Forman Journal of Economic Studies
Vol. 11, 2015 (January–December) pp. 53-66

Relationship between Real and Nominal Uncertainty in Pakistan: Analysis based on Bivariate GARCH (BEKK) Approach

Muhammad Jamil and Sumbal Majeed[1]

Abstract

The paper explores the link between inflation and output growth variability in Pakistan. The study uses quarterly data for the period 1980:1 to 2010:2. The paper employs Bivariate GARCH (BEKK) model to simultaneously estimate conditional variances of output growth and inflation and covariance between them. The conditional variances of output growth and inflation are used as indicators of real and nominal uncertainty in the present study. It is also found that higher inflation is responsible for creating uncertainty about inflation in Pakistan, and this higher inflation uncertainty impacts economic growth negatively in Pakistan. Granger causality results show unidirectional causality from inflation to inflation volatility, output growth to output growth volatility, and inflation volatility to output growth. This indicates that both higher growth and higher inflation uncertainty are responsible for increasing growth uncertainty in Pakistan.

Keywords: Output Growth, Inflation, Uncertainty, BEKK Model, VAR Model,

JEL classification: C58, C22, E31, E32

1. Introduction

Two main goals of monetary policy makers in any economy are output growth and price stability. Output growth and inflation are the two main variables which indicate the overall macroeconomic performance of an economy. Output growth represents the real side of the economy and inflation represents the nominal side of the economy. Decisions about future savings and investments change due to fluctuations in the indicators of macroeconomic performance. Central bank as well as the government have less control over the transitory deviations of output growth and inflation from there trend. This ultimately makes monetary and fiscal policies less credible. As a result, cost of hedging against

[1] The authors are Assistant Professor at School of Economics, Quaid-i-Azam University, Islamabad, and M. Phil Student at Department of Economics, Allama Iqbal University Open, Islamabad-Pakistan, respectively. Email of corresponding author: mjamil@qau.edu.pk

inflation risks increases, risk premium for long term contracts increases, unanticipated transfer of wealth occurs and all these things are the main reasons of inefficient allocation of resources.

Nature of association between output growth and inflation is one of the most debated issues, theoretically and empirically. Particularly, Logue and Sweeney (1981) and Taylor (1979) estimate the link between real and nominal uncertainty and reported a bit contradictory results. Logue and Sweeney (1981) in their study point out that high nominal uncertainty increases real uncertainty whereas, Taylor (1979) argues that the tradeoff between real and nominal uncertainty exists. Regarding the link between inflation and its uncertainty, Friedman (1977) and Cukierman and Meltzer (1986) provide diversified results. Friedman (1977) was of the view that high inflation is the main source of uncertainty in inflation, while, Cukierman and Meltzer (1986) highlighted uncertainty in inflation as the main source of high inflation. Relationship between output growth and its volatility has also been explored in number of studies. For example, Black (1987) show that higher volatility in output growth has positive impact on average output growth but, Pindyck, (1991) on the contrary, reported a negative impact of volatility in growth on the level of economic growth.

The findings of the above mentioned studies raise a number of interesting research questions. First, is the higher inflation causes higher inflation uncertainty? Second, how inflation and its uncertainty affects economic growth? And finally, what kind of link between output growth and its variability exists?

The objective of the current study is to investigate the empirical relationship among four macroeconomic variables: output growth, inflation, output growth uncertainty and inflation uncertainty in Pakistan. The study attempts to test all the theories mentioned above for Pakistan using quarterly data for the period 1980:1 to 2010:2. The paper builds on the earlier econometric work of Karanasos and Kim, (2005) and Bredin and Fountas, (2011) and analyses empirically the issue of link between macroeconomic uncertainties for Pakistan using bivariate GARCH model. Causality tests have also been used to find out the direction of relationship between these two volatilities and their levels.

The plan of the paper is described as: following the section of introduction, section 2 reveals the literature review, the construction and utilization of variables is presented in section 3, methodological issues are discussed in section 4, results and their discussion are presented in section 5. The last section contains conclusion.

