The Inflation–Output Nexus: Empirical Evidence from Pakistan, Indonesia and Iran

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Abstract

This paper observes the dynamic associations among inflation, output growth for Pakistan, Indonesia and Iran with their uncertainties. We use various GARCH models to estimate the conditional variances that are used as proxies for creating uncertainties of output growth and inflation. Finally, we use bi-variate ARMA (p,q)-GARCH-M (1,1) models with diagonal BEKK specification to find the twelve causal relationships between inflation, its uncertainty vs output growth with its uncertainty. Our evidence supports numeral of important conclusions. Firstly, we find that Friedman (1977) hypothesis, i.e., inflation clues to increase the uncertainty of inflation, which is not supported in both Pakistan and Iran but not for Indonesia. Secondly, Cukierman-Meltzer (1986) hypothesis is accepted in Pakistan and Holland (1995) hypothesis is accepted in Indonesia and Iran. Thirdly, Black (1987) hypothesis is accepted in Pakistan and Iran whereas, Deveraux (1989) hypothesis is accepted in Indonesia. We also discover that higher output growth causes to reduce the inflation in both Pakistan plus Indonesia. Higher inflation reduces output growth in both Pakistan and Indonesia but not in Iran. We also conclude that the policy makers of these countries may take measures to reduce inflation rate because output growth is inversely linked with inflation and the prevailing uncertainty in the economy.

Keywords: Inflation; Output Growth; Uncertainty; GARCH Models

Introduction

Inflation is always a monetary phenomenon. Monetary policy practitioners worldwide assumed that output growth of economy is theoretically determined by inflation. However, this relationship is scant. Now-a-days, there is a large number of mutually theoretical with empirical research of considered relationship for inflation, its uncertainty, output growth plus its uncertainty. This study investigates the relationship of inflation and output growth plus their uncertainties considering Muslim countries because very little work of research explores this area. Inflation has a significant impact on economic development that is why it plays a crucial role in any economy as an economic indicator. Numerous literatures point the indefinite impact of inflation on the growth of economy (Fountas & Kasranasos 2006; Ozdemir 2010; Narayan & Narayan 2013). Inflation has influenced the economic development and growth directly by influencing its rate of growth and indirectly its output. This impact has led a great deal of ambiguity among researchers and has not yet been well defined, because of which it has been one of the most researched topic both in theory and on empirical fronts. Dynamic association of inflation vs. output growth, plus their uncertainties are leading issues in mutually theoretical vs. empirical characteristics to be discovered mainly for Muslim countries. Milton Friedman (1977) has pointed out that inflation is directly proportional to uncertainty that leads to overall economic and its growth problems and shows ineffective price mechanism.

Apergis (2004), Balciliar and Ozdemir (2013) have strongly supported the findings of the Friedman Hypothesis. Fountas (2010) and Ozdemir (2010) have found mixed evidence and Cakan (2012) has failed to find any supportive evidence for Friedman Hypothesis. Some empirical studies have highlighted the contributory outcome of inflation vs. its uncertainty. Cukierman and Meltzer (1986) have found a positive association between inflation vs. its uncertainty. The findings of Apergis (2004), Berument, Yalcin and Yildrim (2009), Jiranyakul and Opiela (2010) and Mughal, Aslam, Jabbar and Ullah (2012) have strongly supported the Cukierman-Meltzer Hypothesis. Whereas Fountas and Karanasos (2007), Ozdemir (2010) and Fountas (2010) have found diverse evidences to favor the Cukierman-Meltzer Hypothesis but Cakan (2012) and Javed, Khan, Haider and Shaheen (2012) do not favour it. Ball (1992) examines the misinformation among public vs. policy makers in concern of upcoming inflation policy; he concludes that “high inflation leads to cause its uncertainty high” and is identified as Friedman-Ball Hypothesis. This hypothesis has been strongly supported by the previous studies while inquiring partial relationship of inflation and inflation uncertainty (Fountas, 2001; Berument & Dincer 2005; Daal, Naka & Sanchez 2005; Jiranyakul & Opiela 2010; Javed *et al.,* 2012). Holland (1995) has established negative causative relationship of inflation uncertainty on inflation, known as Holland’s Hypothesis. This hypothesis is supported by Payne (2008) and Balcilar and Ozdemir (2013). Moreover, “output growth is increased due to its uncertainty” proved by Mirman (1971) and Black (1987).

