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Inflation and Inflation Uncertainty Nexus: Empirical Evidence from Pakistan

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ABSTRACT: This study 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. Findings of the study support Friedman-Ball hypothesis for Pakistan as Granger-causality test reveals that inflation affects inflation uncertainty positively. We find no evidence for inflation uncertainty affecting inflation rates as suggested by Cukierman & Meltzer (1986) and only unidirectional relation is evident with causality running from inflation to inflation uncertainty. High volatility persistence for inflation is also confirmed. Results of the study may be useful for policymakers at central bank to devise more efficient monetary policy.

Keywords: Friedman-Ball Hypothesis; Inflation Uncertainty; GARCH; Granger Causality
JEL Classifications: E0; E23; E31

1. Introduction

Loss of predictability, delayed decisions of investment and a fall in purchasing power (hence demand) are amongst some of the costs of unstable inflation compelling "Price Stability" as prime objective for policy makers. Higher inflation levels are believed to cause uncertainty about future inflation by distorting price mechanism. The issue caught great attention on both theoretical and empirical fronts since the path breaking Nobel lecture of Friedman (1977). Voluminous work has been produced on inflation and inflation uncertainty nexus by using different measures and proxies for uncertainty but the area remains unexplored in case of Pakistan. This study attempts to fill the void.

Amid unprecedented higher inflation rate in Pakistan this work has greater policy relevance. Our work fills the void by extending the issue in two directions. Firstly, Instead of standard deviation or variance of inflation, conditional variance is used as proxy for inflation uncertainty[2]. The latest

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[2] See Holland (1993a, 1993b), Davis and Kanago (2000), Batchelor and Dua (1996), and Bomberger (1996) for literature on different measures of uncertainty.

innovation in the field is to use GARCH based conditional variance as proxy for uncertainty[3]. We model inflation in GARCH process to generate conditional volatility of the inflation series. Secondly, the direction of causality between inflation and inflation uncertainty is examined by applying granger causality technique.

This study examines impact of Inflation on Inflation uncertainty and vice versa for Pakistan by using monthly data from 1957:1-2007:12. ARMA-GARCH model is applied to estimate conditional volatility, used as proxy for Inflation uncertainty. The results show high volatility persistence for inflation. Findings of the study support Friedman-Ball hypothesis for Pakistan. Granger-causality test reveals that an increase in inflation has a positive impact on inflation uncertainty. We find no evidence for inflation uncertainty affecting inflation rates as suggested by Cukierman and Meltzer (1986). Only unidirectional relation is evident with causality running from inflation to inflation uncertainty. The results of the study may be useful for policymakers at central bank to devise more efficient monetary policy. Rest of the paper is organized as follows. Section two gives theoretical background while the relevant literature is briefly reviewed in section three. Data, methodology and results are discussed in section four. Section five concludes the study by laying some guidelines for policy makers.

2. Inflation-Inflation Uncertainty Nexus: The Theoretical Background

Higher inflation brings inflation uncertainty which results in welfare loss through distortion of price mechanism (Friedman 1977). The uncertainty about future inflation can stem from the expectations about the role of central bank for future in the presence of costs of disinflation. Ball (1992) puts a case for the argument in a game theoretical framework where asymmetric information notion holds. According to Friedman-ball, higher inflation rates generate greater uncertainty about the future policy so about future inflation rates. A quite reverse outcome is proposed by Ungar and Zilberfarb (1993) where a great allocation of resources to understand the inflation uncertainty in presence of high inflation decreases the future uncertainty.

The relation can also be the other way round where a feedback from inflation uncertainty can affect the inflation rates. Cukierman and Meltzer (1986), in Barro and Gordon (1983) model of Fed behavior, put an argument that inflation uncertainty can increase inflation level. (Devereux 1989) extends Cukierman and Meltzer (1986) by incorporating the wage indexation in Barro and Gordon (1983) and concludes that higher inflation uncertainty through wage indexation can speed up the inflation rates. Contracts are made at higher wages if higher inflation rates are perceived for future resulting in further popping the inflation rates up. While, for Holland (1995), an increase in inflation uncertainty can bring a reduction in inflation rate as an outcome of the stabilization policy pursued in times of greater inflation uncertainty.