2. Review of Literature

Empirical and theoretical literature on the relationship between uncertainties in nominal and real variables show mixed trends and no unambiguous conclusion can be drawn from previous findings and results

For macroeconomists, the impact of macroeconomic uncertainty on the macroeconomic performance is a matter of considerable interest. Economic theories are diversified regarding the nature of link between these two variables. Friedman, (1977) and Ball, (1992) pointed out that increased inflation increases uncertainty in inflation and lower output growth and welfare. The authors report a causality running from high inflation to inflation volatility. However, Cukierman and Meltzer, (1986) argue that increased uncertainty in inflation affects the average inflation as inflation uncertainty increases the incentives for the policymakers to create inflation surprises by setting unexpectedly high inflation rate. So, the authors conclude that inflation uncertainty causes high inflation.

The impact of uncertainty in output growth on average growth is also not unambiguous. According to Black, (1987) real factors such as technological changes determine output growth, and investment on riskier technologies is made only if return (average output growth) is high. On the other side, Pindyck, (1991) was of the view that volatility in output has a negative impact on output growth because of irreversibility of investment. Similarly, Aghion and Paul, (1998) explain the positive link between growth and its volatility using opportunity cost approach.

Friedman, (1977) argued that higher inflation generate higher uncertainty about future inflation which ultimately reduces the effectiveness of price mechanism and economic inefficiency. Devereux (1989) examines the impact of uncertainty in output uncertainty on inflation. The study explains that wages are endogenously indexed to the changes in the price level. The decrease in values of endogenous wage indexation exogenously increases uncertainty in output. So the model predicts higher average inflation rate because of higher real uncertainty.

Regarding the link between real and nominal uncertainty, Logue and Sweeney, (1981) show that high rate of inflation make producers perplex about nominal and real shifts in demand which causes more variability in relative prices. This ultimately results in more variable real investment and output. Taylor, (1979) estimates tradeoff between output and for the US economy and points out that temporary tradeoff between output growth and inflation decipher a permanent tradeoff between variability of inflation and variability of output (called Taylor effect).

The empirical evidence regarding the link between output growth, inflation and there uncertainties are mixed. Particularly, Bredin and Fountas, (2011) show that inflation uncertainty and output growth uncertainty are positively associated with each other, while, Fountas and Karanasos, (2006) find evidence of negative bidirectional relationship between output growth variability and inflation variability in Japan and Germany. Karanasos and Kim, (2005) conclude that volatility in inflation has a significant impact on the volatility in output growth using the data of USA for the period 1988-2000. Moreover, the authors find opposite causality from output growth volatility to inflation volatility during eighties and nineties in Japan. Grier *et al.* (2001) show that volatilities in output growth and inflation affect each other significantly in an asymmetric manner.

Empirical studies revealed ambiguous results for linkage between output growth and its volatility. For example, Lee (2010) finds that higher output growth leads to higher uncertainty of innovations but the higher growth is not associated with high economic uncertainty. Antonakakis and Badinger, (2012), Macri and Sinha, (2007), and Chatterjee and Shukayev (2006) find a negative impact of output growth volatility on average output growth. While, Grier and Perry (2000) and, Grier and Tullock, (1989) found positive association of real uncertainty with economic growth. Ramey and Ramey, (1995) analyzing data of 92 countries, report that uncertainty in growth negatively affects economic growth but for OECD countries the coefficient is positive and insignificant.

The impact of nominal and real uncertainty on the levels of output growth and inflation is also ambiguous from empirical point of view. Xanthippi *et al*. (2009) investigate dynamic links between macroeconomic volatility and output growth and report a negative causality running from both uncertainty in inflation and uncertainty in output growth to average output growth. Korap, (2009) using the data of Turkish economy, examines the causal relationship between output growth, inflation, and there uncertainties. The study concludes that higher inflation uncertainty reduces output growth but higher output growth trims down uncertainty in inflation and output growth.

The association between inflation and inflation uncertainty is also diversified empirically. Sajid, Javed and Khan, (2010) and Rizvi and Naqvi, (2008) supported Friedman-Ball hypothesis for Pakistan i.e. causality running from inflation to inflation volatility. Daal *et al*. (2004), and Grier and Perry

(1998), support Friedman-Ball hypothesis for European Union, Asian, Latin American, Middle East, and G-7 countries. Rizvi and Naqvi, (2009) analyze inflation volatility in ten Asian economies including Pakistan and find a strong asymmetric component in inflation volatility in almost all Asian countries under consideration.