Deveraux (1989) shows that uncertainty of output growth leads to increased inflation. Black (1987) also finds that inflation is reduced by the uncertainty of higher output growth. These theoretical studies examine the interactions of inflation vs. output growth plus their uncertainties but still remain undiscovered amongst Muslim countries. The objective of this study is to overcome the scant literature on Muslim countries to analyze the connections of inflation vs. output growth with their uncertainties. Here we inspect 12 causations among these four considered variables (inflation, inflation vs. output growth plus uncertainties) applying bi-variate GARCH-M (1, 1) Models. We test the succeeding hypotheses (1) Friedman (1977); (2) Cukierman-Meltzer (1986); (3) Holland (1995); (4) Black (1987); (5) Mirman (1971) and Black (1987); (6) Deveraux (1989) hypotheses for 3 Muslim countries.

This paper is outlined as: Sect-2 presents macroeconomic framework. Sect-3 presents model specification and methodology. Sect-4 reports data, preliminary examination, estimated GARCH models and Empirical results. Sect-5 provides conclusion and policy recommendations.

MACROECONOMIC FRAMEWORK

Impact of Inflation on Inflation Uncertainty

Friedman (1977) hypothesis: 1st part states that inflation clues to its uncertainty and its 2nd part states that it leads to diminish the growth of economy. Demetriades (1988) finds a positive connection between inflation vs. its uncertainty but unable to find any direct causation between both inflation vs. its uncertainty. Ball (1992) ideas the misinformation among public vs policy makers for future inflationary policy. His main idea as Friedman-Ball Hypothesis pointing out more of inflation is due to its uncertainty. Fountas (2010) and Chowdhury (2014) support the hypothesis.

Impact of Inflation Uncertainty on Output Growth

Friedman (1977) states “inflation is the main cause of reducing economy’s growth”. In theory, the signs and descriptions of both output growth and inflation uncertainty are well presented. Theories supporting the negative signs (Fountas, Ioannidis & Karanasos 2004) and positive sign (Abel 1983; Blackburn & Pelloni, 2004) are between uncertainty of inflation and output growth. Huizinga (1993) determines that uncertainty of inflation decreased the output growth. Fountas (2001) and Caglayan, Kandemir and Mouratidis (2012) also support the hypothesis.

Impact of Inflation Uncertainty on Inflation

“Uncertainty of inflation leads to higher the inflation” as Cukierman-Meltzer (1986) hypothesis. Grier and Perry (2000) determine that outcomes are corresponding with the hypothesis. Fountas (2010) and Chowdhury’s (2014) outcomes are parallel with it. Omay's (2011) outcomes are mixed and Naryan and Naryan (2013) miscarry hypothesis.

Holland (1995) discovers the negative link between inflation vs. its uncertainty. This hypothesis is supported for Sweden but no supportive evidence for Netherlands and Germany (Karanasos & Schurer 2008). Narayan, Narayan and Smyth (2009) also support it as well as Balcilar and Ozdemir (2013).

Impact of Output Growth Uncertainty on Output Growth

Mirman (1971) and Black (1987) achieve the positive link between growth vs. its uncertainty; Friedman (1968) determines nothing and Pindyck (1991) establishes negative association between both variables. "Higher uncertainty of output increases output growth" states Mirman (1971) and further this work is clarified by Black (1987). Dejuan and Gurr (2004), and Naryan and Naryan (2013) conclude the positive, whereas, Kneller and Young (2001) achieve negative relation. Zero effect between both variables is in the findings of Dawson and Stephenson (1997).

Impact of Output Growth Uncertainty on Inflation

Deveraux (1989) concludes "impact of inflation by uncertainty of output growth" by considering Barro and Gordon (1983) index of wage in the model as exogenous variable. Firstly, progressive outcome of inflation proceeding uncertainties of output growth. Secondly, also uncertainty of output growth causes uncertainty of inflation. Cukierman and Gerlach (2003) favour Deveraux (1989).