3. Literature Review

Empirical literature on inflation and inflation uncertainty is inconclusive about the relationship and mixed results are reported. Brunner and Hess (1993) and Grier and Perry (1998) find the evidence supporting Friedman and Ball hypothesis using ARCH and GARCH models respectively for G-7 countries. But a week support was found for Cukierman and Meltzer hypothesis. Nas and Perry (2000) put strong evidence that inflation rates increases inflation uncertainty in turkey. Using ARCH model to measure uncertainty, similar results are reported in Neyapti and Kaya (2001). Again Ozdemir and Fisunoglu (2008), using GARCH modeling, establishes a strong and weak evidence for Friedman-Ball and Cukierman and Meltzer hypothesis respectively for Jordan, Philippines and Turkey. Positive impact of inflation uncertainty on inflation is also reported by Golob (1994) for US using quarterly data. In his study on UK, Joyce (1995) reports higher sensitivity if inflation uncertainty to positive inflation shocks as compared to negative shocks. Ricketts and Rose (1995), in Markov-Switching model, found the evidence that inflation uncertainty increases during high inflation periods in Canada.

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[3] Single country studies using ARCH-GARCH generated proxy include Fountas (2001) and Kontonikas (2004) for the UK; Bohara and Sauer (1994) for Germany; Nas and Perry (2000) and Telatar and Telatar (2003) for Turkey; Brunner and Hess (1993), Caporale and McKiernan (1997), Balcombe (1999); Hwang (2001) for the USA; and Thornton (2007b) for Argentina.

On the other hand, Baillie et al. (1996) find evidence supporting the Cukierman–Meltzer hypothesis for UK. While Grier et al. (2004) and Karanasos et al. (2004), using GARCH model on US data, report that inflation uncertainty affects inflation rate negatively and positively respectively. Grier and Perry (2000) and Grier et al. (2004) fail to find any evidence for Devereux hypothesis. Fountas et al. (2006) finds support for Friedman-Ball hypothesis for G7 countries excluding UK where Ungar and Zilberfarb hypothesis is evident. Karanasos and Stefanie (2008) test the alternative hypothesis for Germenay, Netherland and Sweden. They find a strong evidence for Friedman-Ball hypothesis for all 3 countries. While Holland and Devereux hypothesis are confirmed for Sweden, and Netherland and Germany respectively. Similarly Thornton (2007), using GARCH modeling, confirms Friedman-Ball hypothesis for all emerging markets, while Holland hypothesis gets support for Israel, Mexico, Colombia and Turkey. They also confirm Devereux hypothesis for Hungary, Korea and Indonesia. Again Thornton (2008), reports the findings of his work supporting Friedman hypothesis for Argentina. From this brief review of empirical literature we can see that mixed results have been reported for inflation-inflation uncertainty issue. Another point to be mentioned is that most of these studies, as cited above, use data from developed world especially US data.

In context to Pakistan, inflation has always been taken as to be a monetary phenomenon. Qayyum (2006), while testing Monetarist hypothesis, establishes easy monetary policy contributing 90% to the inflation rise in Pakistan. For Bokil and Schimmelpfennig (2005), both private sector credit and broad money growth explain bulk of inflation for Pakistan. Quite interestingly the bulk of literature on inflation is only restricted to find long run determinants of inflation in Pakistan[4]. Existing literature remains silent about the nature of inflation-inflation uncertainty nexus for Pakistan. 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. The work also concludes that "VAR results show that inflation, money supply and the interest rate move into same direction". We differ from Saleem (2008) both in data period and methodology as well as in scope of the study. We use a longer data span and apply GARCH model. Moreover, we don't finish with finding the volatility but this works goes one step ahead and granger causality test is applied to investigate the link and direction between level of inflation and inflation uncertainty. Our study tries to fill this void in literature on inflation in Pakistan and uses monthly CPI data to analyze the hypotheses as discussed in section 2 above.