3. Data and Variables

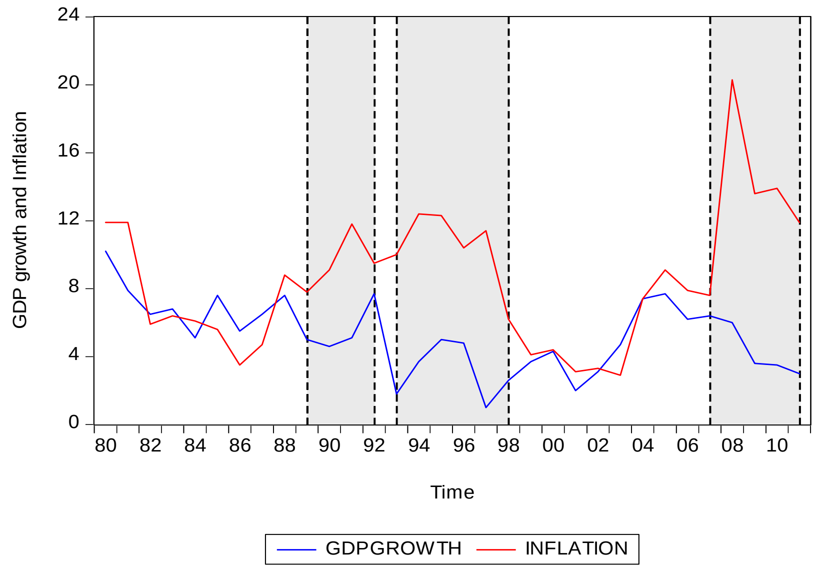
To capture sufficient variability in output growth and inflation, the study employed quarterly data for the period 1980:1 to 2010:2. Secondary data is taken from State Bank of Pakistan (SBP) and International Financial Statistics (IFS). Output growth is measured as the growth rate of GDP and growth rate of inflation is taken as the growth rate of CPI. Variables taken and their definitions are given in Table 1.

Table 1: Variables and their Definitions

Variables	Symbols	Definition
Inflation	π_t	Growth rate of quarterly CPI is used as the measure of inflation: $$INF_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} * 100$$
Output growth	y_t	Growth rate of quarterly GDP is used as a measure of output growth.
Conditional standard deviation of inflation	$h_{\pi t}^{1/2}$	Standard deviation of inflation is taken as a measure of inflation volatility. This variable is generated from the conditional variance equation of inflation described in next section.
Conditional Standard deviation of output growth	$h_{yt}^{1/2}$	Standard deviation of output growth is taken as a measure of output volatility. This variable is generated from the conditional variance equation of output growth described in next section.

Exceptionally, the negative relationship between inflation and growth rate of GDP can be observed in Pakistan. This negative relationship is quite apparent in the highlighted areas in Figure 1.

Figure 1: Relationship between inflation and output growth in Pakistan



4. Econometric Methodology

The paper uses Bivariate VAR (Vector autoregressive) model to simultaneously estimate equations for inflation and output growth and to get conditional covariance between errors. To model conditional covariance between output growth and inflation, diagonal BEKK model is used, presented by, Engle and Kroner (1995). This model enables us to find out whether variation in one series spillovers into the variation of other series. To find out the direction of relationship among variables Granger causality test has also been conducted. These econometric techniques enable us to test the theories, which have been put forward in concern with the nature of relationship between output growth, inflation, and their volatilities, for Pakistan.

4.1. VAR Model

A VAR model is used as a mean equation to estimate inflation and output growth simultaneously and to get an error having zero mean and conditional covariance H_t . This model is represented by the following specification:

$$Y_t = \alpha_{0+} \sum_{i=1}^{p} \alpha_i Y_{t-i} + + \epsilon_t \quad (1)$$

Where, $\epsilon_t|\Omega_t \sim (0, H_t)$ and Ω_t is the information available at time t. The conditional covariance matrix H_t is

$$H_t = \begin{bmatrix} h_{\pi t} & h_{y\pi,t} \\ h_{\pi y,t} & h_{yt} \end{bmatrix}$$

and

$$Y_t = \begin{bmatrix} \pi_t \\ y_t \end{bmatrix}; \quad \epsilon_t = \begin{bmatrix} \epsilon_{\pi t} \\ \epsilon_{yt} \end{bmatrix}; \quad \alpha_0 = \begin{bmatrix} \alpha_{01} \\ \alpha_{02} \end{bmatrix}; \quad \alpha_1 = \begin{bmatrix} \alpha_{11}^i & \alpha_{12}^i \\ \alpha_{21}^i & \alpha_{22}^i \end{bmatrix};$$

