THE INFLATION–OUTPUT NEXUS: EMPIRICAL EVIDENCE FROM DEVELOPING COUNTRIES

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Spring, 2015

- Macroeconomics
- Output Growth
-

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Submitted in partial fulfillment of the requirements for the degree of Masters of Philosophy in Economics and Finance at International Institute of Islamic Economics, International Islamic University, Islamabad

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Certificate

The thesis entitled – **"The Inflation-Output Nexus: Empirical Evidence from Developing Countries"**

Certified that M.S Dissertation titled **"The Inflation-Output Nexus: Empirical Evidence from developing Countries"** prepared by Ms. Saira Rasul wide Reg. no. 107-FE/MS(EF-2)/F12 has been approved for submission to the Department of Economics and Finance, International Institute of Islamic Economics (IIIE), International Islamic University (IIUI), Islamabad.

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APPROVAL SHEET

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ACKNOWLEDGEMENT

Thanks to Almighty Allah, the Most Merciful and Beneficent, who blessed me with knowledge, courage, strength and resilience to complete this task and enabled me to pursue this endeavor of my life.

I am thankful to my respectable supervisor Dr. Arshad Ali Bhatti (Assistant Professor and Head of the Department (IIIE), who is the real source of inspiration and motivation throughout this research. His guidance helped me in the quest to add more and accomplish my thesis. He put my thoughts on the right track. I am deeply indebted to him and pay profound gratitude to my respected supervisor who kindly gave his time during my research.

I am also thankful to Ms. Munazza Jabeen, who really helped me a lot during my whole research. I also thankful to my friends and sisters, Faiza Rasul and Tahira Rasul especially for solving my whole problems relating draft write up and assisting me emotionally to complete my thesis. Last but not the least my parents Mrs. and Major (R) Ghulam Rasul, only for them I have done all this.

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Abstract

This study examines the relationship among inflation, inflation uncertainty, output growth and output growth uncertainty for 12 developing countries covering data from 1982-M1 to 2012-M12. We use various GARCH models for finding the conditional variances being used as proxies for the uncertainties of inflation and output growth. Finally, we use the bi-variate ARMA (p,q) diag-BEKK MGARCH(1,1) models for finding the 12 causality relationship among the inflation, output growth and their uncertainties. Our evidence supports the number of important conclusions. Firstly, the results are consistent with the findings of Friedman hypothesis that is, inflation is the main reason causing inflation uncertainty in most of the developing countries. Secondly, we find the strong evidence for supporting the Cukierman-Meltzer (1986) hypothesis that is, higher inflation uncertainty leads to increase the inflation in developing countries and also find supporting evidence for the Holland (1995) hypothesis. Thirdly, our results strongly supported the findings of Balck (1987) hypothesis that is, higher output growth uncertainty leads to decrease the inflation. Fourthly, our results conclude that higher inflation is the main reason for lower output growth in the developing countries. Finally, we find very weak evidence for supporting the hypothesis that inflation uncertainty is reduced by output growth. The findings of this study conclude that policy makers of developing countries must take into account to lower the inflation rate because output growth is cruelly disturbed inflation and its prevail uncertainty in the economy.

Chapter 1
Introduction

Inflation is always a monetary phenomenon. Monetary policy practitioners worldwide believed that inflation is potentially detrimental to the growth of an economy's output but still this relationship is scant. However, there is now a large body of both theoretical and empirical research on the relationship between inflation, inflation uncertainty, output growth and output growth uncertainty. In this study, we examine the relationship between inflation, output growth and their uncertainties considering developing countries. This chapter discusses the background, research objectives, research question, research hypotheses, significance and importance of study and structure of study.

1.1. Background

Inflation, as an economic indicator, plays a crucial role in any economy because of its significant impact on economic development or growth. The theoretical literature points out towards the ambiguous impact of inflation on economic growth (Fountas & Kasranasos, 2006; Payne, 2008; Ozdemir, 2010; Omay, 2011; Narayan & Narayan, 2013). For example, the impact of inflation on economic growth may take place indirectly, via the inflation uncertainty. Whereas, inflation may yield inflation uncertainty or inflation uncertainty may leads to inflation. Furthermore, output growth may be influenced by output growth uncertainty in addition to inflation uncertainty. The output growth uncertainty may affect inflation. Given this dynamic relationship among inflation, output growth, inflation uncertainty and output growth uncertainty are one of the important issues in both theoretical and empirical aspects that need to be explored particularly for the developing countries.