4. Modeling the Inflation Uncertainty

The ARCH model pioneered by Engle (1982) and its subsequent extensions have generated a vast literature on modeling conditional volatility in empirical literature. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) by Engle 1982 and Bollerslev 1986 is most widely used technique to model the time varying volatility in high frequency data.

The generalized ARCH model, GARCH (p, q) model, is specified as follows:

$$y_t = f(x_t;\, \delta) + e_t \quad {}^{e_t}/_{\psi_{t-1}} \sim \mathrm{D}\left(0, \mathrm{h}_t^2\right) \qquad (1)$$

Where $f(\mathbf{x}_t;\delta)$ and $\mathbf{x}_t$ are conditional mean and matrix of explanatory variables respectively while δ is vector of parameters. Error term e_t is conditional on information available till point of time t-1 i.e. Ψ_{t-1} and has D-distribution. Error term, with zero means, has time changing variance h_t^2. GARCH (p, q) process is explained in equation 2 where α_0, ε_{t-1}^2 and σ_{t-1}^2 are mean level volatility, ARCH and GARCH terms respectively. While σ_t^2, in equation 2, is uncertainty measure conditional on past information. The sum of ARCH and GARCH term indicates persistence. The higher the persistence level, the slower the decay rate is.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \quad ....(2)$$

[4] For example Mubarik (2005), Jones and Khilji (1988), Khan and Siddiqui (1990), Bengali *et. al.* (1997), and Hussain and Mahmood (1997)

The complete general model used for inflation series π_t in our work, is given bellow in equation 3.

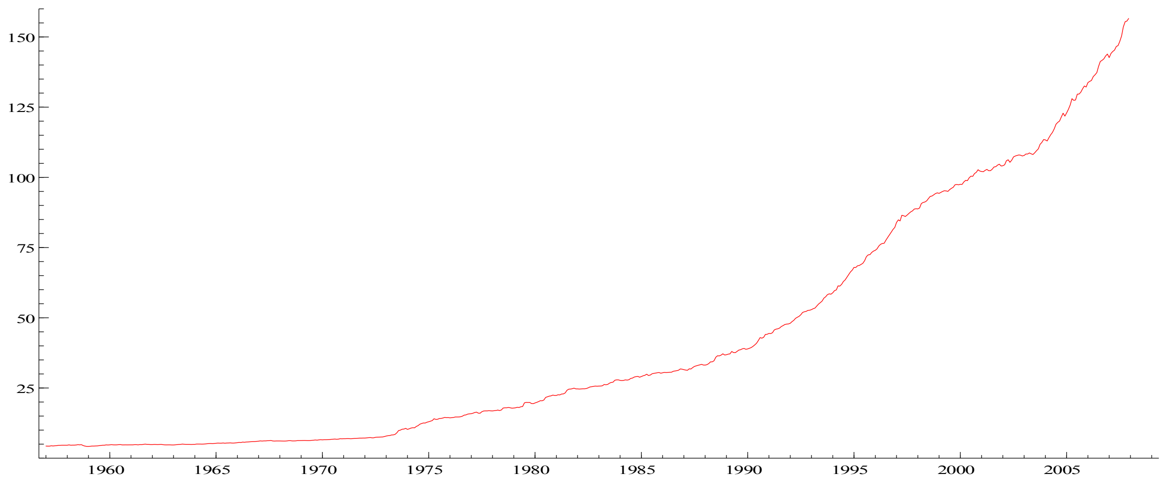
$$\pi_t = \omega + \sum_{i=1}^{r} a_i \pi_{t-i} + \sum_{j=0}^{s} b_i \varepsilon_{t-j} \text{.........} (3)$$

Where $\varepsilon_t = \eta_t \sigma_t$ *and* $\eta_t \sim D(0,1)$

4.1. Data and Methodology

Monthly data of consumer's price index (CPI) was obtained from International Financial Statistics for Pakistan over a period of 1957:1-2007:12. Analysis begins with the series tested for time series properties. Original CPI series is found to have unit root at level as well as at first difference. After log transformation the series remains non-stationary.