4.2. Bivariate BEKK-GARCH model

The conditional covariance matrix is parameterized as:

$$H_t = CC' + A\epsilon_{t-1}\epsilon_{t-1}'A' + BH_{t-1}B' \quad (2)$$

Where,

$$C = \begin{bmatrix} c_{\pi\pi} & c_{\pi y} \\ c_{y\pi} & c_{yy} \end{bmatrix}; \; A = \begin{bmatrix} a_{\pi\pi} & a_{\pi y} \\ a_{y\pi} & a_{yy} \end{bmatrix}; \; B = \begin{bmatrix} \beta_{\pi\pi} & \beta_{\pi y} \\ \beta_{y\pi} & \beta_{yy} \end{bmatrix}$$

This is standard BEKK-model representation named after Baba et al. (1991). The striking property of the model is that the conditional covariance matrices are positive definite by construction. This is because of presence of paired transposed matrix for each of these matrices. The drawback of this model is that there are large numbers of parameters that have to be estimated, making the interpretation somewhat difficult. To avoid this problem the paper uses simplified version of BEKK model in which A and B matrices are diagonal. Further, the conditional (co)variances in diagonal BEKK equation can be expressed as:

$$h_{\pi t} = c_{\pi\pi} + a_{\pi\pi}\epsilon_{\pi t-1}^2 + \beta_{\pi\pi}h_{\pi t-1} \quad (3)$$

$$h_{yt} = c_{yy} + a_{yy}\epsilon_{yt-1}^2 + \beta_{yy}h_{yt-1} \quad (4)$$

$$h_{\pi y,t} = c_{\pi y} + a_{\pi y}\epsilon_{\pi t-1}\epsilon_{yt-1} + \beta_{\pi y}h_{\pi y,t-1} \quad (5)$$

Where, $a_{\pi y} = a_{\pi\pi}a_{yy}$, and $\beta_{\pi y} = \beta_{\pi\pi}\beta_{yy}$. The parameters of the last equation provide information on the covariance between output growth and inflation. The significant values of these parameters enable us to test Logue and Sweeney's hypothesis and Taylor's effect for Pakistan.

5. Results and Discussion

This section contains the results of our econometric analysis. Mean equation of BEKK model has been estimated through VAR. variance-covariance results have been shown in Table 2. Table 3 contains Grange causality results where, causal relationship between concerned volatilities and their levels has been tested.

Table 2: Results of VAR Model

Variables	π_t	y_t
π_{t-1}	0.5728 (6.2685)***	0.0109 (0.0619)
y_{t-1}	-0.0102 (-0.3264)	-0.6996 (-9.3509)***
Constant	0.8324 (3.7286)***	3.5940 (7.3690)***
R-squared	0.3045	0.4689
Adj. R-squared	0.2926	0.4598

Note: *, **, and *** indicate significant level at 10%, 5%, and 1% level of significance, respectively.

5.1. Results of VAR Model

Mean equation of conditional covariance has been estimated with VAR model to simultaneously estimate inflation and output growth. Lag length has been selected through SIC (Schwarz Information Criteria). Results are shown in Table 2. Results show that inflation in previous period impacts the current inflation positively and significantly. This shows the phenomenon inflation inertia in Pakistan. Moreover, results show that previous period inflation has a positive but insignificant impact on current growth. The results also show negative and insignificant effect of lagged growth on both output growth and inflation.

5.2. Results based on BEKK Model

Results are shown in Table 3. First six coefficients are the coefficients of variance equations of inflation and output growth respectively. Last three coefficients are covariance equation coefficients.