Before 1980s, the theories of the business cycle (and its variability) and economic growth were treated independently in macroeconomic analysis. However, this assumption of independence between the variability of the business cycle and economic growth lacks substantial evidence; later several theories built the relationship between business cycle and economic growth (Mirman, 1971; Black, 1987; Pindyck, 1991; Blackburn & Pelloni, 2004, 2005). Recently, empirical evidence is emerged that corroborates these theoretical findings which are still scant (Caporale & McKiernan, 1996, 1998; Kneller & Young, 2001; Henry & Olekalns, 2002; Karanasos & Schurer, 2005).

Friedman (1977) argues that higher inflation leads to higher inflation uncertainty, which distorts the effectiveness of the price mechanism in allocating resources efficiently, and thus creates economic inefficiency and lowers output growth rate. Further, inflation uncertainty by affecting interest rates, impacts on the intertemporal allocation of resources. Cukierman and Meltzer (1986) provide a positive causal effect of inflation uncertainty on inflation, whereas Holland (1995) points out the negative causal relationship between inflation and its uncertainty. Moreover, Mirman (1971) and Black (1987) find that the higher output growth uncertainty increases output growth. Deveraux (1989) shows that higher output growth uncertainty increases inflation, whereas Black (1987) finds that higher output growth uncertainty reduces inflation. These theoretical studies postulate certain causality relationships among inflation, output growth, inflation uncertainty and output growth uncertainty. However, the empirical evidence on these relationships remains scant or nonexistent; particularly, for developing countries. Therefore, there is a lack of comprehensive study of the empirical relationships among these four variables especially covering the developing countries of the world.

1.2. Research Objectives

The objective of this study is to undertake the comprehensive analysis of relationships among inflation, output growth and their uncertainties considering both theoretical and empirical literature. Further, it investigates 12 causality relationships among these four variables, that is, inflation, inflation uncertainty, output growth and output growth uncertainty using bi-variate GARCH-M (1, 1) Models. Specifically, it tests the following hypotheses (1) Friedman (1977) Hypothesis; (2) Cukierman-Meltzer (1986) Hypothesis; (3) Holland (1995) Hypothesis; (4) Black (1987) Hypothesis; (5) Mirman (1971) and Black (1987) Hypothesis; (6) Deveraux (1989) Hypothesis (1989). Further, it tests empirically the above hypotheses for 12 developing countries.

1.3. Research Question

This study investigates the following research question: "What are the dynamic linkages among inflation, inflation uncertainty, output growth and output growth uncertainty?"

1.4. Research Hypotheses

The primary objective of this study is to determine the dynamic linkages between inflation, output growth, and their uncertainties for 12 developing countries. Specifically the study intends to test the following hypotheses:

H_o^1: Higher inflation increases inflation uncertainty (Friedman, 1977)

H_o^2: Higher inflation uncertainty reduces output growth (Friedman, 1977)

H_o^3: Higher inflation uncertainty increases inflation (Cukierman and Meltzer, 1986)

H_o^4: Higher inflation uncertainty reduces inflation (Holland, 1995)

H_o^5: Higher output growth uncertainty increases output growth (Mirman, 1971; Black, 1987)

H_o^6 : Higher output growth uncertainty reduces inflation (Taylor, 1979; Black, 1987)

H_o^7: Higher output growth uncertainty increases inflation (Deveraux, 1989)

H_o^8 : Higher output growth reduces inflation

H_o^9 : Higher output growth reduces inflation uncertainty

H_o^{10}: Higher output growth increases output growth uncertainty

H_o^{11}: Higher inflation reduces output growth

H_o^{12}: Higher inflation increases output growth uncertainty

1.5. Significance and Importance of Study

This study makes several contributions, like it examines the dynamic relationships between inflation, output growth and their uncertainties for 12 developing countries. Past literature focused on developed or industrialized countries and this study focuses on developing countries specifically. Further unlike VAR approach, this study employs bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) models to empirically test the above stated hypotheses. Moreover, this study also helps the policy makers of developing countries to formulate more specific policy objectives to ensure the price stability and to strengthen the public confidence. By decreasing inflation, the policy makers are able to achieve the goal of stables prices as well as higher output growth.