Inflation rate is lowered down by uncertainty of output growth theoretically known as Taylor (1979) effect, if rate of inflation is controlled as proposed by Cukierman-Meltzer (1986) hypothesis. Negative association between uncertainty of output growth and inflation is proposed by Black (1987). Grier and Perry (2000) fail to upkeep the Deveraux (1989) hypothesis but backup Black (1987). Fountas, Karanasos and Kim (2002) fail to upkeep and Naryan and Naryan (2013) maintain the Black (1987) hypothesis.

Impact of Output Growth on Inflation

Most of the researchers discussed the inflation direct impact on output growth. Briault (1995) and Klump (2003) conclude the positive association and Barro (1995) found negative association inflation and output growth. Negative effect on output growth is due to inflation as by Khan and Senhadji (2001). Caporin and Di Maria (2002) inspect the negative link between inflation and output growth.

Impact of Output Growth on Inflation Uncertainty

Pourgerami's and Maskus (1987) found an inverse association between uncertainty of inflation and output growth. Brunner (1993) found that uncertainty of policy responses leads to increase the uncertainty of inflation and decreases output growth. Uncertainty of inflation is decreased by output growth as by Ungar and Zilberfarb (1993). Fountas *et al.* (2002) claims no causation among variables for Japan. But Fountas and Karanasos (2007) support partially by considering G-7 countries for uncertainty of inflation vs. output growth.

Impact of Output Growth on Output Growth Uncertainty

Theoretically, signs of the relation between output growth vs. its uncertainty is very ambiguous and researchers examined it. By considering negative effect, increase of output growth also causes inflation to increase ('Phillips curve' in short-run) plus cause to increase the uncertainty of inflation (Friedman ;1977). Fountas *et al.* (2002) found positive relationship. Fountas and Karanasos (2006) find the negative association.

Impact of Inflation on Output Growth

Uncertain situation for investment projects are always disturbed by high inflation causing higher prices. Which clues to cut the overall output growth investigated in most studies. Negative sign is found in Naqvi and Khan's (1989) study. Sarel (1995) settles positive association of output growth with inflation. But Bruno and Easterly (1995) found no relation among both variables.

Impact of Inflation on Output Growth Uncertainty

Inverse connection between inflation and uncertainty of output growth is unclear and its sign is also vague. With the coalition of Friedman (1977) hypothesis through Taylor (1979) series, Inflation may have negative influence on uncertainty of output growth. Conrad and Karanasos (2008) accomplish that inflation indirectly disturbs uncertainty of output growth and directly disturb output growth; finds positive effect on output growth uncertainty due to inflation considering India (Balaji, 2014).

Model Specification and Methodology

In our study, we apply bivariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models to examine linkage of output growth vs. inflation plus respective uncertainties. Changing aspects of inflation vs. output growth plus respective uncertainties are examined by specified models. We use univariate GARCH models like GARCH (1,1), EGARCH (1,1) and GJR-GARCH (1,1) to find conditional variances for inflation plus output growth further to be used as uncertainties of both variables for further analysis. We also use bivariate GARCH-M (1,1) model with diagonal BEKK specification to estimate the association between inflation & output growth by applying conditional variances and conditional means of inflation & output growth in conditional mean equation as explanatory variables.

Bi-variate ARMA (p,q)-GARCH-M (1,1) Models of Inflation and Output Growth Series

Here we use the bi-variate ARMA (p,q) GARCH-M (1,1) with diagonal BEKK specification (Engle & Korner 1995) to find the relations between inflation and output growth with respective uncertainties simultaneously. In model, dependent variables are inflation and output growth; the explanatory variables could predict the inflation & output growth in mean equations and their uncertainties in variance equations.

An ARMA (p,q)- GARCH-M (1,1) is specified as follows:

$$X_t = a + \sum_{j=1}^{Q} \alpha_j X_{t-j} + \sum_{i=1}^{p} \beta_i \mu_{t-i} + \theta_1 Z_{Xt}^2 + \theta_2 Z_{Wt}^2 + \sum_{k=1}^{n} \tau_k W_{t-k} + \mu_t \quad (3.1)$$

$$Z_{Xt}^2 = \gamma_0 + \alpha_1 \mu_{t-1}^2 + \beta_1 Z_{X(t-1)}^2 + \sum_{i=1}^{p} \alpha_i X_{t-i} + \sum_{k=1}^{n} \tau_k W_{t-k} \quad (3.2)$$