Table 3: Variance-covariance (BEKK) results

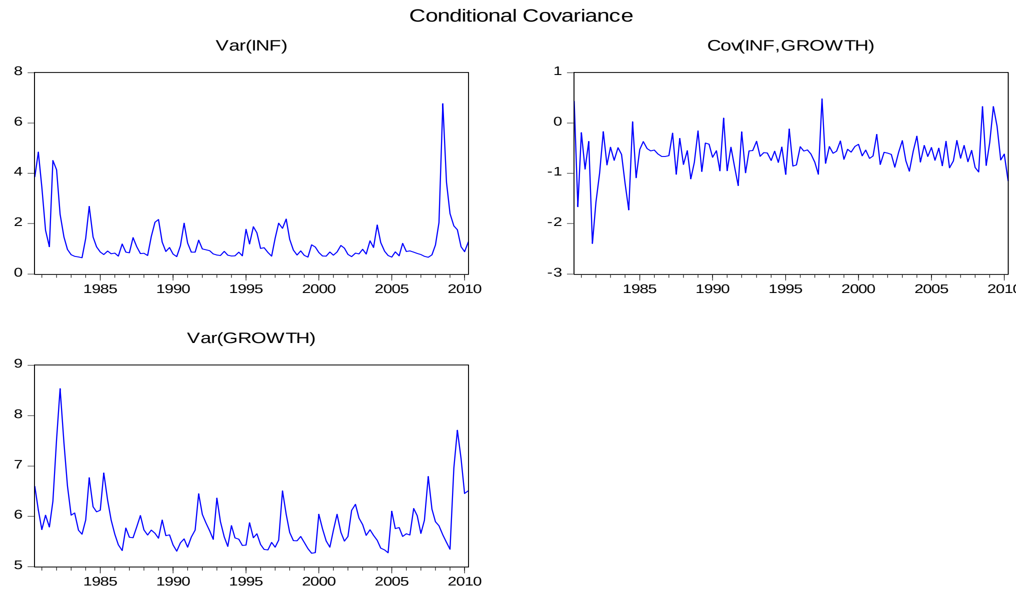
Coefficients	z-statistics
$c_{\pi\pi}$	0.3823***
$a_{\pi\pi}$	0.3088***
$\beta_{\pi\pi}$	0.3845***
c_{yy}	2.0106
a_{yy}	0.0509
β_{yy}	0.6066***
$c_{\pi y}$	-0.8768***
$a_{\pi y}$	0.1253*
$\beta_{\pi y}$	-0.4830***

Note: *, **, and *** indicate significant level at 10%, 5%, and 1% level of significance, respectively.

Results show that elements of conditional covariance matrix are significant. Significant values of these coefficients show that time varying covariance between real and nominal uncertainty exists in Pakistan. This reveals the fact that variation in one variable spillover into the variation of other variable. The plot of conditional variances and conditional covariance is presented in Figure 2.

Graphs of conditional variances and conditional covariance between output growth and inflation are presented in Figure 2. Graph of conditional covariance shows that covariance between output growth and inflation is time varying, which is the general property of conditional covariance. But this conditional covariance is negative in most of the periods, confirming the presence of Taylor's effect in Pakistan i.e. there exist tradeoff between volatility in output growth and volatility in inflation.

Figure 2: Conditional Variance and Covariance of Output Growth and Inflation



5.3. Results based upon Granger Causality Test

To determine the direction of relationship among variables, Granger causality test has been performed after getting the conditional standard deviations of output growth and inflation from the equations of conditional variances presented in the section of methodology, Here, the conditional standard deviations of output growth and inflation have been used as indicators of output growth uncertainty and inflation uncertainty.

The results of Granger causality test provide strong evidence of existence of Friedman-Ball hypothesis in Pakistan, as high inflation causes inflation uncertainty in Pakistan. Output growth also causes output growth uncertainty in Pakistan but the opposite does not hold. Inflation uncertainty causes output growth after two lags, showing the evidence of Friedman (1977) hypothesis in which high inflation uncertainty causes output growth losses. Output growth uncertainty has no causal relationship with inflation.