1.6. Structure of Study

This study is structured as follows: **Chapter 1** explains the outline of our research. **Chapter 2** briefly provides a literature review of prominent theoretical as well as empirical studies in the area of research. **Chapter 3** describes a theoretical framework to understand the relationship between inflation, output growth and their uncertainties. **Chapter 4** discusses the data, model specification and estimation method to examine the relationship among inflation, output growth and their uncertainties. **Chapter 5** discusses the estimation and results of 12 developing countries. **Chapter 6** is Conclusion which includes summary of results and policy recommendations.

Chapter 2
Literature Review

Inflation is one of the most important factors to be considered for economic development and growth of a country. Inflation may have direct impact on its uncertainty, while indirect impact on output growth. Output growth may also have direct impact on its uncertainty and indirect impact on inflation. Lot of studies have been conducted on both theoretical and empirical aspects of inflation, output growth and their uncertainties but still this issue needs to be explored particularly for developing countries. Firstly, this issue has been pointed out by Friedman (1977) and according to him there is a positive relationship between inflation and its uncertainty, while inflation has negative impact on output growth. Afterwards this issue has been raised by many further studies.

This chapter reviews the theoretical as well as empirical literature on dynamic relationships among inflation, output growth and their uncertainties.

2.1. Theoretical Review

Friedman (1977) points out the ambiguous relationship of inflation and inflation uncertainty for the first time in his Nobel lecture and focuses the two main points. First, higher inflation leads to higher inflation uncertainty. Second, higher inflation leads to reduce the overall growth of the economy. Ball (1992) formalizes the first part of the Friedman (1977) hypothesis and examines that there is half-truth between public and policy makers regarding future inflation policy (monetary policy). He concludes that uncertainty of inflation is the main cause of high inflation, known as the Friedman-Ball hypothesis. Due to uncertainty of future inflation, the average rate of inflation is likely to be exaggerated. This critical point is not clear-cut in terms of theoretical aspects. Cukierman and Meltzer (1986) claims that uncertainty about future inflation is owed to the rate of money supply growth and the uncertainty about what the policy makers will do. They show that higher inflation uncertainty increases mean inflation, known as the Cukierman-Meltzer (1986) hypothesis. On the other hand, Holland (1995) tries to establish the importance of central bank in order to adopt strict monetary policy and control higher inflation (the Holland's hypothesis) and finds negative relationship between inflation and its uncertainty.

The second part of Friedman (1977) hypothesis points out that higher inflation uncertainty reduces the ratio of economic growth of the overall economy and establishes the negative relationship between both variables. Mirman (1971) concludes that higher output uncertainty increases output growth. Following this line further work is being much clearer by Deveraux (1989) and Black (1987). Theoretically, output growth uncertainty may reduce the inflation rate. This is known as Taylor (1979) effect, if Cukierman-Meltzer (1986) hypothesis grips, the rate of inflation. Deveraux (1989) reinforces the linkage between an increase in uncertainty of real variables and inflation in a positive theory of monetary policy framework. He determines that higher output volatility increases mean inflation and known as the Deveraux (1989) Hypothesis. He also considers the wage indexation and point out that the uncertainty of real variables lowers prime amount of wage indexation. Black (1987) considers the node between output uncertainty and average growth rate. He also highlights the relationship between risk and return and claims that when any economy finance in a specified risky technology, the result leads to the higher economic growth. This indicates that better technology leads to increase the output growth and reduce inflation –an antithesis to Deveraux's (1989) view.

2.2. Empirical Review

Many empirical studies investigate the relationship between inflation and its uncertainty using the variance (or standard deviation) for measuring uncertainty. But with the advancement of ARCH approach by Engle (1982), most of the studies use conditional variance as a proxy to measure the uncertainty. Maximum studies find the results parallel with first part of the Friedman (1977) hypothesis that higher inflation leads to increase the inflation uncertainty. Grier and Perry (2000) use GARCH model to measure inflation uncertainty and finds results parallel with the Friedman (1977) Hypothesis. Similarly, Fountas, Karanasos and Kim (2002) use bivariate GARCH model to proxy the inflation and output growth uncertainty and then apply Granger causality test to investigate the relationship. Their findings strongly support the Friedman (1977) hypothesis. Apergis (2004) results are also parallel with the Friedman (1977) Hypothesis by applying uni-variate GARCH models on G-7 countries.