$$W_t = c + \sum_{j=1}^{q} k_j W_{t-j} + \sum_{i=1}^{p} \emptyset_i \mu_{t-i} + \partial_1 Z_{Wt}^2 + \partial_2 Z_{Xt}^2 + \sum_{k=1}^{n} \rho_k X_{t-k} u_t + \varepsilon_t \quad (3.3)$$

$$\sigma_{Wt}^2 = \gamma_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{W(t-1)}^2 + \sum_{i=1}^{p} k_i W_{t-i} + \sum_{k=1}^{n} \rho_k X_{t-k} \quad (3.4)$$

$$COV = \rho_{\varepsilon\mu} Z_{\varepsilon t} Z_{\mu t} \quad (3.5)$$

Equation (3.1) defines a function of autoregressive & moving average modules with lags of p and q of mean inflation (X_t), conditional variances of both (inflation (Z_{Xt}^2)& output growth(Z_{Wt}^2)) and real output growth (W_t). Equation (3.2) defines conditional variance of inflation. Equation (3.3) defines a function of autoregressive & moving average modules with lags of p and q of output growth (W_t), conditional variances of both (inflation (Z_{Xt}^2)& output growth(Z_{Wt}^2)) plus inflation (X_t). Equation (3.4) defines conditional variances of output growth. Equation (3.5) denotes the constant covariance among residuals of conditional correlation model of Eq. (3.1 & 3.3). The positivity of GARCH, $\omega_0 > 0$, $\alpha_1 > 0$ and $\beta_1 > 0$ (Eq. (3.2 & 3.4)), Bi-variate GARCH (1, 1) for stationarity condition is used with diagonal BEKK specification ($(\alpha_1)^2 + (\beta_1)^2 < 1$).

Bi-variate (diag-BEKK GARCH (1, 1)) general form is as follows:

$$I_t = A'A + B'\mu_{t-1}\mu_{t-1}'B + C'I_{t-1}C \quad (3.6)$$

with

$$A = \begin{bmatrix} a_{XX} & a_{XZ} \\ a_{XZ} & a_{ZZ} \end{bmatrix}, B = \begin{bmatrix} b_{XX} & b_{XZ} \\ b_{XZ} & b_{ZZ} \end{bmatrix}, \text{ and } C = \begin{bmatrix} c_{XX} & c_{XZ} \\ c_{XZ} & c_{ZZ} \end{bmatrix}$$

The bi-variatediag-BEKK GARCH (1, 1) model represents in the equ. (3.6) all diagonal elements is unique of matrix A is positive and $b_{\pi\pi}, c_{\pi\pi}$>0. For the stationary condition, Engle and Korner (1995) show that the diagonal BEKK model is covariance stationary if and only if $(b_{\pi\pi})^2 + (c_{\pi\pi})^2 < 1$.

To estimate GARCH Models, ARMA (p,q) model is examined with various specifications and both conditional variance and conditional mean is simultaneously estimated. Maximum-likelihood estimation is used for GARCH model's estimation. AIC and SIC log-likelihood values, LM ARCH test, Box-Pierce Q and Q^2 Statistics are used (normal and t-distribution) for estimating GARCH models. For estimating ML of the parameters, we use Broyden–Fletcher–Goldfarb-Shanno (Fletcher, 1987). Bi-variate GARCH models with Diag- BEKK model (Engle & Korner 1995) is used for inflation and output growth condition.

Data and Preliminary Analysis

Association of inflation vs. output growth with their uncertainties are established for Pakistan, Indonesia and Iran. For analysis, consumer price index & industrial production/ manufacturing production used proxies of inflation vs. output growth. Monthly Data used in this study ranges for Pakistan (1979-M1 to 2012-M12), Indonesia (1984-M4 to 2012-M12) and Iran (1989-M4 to 2012-M12) from IFS (Intl. Financial Statistics) data base. Both Inflation vs. output growth are measured as: monthly difference (as log of CPI ($\pi_t = \log(CPI_t/CPI_{t-1}) * 100$) and log of ($W_t = \log(IP_t/\,IP_{t-1}) * 100$) as Industrial production / manufacturing production). For the uncertainties of both variables, proxies of monthly squared returns series are used as not observed directly.

