between Inflation and its Uncertainty, Journal of Business Studies Quarterly Vol. 2, No. 1, pp. 36-51

Kontonikas, A. 2004. Inflation and inflation uncertainty in the United Kingdom, evidence GARCH modeling. Economic Modeling 21: 525-543.

Johnson, D., 2002. The effect of inflation targeting on the behavior of expected inflation: evidence from an 11 country panel. Journal of Monetary Economics 49, 1521-1538.

Nadia Saleem (2008), Measuring Volatility of Inflation in Pakistan. *The Lahore Journal of Economics, : 2 (Winter 2008): pp. 99-128*

Nas, T. F. & Perry, M. J. 2000. Inflation, inflation uncertainty, and monetary policy in Turkey: 1960–1998. Contemporary Economic Policy 18: 170–80.

Sajid A. , Saud A. & Azad Haider (2012), Inflation and Inflation Uncertainty Nexus: Empirical Evidence from Pakistan, *International Journal of Economics and Financial Issues Vol. 2, No. 3, 2012, pp.348-356 ISSN: 2146-4138.*