Similarly, Fountas, Ioannidis and Karanasos (2004) uses the Exponential GARCH (EGARCH) model to proxy the inflation uncertainty and then apply Granger causality test to investigate the relationship between inflation and its uncertainty, supporting the Friedman (1977) Hypothesis for all European countries except Germany. Like, Bredin and Fountas (2006) use Markov regime switching heteroskedasticity by considering four European countries and their results partially support the Friedman's hypothesis. Chen, Shen and Xie (2008) also investigate the relationship between inflation and its uncertainty by considering four countries named Taiwan, Hong Kong, Singapore and South Korea. They use GARCH-type model to proxy inflation uncertainty and Hamilton's flexible regression model to investigate the two hypotheses. Except Hong Kong evidence is in favor of the Friedman (1977) hypothesis. Karanasos and Schurer (2008) use parametric power ARCH (PARCH) model to proxy the inflation uncertainty and then apply simultaneous-estimation approach to test the relationship between two variables. Results are in favor of the Friedman (1977) Hypothesis for three European countries namely Germany, the Netherlands and Sweden.

However, Mladenovic (2009) uses the GARCH model to decompose inflation into permanent and transitory components and then apply VAR model to test for Granger causality between inflation and its uncertainty. Results support the Friedman (1977) hypothesis and conclude that monetary policy in Serbia has been relatively efficient in recent years for long and short horizons. Yeh, Wang and Suen (2009) also use the Quantile regression instead of linear or nonlinear regression to estimate the relationship between inflation and inflation uncertainty with cross-sectional data in 90 countries for the period of 1961-2002. ARIMA model is use to generate the expected and unexpected inflation. Then apply GARCH, component-GARCH (CGARCH) and exponential GARCH (EGARCH) model to investigate the relationship between considered variables and outcomes are parallel with the Friedman (1977) hypothesis. Also, Narayan, Narayan and Smyth (2009) use EGARCH model to test four hypotheses in China and their findings support the Friedman (1977) hypothesis. Fountas (2010) uses GARCH-M to measure the conditional variances and his findings partially support the Friedman (1977) hypothesis for annual data over one century for 22 industrial countries. Further, Ozdemir (2010) tries to explore the ambiguous relationship of inflation on output growth of the UK by applying vector autoregressive fractionally integrated moving average BEKK MGARCH (VARFIMA-BEKK MGARCH) model. His findings partially support the Friedman (1977) Hypothesis considering full data and no relationship in case of sub-periods, the reason is innovation.

Moreover, Omay (2011) uses STAR-GARCH model to measure both uncertainties (inflation and output growth) and then apply VAR model to test the relationship among these variables. Results are parallel with the findings of the Friedman (1977) hypothesis for linear model and low inflationary regime. Cakan (2012) investigate the non-linear causality of inflation uncertainty on stock returns using the US data. His findings do not support the Friedman (1977) hypothesis using non-linear Granger causality test and also apply GARCH model to discover inflation uncertainty. Bacilar and Ozdemir (2013) explore the bi-directional relationship between inflation and its uncertainty by using fractionally integrated smooth transition autoregressive moving asymmetric power ARCH (FISTARMA-APARCH) model on G-7 countries. They use time varying model and determine the sign of the Granger causality. Their findings strongly support the Friedman (1977) hypothesis for G-7 countries excluding Canada. Also, Narayan and Narayan (2013) investigate the volatility of inflation and output growth for India, South Africa and Brazil. They use EGARCH model and find the results parallel with the Friedman (1977) hypothesis.

Further, Chowdhury (2014) applies GARCH model to proxy inflation uncertainty and then Granger causality test to check the impact of inflation on its uncertainty. He finds that the Friedman (1977) hypothesis holds in India. Ball (1992) formalizes the Friedman (1977) hypothesis and talk about the half-truth between public and policy makers related to monetary policy, known as the Friedman-Ball hypothesis. Moreover, Fountas (2001) applies GARCH model to investigate the relationship between inflation and its uncertainty and finds that outcomes are parallel with the Friedman-Ball Hypothesis. Kontonikas (2004) uses GARCH model to investigate the relationship by taking long series data of the UK favors the Friedman-Ball Hypothesis. Berument and Dincer (2005) use the Full Information Maximum method with extended lags and their results are parallel with the Friedman-Ball Hypothesis. Daal, Naka and Sanchez (2005) apply the asymmetric power GARCH model. Their findings strongly support the Friedman-Ball Hypothesis. They use data of 22 countries including Asia, G-7, Latin America and Middle East composed of both developed and emerging economies. Erkam and Cavusoglu (2008) apply the ARCH modeling framework by using both conventional Granger non causality test and the Holmes-Hutton approach to explore the inflation uncertainty in seven transitional economies. The results are in the favor of Friedman-Ball hypothesis in Azerbaijan, the Russian Federation and the Ukraine.