Empirical Results

The summary statistics and real economic growth rate for three countries are presented in table 4.1.

able 4.1: Summary Statistics

	Pakistan		Indonesia		Iran	
	Inf.	**Output**	**Inf.**	**Output**	**Inf.**	**Output**
Mean	0.0067028	0.0046579	0.0076408	-0.0012482	0.01464	-0.000235
S-D	0.0076042	0.099134	0.012327	0.06528	0.013912	0.091608
Skew.	0.48819	0.063900	4.3769	-0.17616	0.88676	0.033432
E-K	0.85265	0.80503	27.818	2.7414	2.5428	62.001
J-B	25.765	10.188	13041.	117.14	113.73	45489

Where mean, S-D, skew., E-K and J-B test are presented. Kwiatkowski-Phillips-Schmidt-Shin (KPSS 1992) test with constant and trend terms is used for stationarity of data. Results are given below in Table 4.2.

Table 4.2: Unit Root Tests

Variables		KPSS Test Statistic					
		Level			**First Difference**		
		With Const.	**With Const. &Trend**	**Results**	**With Const.**	**With Const. &Trend**	**Results**
PAK	**Inflation**	13.4781***	0.766226***	Non-Stationary	0.275902***	0.190788***	Stationary
	Output	12.5617***	0.517952***	Non-Stationary	0.00713298***	0.00606625***	Stationary
INDO	**Inflation**	12.4019***	1.15322***	Non-Stationary	0.233548***	0.19192*	Stationary
	Output	9.0055***	2.60441***	Non-Stationary	0.105368***	0.0178686***	Stationary
IRAN	**Inflation**	9.33511***	1.89757***	Non-Stationary	0.26483***	0.117137**	Stationary
	Output	1.009503**	0.939612***	Non-Stationary	0.0898113***	0.0127624***	Stationary
C.V (KPSS)							
		1%	5%	10%			
No Trend		0.739	0.463	0.347			
With Trend		0.216	0.146	0.119			

To check conditional heteroskedasticity, we use LM test. Ljung-Box test is used on both inflation & output growth return series for Pakistan, Indonesia and Iran. Q and Q^2 (Ljung-Box-Pierce) statistics signifying the presence of significant serial correlation in both residual and square residuals at lag 4, 8 and 12. LM test indicates the presence of ARCH effect for both variables (inflation & output growth) squared residual series for Pakistan, Indonesia and Iran.

Estimation GARCH-in-Mean Model of Inflation and Output Growth Pakistan

Results of bi-variate GARCH-M (1, 1) with diagonal BEKK specification model (inflation & output growth) are given below:

An ARMA (0, 3) – diag-BEKK GARCH-M (1, 1) as follows:

$$X_t = \underset{(0.0397)**}{0.0000678} + \underset{(0.0000)***}{0.961978}X_{t-1} - \underset{(0.0000)***}{0.824557}\mu_{t-1} - \underset{(0.0286)**}{0.185198}\mu_{t-2} + \underset{(0.0284)**}{0.117053}\mu_{t-3} - \underset{(0.0965)*}{3.928042}Z_{Xt}^2 - \underset{(0.1331)}{0.047700}Z_{Wt}^2 - \underset{(0.0002)***}{0.008934}W_{t-1} + \mu_t \quad (4.1)$$

$$Z_{\pi t}^2 = \underset{(0.1783)}{0.001019} + \underset{(0.9998)}{0.000039}\mu_{t-1}^2 + \underset{(0.0000)***}{0.883098}Z_{X(t-1)}^2 + \underset{(0.0000)***}{0.038447}X_{t-2} - \underset{(0.8207)}{0.0000002}W_{t-2} \quad (4.2)$$

$$W_t = \underset{(0.4226)}{-0.019820} - \underset{(0.0000)***}{0.579618}W_{t-1} + \underset{(0.0000)***}{0.611562}\mu_{t-1}\underset{(0.0085)***}{0.176073}\mu_{t-2} + \underset{(0.0019)***}{0.205595}\mu_{t-3} + \underset{(0.1355)}{7.845047}Z_{Wt}^2 + \underset{(0.4480)}{77.567640}Z_{Xt}^2 - \underset{(0.0007)***}{1.632303}X_{t-1} + \varepsilon_t \quad (4.3)$$