Table 4: Results based upon Granger causality tests

Direction of Causality	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8
	F-statistics							
Inflation to inflation uncertainty	40.39*** (0.0000)	16.30*** (0.0000)	10.76*** (0.0000)	8.18*** (0.0000)	6.47*** (0.0000)	3.90*** (0.0015)	4.05*** (0.0006)	3.72*** (0.0008)
Inflation uncertainty to inflation	3.10* (0.0807)	0.99 (0.3727)	1.98 (0.1209)	1.57 (0.1885)	1.90 (0.1004)	1.58 (0.1600)	1.36 (0.2285)	0.78 (0.6219)
Output growth to output growth uncertainty	11.12*** (0.0011)	5.59*** (0.0049)	4.53*** (0.0049)	4.02*** (0.0045)	3.01** (0.0140)	2.79** (0.0149)	2.00* (0.0633)	1.97* (0.0591)
Growth uncertainty to growth	0.28 (0.5963)	0.10 (0.9026)	0.35 (0.7866)	0.43 (0.7894)	0.52 (0.7581)	0.53 (0.7839)	1.85 (0.0866)	1.67 (0.1147)
Inflation uncertainty to output growth	0.47 (0.4938)	1.01 (0.3669)	5.18*** (0.0022)	2.70** (0.0344)	2.84** (0.0189)	2.10* (0.0591)	2.28** (0.0339)	1.97* (0.0583)
Output growth to inflation uncertainty	0.15 (0.6981)	1.73 (0.1812)	1.31 (0.2760)	1.13 (0.3449)	1.03 (0.4034)	1.38 (0.2302)	0.98 (0.4502)	0.85 (0.5610)
Output growth uncertainty to inflation	0.04 (0.8365)	0.11 (0.8940)	0.42 (0.7371)	0.83 (0.5163)	0.86 (0.5123)	0.64 (0.6942)	0.90 (0.5110)	0.67 (0.7137)
Inflation to output growth uncertainty	0.44 (0.5089)	1.40 (0.2498)	2.69** (0.0497)	2.18* (0.0760)	2.60** (0.0289)	2.39** (0.0337)	2.15** (0.0455)	1.71 (0.1052)

Note: Values in parenthesis are the P-values. Moreover, *, **, and *** indicate significant level at 10%, 5%, and 1% level of significance, respectively.

6. Conclusion

The paper explores linkages between inflation-output variability and their levels for Pakistan using the data from 1980:1 to 2010:2. To simultaneously estimate conditional variances and covariance between output growth and inflation, the paper employs Bivariate GARCH (BEKK) model. For analysis, conditional variance of output growth and inflation is used as proxy for nominal and real uncertainty.

Results show that there exists negative covariance between volatility in inflation and volatility in output growth. The negative covariance provides the evidence for the presence of Taylor's effect in Pakistan. From the results of the study, it can be concluded that real (nominal) uncertainty can be reduced at the cost of high nominal (real) uncertainty in Pakistan. Granger causality test shows that high inflation is responsible for high inflation uncertainty in Pakistan, confirming the existence of Friedman-Ball hypothesis in Pakistan. Inflation volatility also causes output growth in Pakistan, which is in accordance with Friedman's (1977) theory. The existence of unidirectional positive causality running from growth to growth uncertainty and also from inflation uncertainty to growth uncertainty, showing that both higher growth and higher inflation uncertainty are responsible for increasing growth uncertainty in Pakistan.

References

Aghion, P. & Saint–Paul, G. (1998), On the Virtue of Bad times: An Analysis of the Interaction between Economic Fluctuations and Productivity Growth, *Macroeconomic Dynamics, 2*, 322-344.

Antonakakis, N. & Badinger, H. (2012), *Output Volatility, Economic Growth and Cross-country Spillovers: New Evidence for the G-7 Countries,* FIW working paper No. 98.

Baba, Y., Engle, R.F., Kraft, D.F. & Kroner, K.F. (1991), "Multivariate Simultaneous Generalized ARCH", manuscript, Dept. of Economics, UCSD.

Ball, L. (1992), Why Does High Inflation Rises Inflation Uncertainty? *Journal of Monetary Economics, 29*, 371-388.

Black, F. (1987), *Business Cycle and Equilibrium*, NewYork: Basil Blackwell.

Bredin, D., & Fountas, S. (2011), *Macroeconomic Uncertainty and Performance in the European Union.* UCD Business School, WP 08/11.

Chatterjee, P. & Shukayev, M. (2006), Are *Average Growth Rate and Volatility Related?* Bank of Canada Working Paper 2006-24.