Like most of the researchers, Ozdemir and Fisunoglu (2008) also apply the ARFIMA (p,d,q)-GARCH (r, m) in generating long memory inflation and then use Granger causality to test the relationship between inflation and inflation uncertainty. Their findings confirm the Friedman-Ball hypothesis. Saatcioglu and Korap (2009) use EGARCH model and support the Friedman-Ball hypothesis in the Turkish economy. Jiranyakul and Opiela (2010) apply the Granger causality test and find out that inflation and inflation uncertainty have influence on each other by using ASEAN-5 Economies. Results of their findings are parallel with the Friedman-Ball Hypothesis. Basically Javed *et al.* (2010) also apply ARMA-GARCH model to approximate conditional volatility as substitute for inflation uncertainty in Pakistan. Their results confirm the Friedman-Ball hypothesis (1977) that relation is uni-directional for inflation to inflation uncertainty.

Moreover, Salmanpour and Bahloli (2011) investigate the factors affecting inflation in Iran by using GARCH and Markov Switching method for measuring inflation uncertainty. They also use Angel Granger test, one equated economic measurement models and autoregressive conditional variance heterogeneity. Their findings strongly support the Friedman-Ball Hypothesis (1977) for quarterly period, six-months and nine-month period but fail to hold for one year. Balciliar, Ozdemir and Cakan (2011) apply GARCH model to investigate the nonlinear causality relationship between inflation and inflation uncertainty in G-3 countries. Their results support the Friedman-Ball hypothesis using linear Granger causality and find the bi-directional relationship between considered variables. Hasanov and Omay (2011) use bivariate GARCH model to estimate the uncertainties of inflation and output and then apply bivariate VAR model to test the relationship among considered variables by taking into account selected CEE countries. Results are in favor of the Friedman-Ball hypothesis.

The causal relationship between inflation uncertainty and inflation is also tested empirically by many previous studies. Cukierman-Meltzer (1986) points the positive relationship between the variables. Whereas, Holland (1995) concludes that there is negative relationship between inflation uncertainty and inflation. Previous studies use different econometric techniques to support the both hypothesis. Grier and Perry (2000) discover results parallel with the findings of the Cukierman-Meltzer (1986) hypothesis. Findings of Apergis (2004) are parallel with the Cukierman-Meltzer's (1986) hypothesis using Panel data of G-7 countries by applying GARCH models. Fountas *et al.* (2004) find the mix evidence to support the Cukierman-Meltzer (1986) hypothesis except Germany and the Netherlands.

Further, Fountas, Karanasos and Kim (2006) use bi-variate GARCH model and their findings strongly support the Cukierman-Meltzer (1986) hypothesis for Canada and the UK but not for Italy. Fountas and Karanasos (2007) find partial support to the Cukierman-Meltzer (1986) hypothesis by using data of G-7 countries and applying uni-variate GARCH model. Chen *et al.* (2008) final results are in the favor of Cukierman-Meltzer (1986) hypothesis for four countries i.e., Taiwan, Hong Kong, Singapore and South Korea using flexible regression model. Berument, Yalcin and Yildirim (2009) apply the Stochastic Volatility in Mean Model (SVM) within a dynamic framework of the US to investigate the relationship and results support the Cukierman-Meltzer (1986) Hypothesis. Specifically, Rizvi and Naqvi (2009) investigate the relationship between inflation and inflation uncertainty in Pakistan and apply GARCH model in their study. Asymmetric behavior of inflation uncertainty is explore by applying GJR-GARCH and EGARCH models for further analysis of asymmetry and leverage effects. Their study fails to support the Cukierman-Meltzer (1986) hypothesis.