$$Z_{Wt}^2 = \underset{(0.5366)}{0.000011} + \underset{(0.0000)***}{0.302292}\varepsilon_{t-1}^2 + \underset{(0.0000)***}{0.952580}Z_{W(t-1)}^2 + \underset{(0.7590)}{0.0000004}W_{t-2} - \underset{(0.1225)}{0.048741}X_{t-2} \quad (4.4)$$

$$COV = \underset{(0.0984)*}{-0.009032}Z_{\varepsilon t}Z_{\mu t} \quad (4.5)$$

Friedman (1977) and Cukierman-Meltzer (1986) hypotheses are accepted. For Pakistan, not accepted hypothesis is Holland (1995). Higher output growth reduces inflation vs. opposite case is supported by Ayyoub *et al.* (2011). For both (inflation &output growth) series β (GARCH term) is significant but α (ARCH term) is insignificant for inflation series at 1%, 5% and 10%. Stationarity condition i.e., $\alpha^2 + \beta^2 < 1$ i.e., 0.779862 (inflation series) & 0.998789 (output growth) is satisfied. Diagnostic tests also fulfilled the requirements.

Indonesia

Results of bi-variate diag-BEKK GARCH-M (1,1) model (inflation & output growth) are given below:

An ARMA (0,2)- diag-BEKK GARCH-M (1,1) as follows:

$$X_t = \underset{(0.2722)}{0.001241} + \underset{(0.0065)***}{0.712833}X_{t-1} - \underset{(0.4974)}{0.145593}\mu_{t-1} - \underset{(0.0002)***}{0.51355}\mu_{t-2} + \underset{(0.4432)}{2.873065}Z_{Xt}^2 - \underset{(0.6047)}{0.066759}Z_{Wt}^2 - \underset{(0.0010)***}{0.024969}W_{t-1} + \mu_t \quad (4.6)$$

$$Z_{Xt}^2 = \underset{(0.0069)***}{0.002625} + \underset{(0.0000)***}{0.540527}\mu_{t-1}^2 + \underset{(0.0000)***}{0.841320}Z_{X(t-1)}^2 + \underset{(0.2789)}{0.011595}X_{t-2} - \underset{(1.0000)}{0.0000000}W_{t-2} \quad (4.7)$$

$$W_t = \underset{(0.5196)}{-0.001981} - \underset{(0.0705)*}{0.407040} W_{t-1} - \underset{(0.3632)}{0.337347} \mu_{t-1} - \underset{(0.0910)*}{0.179562} \mu_{t-2} + \underset{(0.0663)*}{1.621177} Z_{Wt}^2 + \underset{(0.5404)}{8.769121} Z_{Xt}^2 - \underset{(0.0263)**}{0.980711} X_{t-1} + \varepsilon_t \qquad (4.8)$$

$$Z_{Wt}^2 = \underset{(1.0000)}{0.000000} + \underset{(0.0000)***}{0.480373} \varepsilon_{t-1}^2 + \underset{(0.0000)***}{0.486373} Z_{W(t-1)}^2 + \underset{(1.0000)}{0.0000000} W_{t-2} - \underset{(0.0000)***}{0.424870} X_{t-2} \qquad (4.9)$$

$$COV = \underset{(0.2387)}{0.021761} Z_{\varepsilon t} Z_{\mu t} \qquad (4.10)$$

Friedman (1977) Hypothesis is not supported in the case of Indonesia contrary to Daal *et al.* (2005) findings. Cukierman-Meltzer (1986) hypothesis is absent and Holland (1995) hypothesis is proved to exist in Indonesia. Inflation reduced by output growth, uncertainty of output growth is increased by output growth and output growth reduced by inflation as proposed by Deveraux (1989) hypothesis is accepted here. Both β (past variances) and α (past shocks) are significant at 1%, 5% and 10%. Stationarity condition as values of $\alpha^2 + \beta^2 < 1$ i.e., 0.999988 (inflation) & 0.467317 (output growth) is satisfied. Diagnostic tests also fulfilled the requirements.