Figure 1. CPI Actual Series



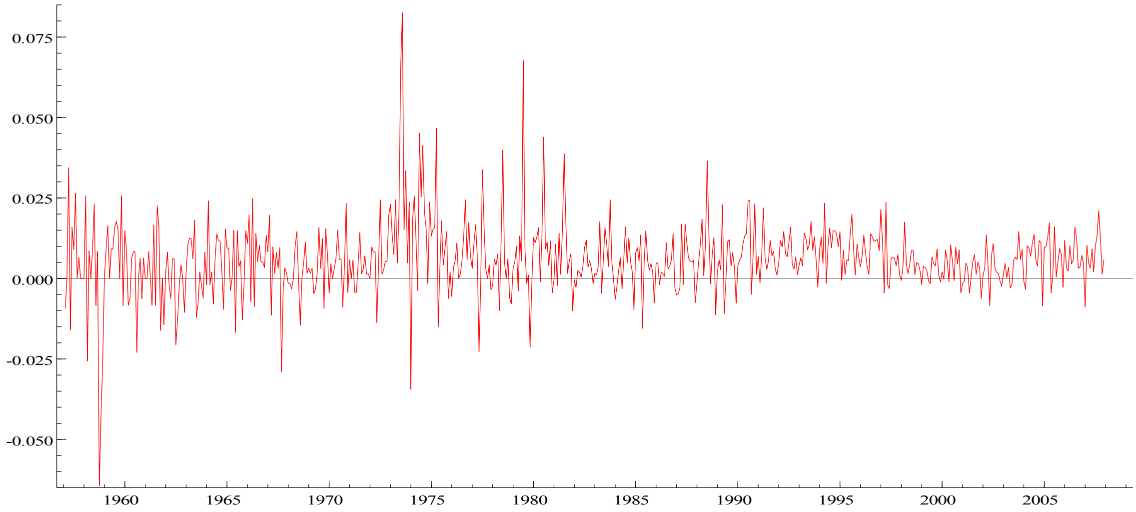
First log difference of CPI series, which now represents the inflation, is stationary and is used for further analysis in present study. To apply ARCH-type models, it is pre-requisite that the data should be stationary process; hence KPSS test is used to check the stationarity of inflation series and it is found that inflation series is stationary process.

Table 1. Descriptive and Preliminary Analysis of Inflation Series (1957:1 - 2007:12)

	Inflation Series	
Mean	0.005876	
S.D	0.011294	
C.V (Coefficient of	1.922	
	Coefficient	**P-Values**
Skewness	0.65351	0.0000
Excess Kurtosis	9.3613	0.0000
JB test Stat:	2274.5	0.0000
Q-stat (5)	33.4337	0.0000
Q-stat (10)	42.9391	0.0000
Q^2–Stat (5)	70.2735	0.0000
Q^2–Stat (10)	91.1665	0.0000
LM-ARCH test stat: (lag	29.844	0.0000
LM-ARCH test stat: (lag	12.726	0.0000
KPSS test stat*:		**0.50264**

KPSS test accepts the null of no unit root in inflation series (1^{st} log difference of CPI) without trend at two lags as is evident from Table 1. Figure 2 also confirms no trend is left in inflation series after it is log differenced.