Findings of Karanasos and Schurer (2008) do not support the Cukierman-Meltzer (1986) hypothesis by using the PARCH model. The findings of Ekram and Cavusoglu (2008) are in favor of the Cukierman-Meltzer (1986) hypothesis for Kyrgyz Republic and in the Russian Federation. Ozdemir and Fisunogli (2008) find weak evidence to support the Cukierman-Meltzer (1986) hypothesis. Mladenovic (2009) concludes that the Cukierman-Meltzer (1986) hypothesis does not hold for long and short horizons. Jiranyakul and Opiela (2010) use Granger causality test to find the relationship between inflation with its uncertainty and find results parallel with the Cukierman-Meltzer (1986) hypothesis by using data of ASEAN-5 Economies. Fountas (2010) uses Granger causality test and find partial support to the Cukierman-Meltzer (1986) hypothesis. Also, Chang and He (2010) apply AR-SWARCH model to find the dynamic process of inflation and then use bivariate

Markov regime switching model to test the relationship between inflation and inflation uncertainty, supporting the Cukierman-Meltzer (1986) hypothesis.

Results of Salmanpour and Bahloli (2011) conclude that the Cukierman-Meltzer (1986) hypothesis holds for Iran in quarterly, six and nine months but not for one year period. The findings of Balcilar *et al.* (2011) only support the Cukierman-Meltzer (1986) hypothesis for Japan i.e., inflation uncertainty has an impact on inflation but does not holds for the US and the UK. Omay (2011) finds mixed evidence for the Cukierman-Meltzer (1986) hypothesis. Hasanov and Omay (2011) conclude that the Cukierman-Meltzer (1986) hypothesis hold for only two countries taking into account ten Central and Eastern European transition countries. Specifically, Mughal *et al.* (2012) use GARCH model to examine the instability and extended GARCH (EGARCH) model to inspect the asymmetric behavior of inflation. They also apply the Granger causality test and results are parallel with the Cukierman-Meltzer (1986) hypothesis by taking into account four South East Asian Countries (Indonesia, Thailand, Philippines and Malaysia).

The results of Cakan (2012) are inconsistent with the Cukierman-Meltzer (1986) hypothesis by using non-linear Granger causality tests. Javed *et al.* (2012) use autoregressive moving average GARCH (ARMA-GARCH) model and their empirical findings are not parallel with the Cukierman-Meltzer (1986) hypothesis for Pakistan. Naryan and Narayan (2013) strongly support the Cukierman-Meltzer (1986) hypothesis that inflation volatility raises inflation. The findings of Chowdhury (2014) conclude that the Cukierman-Meltzer (1986) hypothesis holds for India. The findings of Fountas *et al.* (2002) conclude that the Holland (1995) hypothesis hold i.e., inflation uncertainty considerably lowers real output growth and average inflation. Fountas *et al.* (2006) find that the Holland (1995) hypothesis holds for Japan but does not hold for Canada and the UK. Payne (2008) applies ARMA-GARCH model and conditional variance as substitute for inflation uncertainty considering three Caribbean countries (Bahamus, Barbados and Jamaica). His findings are in favor of the Holland's (1995) hypothesis.

Similarly, Karanasos and Schurer (2008) find that the Holland (1995) hypothesis hold for Sweden but for Germany and the Netherlands found no evidence supporting the Holland (1995) hypothesis. Narayan *et al.* (2009) find that Chinese output-inflation behavior is consistent with the Holland (1995) hypothesis that increasing inflation uncertainty lowers average inflation. Bhar and Malik (2012) use the multivariate EGARCH model to test the relationship between inflation, its uncertainty and its effect on overall growth of the Australian economy. They find out the bi-directional relationship between the variables and conclude that the Holland (1995) hypothesis holds. Balcilar and Ozdemir (2013) apply FISTARMA-APARCH model on G-7 countries. Their findings support the Holland (1995) hypothesis using the Markov switching vector autoregressive (MS-VAR) model in G-7 countries.

Previous empirical studies also focus on the relationship between inflation, output growth and their uncertainties by applying different techniques. Fountas (2001) find that inflationary periods are similar with high inflation and enlarged inflation uncertainty clues to decrease output. Grier and Perry (2000) fail to find any evidence to support the Deveraux (1989) hypothesis and also find no significance that output growth is positively correlated by inflation as proposed by Mirman (1971) and Black (1987). The findings of Fountas *et al.* (2002) also fail to support the Black's (1987) hypothesis i.e., finds no effect of output growth on average inflation or output growth. Apergis (2004) finds that inflation has impact on output growth by using panel data of G-7 countries.