Iran

Results from bi-variatediag-BEKK GARCH-M (1, 1) model (inflation & output growth) are given below:

An ARMA (0,2)- diag-BEKK GARCH-M (1,1) as follows:

$$X_t = \underset{(0.0003)***}{0.002412} + \underset{(0.0000)***}{1.359622} X_{t-1} - \underset{(0.0342)**}{0.615053} X_{t-2} - \underset{(0.0025)***}{1.06375} \mu_{t-1} + \underset{(0.2670)}{0.388574} \mu_{t-2} + \underset{(0.0200)**}{3.496578} Z_{Xt}^2 + \underset{(0.0583)**}{0.196970} Z_{Wt}^2 - \underset{(0.3343)}{0.004801} W_{t-1} - \underset{(0.2628)}{0.009936} W_{t-2} + \mu_t \qquad (4.11)$$

$$Z_{Xt}^2 = \underset{(0.2825)}{0.003087} + \underset{(0.0007)***}{0.505437} \mu_{t-1}^2 + \underset{(0.0064)***}{0.517680} Z_{X(t-1)}^2 - \underset{(0.0000)***}{0.057625} X_{t-3} - \underset{(0.7193)}{0.006819} W_{t-3} \qquad (4.12)$$

$$W_t = \underset{(0.5039)}{0.001107} + \underset{(0.0717)*}{0.231589} W_{t-1} + \underset{(0.4133)}{0.081972} W_{t-2} - \underset{(0.0000)***}{0.882160} \mu_{t-1} + \underset{(0.3296)}{0.119182} \mu_{t-2} - \underset{(0.0317)**}{0.740517} Z_{Wt}^2 + \underset{(0.9601)}{0.261806} Z_{Xt}^2 - \underset{(0.1467)}{0.338659} X_{t-1} + \underset{(0.1607)}{0.369263} X_{t-2} + \varepsilon_t \qquad (4.13)$$

$$Z_{Wt}^2 = \underset{(0.0066)^{***}}{0.062508} + \underset{(0.0000)^{***}}{0.219616}\varepsilon_{t-1}^2 + \underset{(0.0130)^{**}}{0.416913}Z_{W(t-1)}^2 + \underset{(0.6341)}{0.004373}W_{t-3} + \underset{(0.9589)}{0.000899}X_{t-3} \quad (4.14)$$

$$COV = \underset{(0.9453)}{-0.000293}Z_{\varepsilon t}Z_{\mu t} \quad (4.15)$$

Friedman (1977) is accepted but Cukierman-Meltzer (1986) hypothesis is not accepted for Iran. Holland (1995) hypothesis is accepted. Uncertainty of output growth is decreased due to inflation, also uncertainty of output growth upsurges the output growth and also increases the inflation as proposed by Balck (1987) is accepted for Indonesia at 10% significant level.

Both β and α are significant (at 1%, 5% and 10%). Stationarity condition as values of $\alpha^2 + \beta^2 < 1$ i.e., 0.523459 (inflation) series & 0.222048 (output growth) is satisfied. Diagnostic tests also fulfilled the requirements.

Conclusion and Policy Recommendations

Our paper empirically investigates causal association between inflation vs. output growth along with their uncertainties for Pakistan, Indonesia and Iran. We use bi-variate GARCH-in-Mean (1, 1) with diagonal BEKK specification, to estimate the 12 Causal relationships between these variables. Friedman (1977) Hypothesis is accepted for both (Pakistan & India) but in case of Indonesia it fails. Cukierman-Meltzer (1986) hypothesis is accepted for Pakistan whereas, for Indonesia Holland (1995) hypothesis is the accepted one. Black (1987) Hypothesis is accepted in Pakistan and Iran whereas Deveraux (1989) Hypothesis is accepted in Indonesia.

Inflation is reduced by higher output growth as proposed in previous studies (Briault 1995; Klump 2003) is also accepted here for Pakistan and Indonesia but not in Iran. In conclusion, we can say that normal uncertainty of inflation plus inflation existed in the economy leads to affect its output growth. So government of Muslim countries must try to lower down inflation rate. Price stability as a main objective of these economies must be controlled effectively by their respective central banks. To reduce inflation, policy makers must emphasize that inflation rate has to be controlled. This paper also leads to analyze the inflation-output nexus not only centered on geographical regions but also based on religion and cultural activities.

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