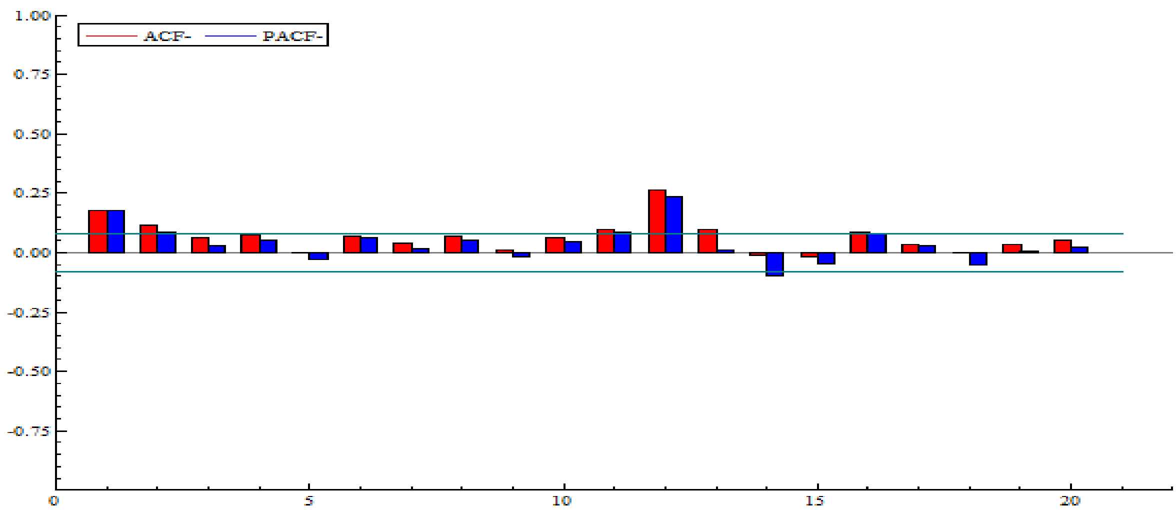
Figure 2. Inflation Actual Series



On inflation data a series of tests is applied such as, LM-ARCH test which captures the presence of ARCH effect, if any, in the series with null hypothesis of no ARCH effect, Q-stat checks for serial correlation with null of no serial correlation and also gives idea about memory of series; significant Q^2-stat confirms the presence of volatility in inflation series. Graphical analysis of the series in figure 2 above depicts the presence of volatility clustering in the series as periods of low volatility mingles with periods of high volatility. This is a clear sign of presence of ARCH effect in the series. Presence of ARCH effect is confirmed from LM test of series where the null of "NO ARCH" is rejected. Again the inflation for Pakistan is found to be highly Kurtic.

GARCH (1, 1) is estimated to get the conditional variance of unpredictable part of inflation series. Autocorrelation function (ACF) and Partial autocorrelation function (PACF) of inflation series (Figure 3) suggest ARMA (1,1) x (12,12) model for conditional mean equation.

Figure 3. ACF and PACF of Inflation Series



ARCH-type models are usually estimated by maximum likelihood. Hsieh (1989) and Baillie (1989), among others, show that heavy tail distributions perform better to capture higher kurtosis. In present study, student-t distribution is used as inflation series is leptokurtic. Results of estimated model are given in Table 2.

Sum of ARCH and GARCH term is 0.98 showing a higher level of persistence and that the shocks will prevail for longer periods of time. Out of 9 terms (including student DF), only one AR -1 term is insignificant but to keep theory in line and to ensure the whiteness of residuals it is not dropped. Significant level varies from 1% to 10%. Conditional mean estimation results show that in

ARMA model intercept is significantly different from zero which reveals that average inflation is non zero and positive on the average. Conditional variance results show that the intercept is positive and statistically significant interpreting that volatility remains constant over time.

Table 2. GARCH and Mean Equations

Mean Equation			Variance Equation		
	Coefficient	**P-value**		**Coefficient**	**P-value**
Constant	0.005	0.0000	Constant	0.032	0.0814
AR-1	-0.021	0.5409	ARCH-1	0.120	0.0699
AR-12	0.812	0.0000	GARCH-1	0.863	0.0000
MA-1	0.115	0.0612	Student's Degree of	3.969	0.0000
MA-12	-0.628	0.0000			
Log Likelihood		***2049***	***Persistence***		***0.983***