Specifically, Fountas *et al.* (2004) use exponential GARCH (EGARCH) model to proxy the inflation uncertainty and then apply Granger causality to investigate the relationship between variables under the consideration. They conclude that inflation uncertainty is negatively related to output growth in the case of the UK. Grier and Grier (2006) find no direct relationship in case of Mexico. Also, Wilson (2006) concludes that increased uncertainty narrates to higher average inflation but no relationship to growth. In case of Japan, negative surprises raise the inflation uncertainty along with growth uncertainty more as compared to positive surprises. Fountas *et al.* (2006) concludes that high volatility in the business cycle leads to increase output growth.

Further, Fountas and Karanasos (2006) apply GARCH-ML models and substitutes output uncertainty by the conditional variance of shocks to output growth. They find bi-directional relationship between output and its uncertainty. Their findings support the Mirman (1971) and Black's (1987) hypothesis. Fountas and Karanasos (2007) find partial support that growth is being affected by inflation uncertainty taking into account G-7 countries. Chapsa *et al.* (2009) use GARCH model to estimate the uncertainty of inflation and output growth. Then apply VAR model to test the relationship between these variables and conclude that growth leads to significantly Granger cause its uncertainty and the inflation rate.

However, Narayan *et al.* (2009) strongly support the Black (1987) hypothesis but find no evidence to support the Deveraux (1989) hypothesis. But Ozdemir (2010) finds that with the industrial development, macroeconomic performance has been upgraded as compared to the previous studies by using the UK data. Fountas (2010) finds no evidence in backing inflation to growth by considering 22 industrial countries. Chang and He (2010) find that the direct effect of inflation and output growth is insignificant but indirect effect is significant. Ayyoub, Chaudhry and Farooq (2011) apply simple OLS technique and conclude that high prices are the main cause of inflation in Pakistan which leads to decrease the overall growth of Pakistan economy.

The findings of Omay (2011) are parallel with the findings of Black (1987) hypothesis for low inflationary period but no effect in case of high inflation. Hasanov and Omay (2011) find that high output growth reduces macroeconomic uncertainty for the CEE countries. Mughal *et al.* (2012) find mixed results using four South East Asian countries (Indonesia, Thailand, Philippines and Malaysia) and no relationship in case of Thailand. Caglayan *et al.* (2012) try to investigate the impact of inflation uncertainty on overall growth of the economy by using MRS-IV approach. They find that inflation uncertainty has negative impact on output growth. Jha and Dang (2012) find negative influence of inflation on output growth for developing countries when inflation rise up to 10%. They also find no significant influence of inflation uncertainty on output growth. The findings of Narayan and Narayan (2013) support the Black (1987) hypothesis that is, output volatility increases growth and output uncertainty reduces inflation.

Overall, the previous theoretical and empirical studies explore the relationship between inflation, output growth and their uncertainties in different perspectives separately. Apergis (2004), Fountas (2010), Cakan (2012) and Bacilar and Ozdemir (2013) explore the relationship between inflation and its uncertainty in different parts of the world. Inflation also impact overall growth of the economy as pointed out by Friedman (1977), which is follow by further researches (Fountas,2001; Wilson, 2006; Fountas & Karanaos, 2007). Very few studies explore the relationship among inflation, output growth, and their uncertainties together (Fountas & Karanasos, 2007;

Ozdemir, 2010; Narayan, *et al.*, 2009; Narayan & Narayan, 2013). Hence, there is a lack of comprehensive study on cross relationship of these variables for developing countries specifically. This study simultaneously explores the dynamic relationship between inflation, inflation uncertainty, output growth and output growth uncertainty by using bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model.

Chapter 3
Macroeconomic Framework

This chapter presents a theoretical framework to understand the relationships among the inflation, output growth and their uncertainties.