Cukierman, A., & Meltzer, A. (1986), A Theory of Ambiguity, Credibility and Inflation Under Discretion and Asymmetric Information. *Econometrica, 54*, 1099-1128.

Daal, E., Naka, A., & Sanchez, B. (2004), *Re-examining Inflation and Inflation Uncertainty in Developed and Emerging Countries*, Department of Economics and Finance Working Papers 1991-2006, Paper No. 26.

Devereux, M. (1989), A Positive Theory of Inflation and Inflation Variance, *Economic Inquiry, 27*, 105-116.

Engle, R. & Kroner, K. F. (1995), Multivariate Simultaneous Generalized ARCH, *Econometric Theory, 11*, 122-150.

Fountas, S., & Karanasos, M. (2006). The Relationship between Economic Growth and Real Uncertainty in the G3. *Economic Modelling*, *23*(4), 638-647.

Friedman, M. (1977), Noble Lecture: Inflation and Unemployment. *Journal of Political Economy*, *85*, 451-472.

Grier, K., Henry, O. T. & Nilss, Ol. (2001), *The Effects of Uncertainty on Macroeconomic Performance: The Importance of Conditional Covariance Model*, University of Oklahoma and University of Melbourne.

Grier, K. & Perry, M. (1998), On Inflation and Inflation Uncertainty in the G7 Countries, *Journal of International Money and Finance*, *17*, 671–689.

Grier, K. & Perry, M. (2000), The Effects of Real and Nominal Uncertainty on Inflation and Output Growth: Some GARCH-M Evidence, *Journal of Applied Econometrics*, Paper No. 15, 45-58.

Grier, K. & Tullock, G. (1989), An Empirical Analysis of Cross-National Economic Growth, 1951-80, *Journal of Monetary Economics, 24*, 259-276.

Karanasos, M. & Kim, J. (2003), The Inflation-Output Variability Relationship in the G3: A Bivariate GARCH (BEKK) Approach, *Risk Letters, 1*(2)*,* 17-22.

Korap, L. (2009), *On the Links between Inflation, Output Growth and Uncertainty: System-GARCH Evidence from the Turkish Economy*, Istanbul University Institute of Social Sciences, MPRA Paper No. 19054, Online at http://mpra.ub.uni-muenchen.de/19054/.

Lee, J. (2010). The Link between Output Growth and Volatility: Evidence from a GARCH Model with Panel Data, *ELSEVIER*, *106,* 143-145. Online at www.elsevier.com/locate/ecolet.

Logue, D. & Sweeney, R. (1981), Inflation and Real Growth: Some Empirical Results, *Journal of Money, Credit and Banking*, *13*, 497-501.

Macri, J. & Sinha, D. (2007), *Does Blacks's Hypothesis for Output Variability Hold for Maxico?* MPRA Paper No. 4021, Online at http://mpra.uni_muenchen.de/4021/

Pindyck, R. (1991), Irreversibility, Uncertainty and Investment, *Journal of Economic Literature 29*, 110-148.

Ramey, G. & Ramey, V. A. (1995), Cross-country Evidence on the Link between Volatility and Growth, *American Economic Review, 85*(5)*,* 1138-1150.

Rizvi, S. K. & Naqvi, B. (2008), *Asymmetric Behaviour of Inflation Uncertainty and Friedman-Ball Hypothesis: Evidence from Pakistan*, Munich Personal RePEc Archive, Paper No. 19488, Online at http://mpra.ub.uni_munechen.de/19488/

Rizvi, S. K. & Naqvi, B. (2009), *Inflation Volatility: An Asian Perspective*, Munich Personal RePEc Archive, Paper No. 19547, Online at http://mpra.ub.uni_munechen.de/19547/

Sajid, A., Javed, S. & Khan, A. (2010), *Inflation and Inflation Uncertainty: A GARCH Application-An Appraisal from Pakistan*, International Conference on Applied Econometrics – ICOAE 2010.

Taylor, J. B. (1979), Estimation and Control of a Macroeconomic Model with Rational Expectations, *Econometrica*, *47*(5), 1267-1286.

Xanthippi C., Constantinos K., Nikolaos T. & Georgios K. (2009), *Dynamic Linkages between Output Growth and Macroeconomic Volatility: Evidence using Greek Data*, International conference on applied econometrics-ICOAE