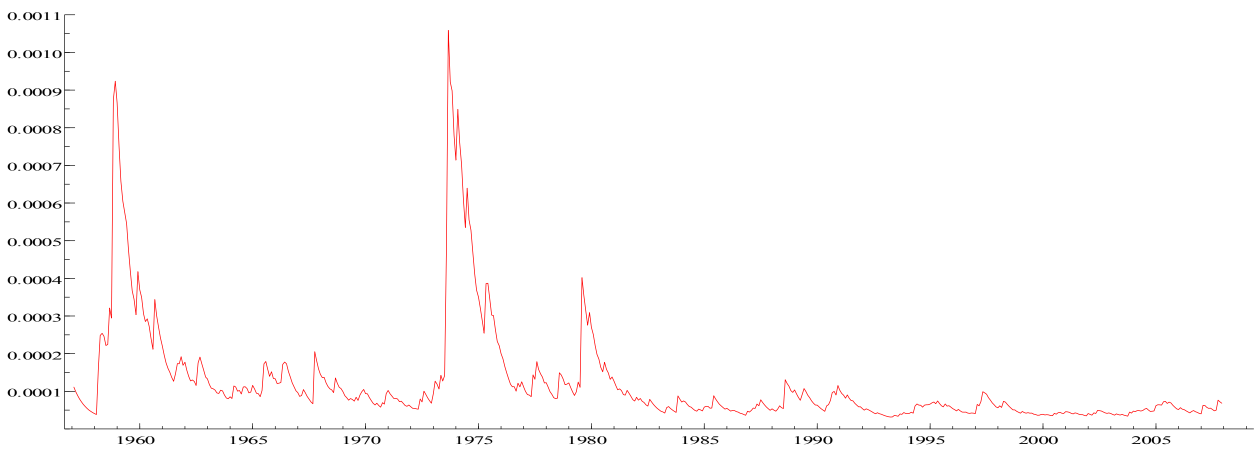
The residuals analysis is also carried out to confirm the validity of results. GARCH (1, 1) is found adequate to capture ARCH effect (Table 3). Q-stat on residuals and squared residuals accepts the null of no serial correlation. Furthermore the LM-ARCH test, upto 10 lags, shows that no ARCH is left in residuals. This also justifies that GARCH (1, 1) captures the ARCH effect adequately.

Table 3. Residual Analyses

Statistics	Standard residual	P-Value
Q-stat (5)	5.8414	0.3220
Q-stat (10)	9.1781	0.5153
Q-stat (20)	21.9521	0.3431
Q^2–Stat (5)	4.75723	0.4462
Q^2–Stat (10)	14.6925	0.1437
Q^2–Stat (20)	18.4055	0.5607
LM-ARCH test stat: (lag 1-2)	1.8055	0.1653
LM-ARCH test stat: (lag 1-5)	0.88253	0.4924
LM-ARCH test stat: (lag 1-10)	1.4232	0.1659
KPSS test stat*:		***0.16562***

Conditional variance of inflation (see Figure 4), is the variable of our interest as it proxy for inflation-uncertainty adequately.

Figure 4. Conditional Variance (Uncertainty of Inflation)



4.2. Granger Causality Test

After getting uncertainty measure, Granger Causality test is applied, with different lag lengths, in order to check the direction of the relation between Inflation and Inflation uncertainty. Granger-causality test reveals that an increase in inflation has a positive impact on inflation uncertainty. See Table 4 below for ready reference.

Table 4. Granger Causality Test

	F-Stat		
	Lag-2	**Lag-4**	**Lag-8**
Inflation uncertainty does not granger cause inflation	0.809 (0.44594)	0.69303 (0.59697)	1.535 (0.14170)
Inflation does not granger cause inflation uncertainty	7.643 (0.00053)	5.002 (0.00057)	4.378 (3.8×10^{-5})

Results of Granger Causality test, reported in Table 4, confirm the Friedman-ball hypothesis for Pakistan that the relation is unidirectional from inflation to inflation uncertainty and carries a positive sign which shows that an increase in inflation is accompanied with higher rates of uncertainty. It is evident from Table 4 that the inflation granger causes inflation uncertainty at all lag lengths considers in this study. We find no evidence for Cukierman and Meltzer (1986) hypothesis. Ganger causality test accepts the null of inflation uncertainty not granger causing inflation at all lags.

5. Conclusion

This is first attempt to study inflation-inflation uncertainty nexus for Pakistan. GARCH modeling is employed on monthly data over a period of 1957:1-2007:12 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. There is no evidence for inflation uncertainty affecting inflation rates as suggested by Cukierman and Meltzer (1986), only unidirectional relation is established with causality running from inflation to inflation uncertainty. The work will help the tinkerers and 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 Pakistan. The results of our study justify lower inflations as a target of monetary policy of Central Bank of Pakistan.

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