3.1. Impact of Inflation on Inflation Uncertainty

Friedman (1977) proposes the hypothesis in which points out the definite factors disturbing the inflation. His hypothesis contains two parts. In first part, higher inflation leads to the higher inflation uncertainty and in second part, higher inflation leads to reduce the overall growth of the economy. This issue has been pointed out by Friedman (1977) has been further extended by many studies. Demetriades (1988) finds out that in the presence of lop-sided information between the public and the policy makers leads to have a positive correlation between inflation and its uncertainty but fails to find the causation direction between inflation and its uncertainty. Ball (1992) further elaborated the idea of Friedman (1977) and points out that there is misinformation between public and the policy makers in concern of future inflationary policy (monetary policy). He considered two types of policy makers: a weak type i.e., incapable to swallow the cost of inflation and a tough type i.e., able to swallow the cost of inflation. He concluded that high inflation uncertainty is the cause of high inflation, known as the Friedman-Ball Hypothesis. Lot of studies like Fountas (2010), Ozdemir (2010), Javed *et al.* (2010), Omay (2011), Baciliar and Ozdemir (2013), Naryan and Naryan (2013) and Chowdhury (2014) favor the Friedman (1977) hypothesis and conclude that higher inflation causes higher inflation uncertainty.

3.2. Impact of Inflation Uncertainty on Output Growth

Friedman (1977) also points out that higher inflation leads to reduce the overall growth of the economy. In economic theory, the relationship between inflation uncertainty and output growth is well developed both in terms of the sign and descriptions presented. Some of the theories particularly support the negative relationship between the uncertainty of inflation and output growth (Pindyck, 1991; Fountas *et al.*, 2004) and some find the positive sign (Abel, 1983; Dotsey & Sarte 2000; Blackburn & Pelloni, 2004). Pindyck (1991) and Huizinga (1993) conclude that output growth is also decreased by inflation uncertainty with the accumulative choice of suspending the irreversible investment; it clues to suspended investment projects. Fischer (1993) claims that uncertainty of inflation leads to decrease the output growth by concluding inflation uncertainty as an indicator of economic instability. Fountas (2001), Wilson (2006), Chapsa *et al.* (2009) and Caglayan *et al.* (2012) also favor the Friedman (1977) hypothesis.

3.3. Impact of Inflation Uncertainty on Inflation

Due to uncertainty of future inflation, the average rate of inflation is likely to be exaggerated by this uncertainty. Cukierman and Meltzer (1986) claims that uncertainty about future inflation is owed to the rate of money supply growth and the uncertainty about what the policy makers will do. They determine that higher inflation uncertainty increases mean inflation and known as the Cukierman-Meltzer (1986) hypothesis. Grier and Perry (2000) discover results parallel with the findings of the Cukierman-Meltzer (1986) hypothesis. Grier and Perry (2000) discover results parallel with the findings of the Cukierman-Meltzer (1986) hypothesis. Fountas (2010), Chang and He (2010), Salmanpour and Baholi (2011), Mughal *et al.* (2012), Cakan (2012) and Chowdhury (2014) supports the Cukierman- Meltzer (1986) hypothesis. Omay (2011) find mix evidence for the Cukierman-Meltzer (1986) hypotheis. Karanasos and Schurer (2008) and Naryan and Naryan(2013) fails to support the Cukierman-Meltzer (1986) hypothesis.

Holland (1995) establishes the importance of central bank in order to adopt strict monetary policy and also control higher inflation (the Holland's, 1995 hypothesis) and find negative relationship between inflation and its uncertainty. Karanasos and Schurer (2008) find that the Holland hypothesis hold for Sweden but for Germany and the Netherlands found no evidence supporting the Holland (1995) hypothesis. Narayan *et al.* (2009), Bhar and Malik (2012) and Balcilar and Ozdemir (2013) also support the outcomes of Holland (1995) hypothesis.

3.4. Impact of Output Growth Uncertainty on Output Growth

The impact of output growth uncertainty on output growth is also been covered in possible directions i.e., Mirman (1971) and Black (1987) concludes the positive relationship between both variables, Friedman (1968) concludes zero and Bernanke (1983) and Pindyck (1991) found negative relationship between the variables. Mirman (1971) concludes that higher output uncertainty increases output growth and this work is further cleared by Black (1987). He considers the node between output uncertainty growth and average growth rate. He also highlights the relationship between risk and return and claims that when any economy finance in a risky project leads to the higher economic growth. Dejuan and Gurr (2004), Fountas et al. (2006) and Naryan and Naryan (2013) support the positive relationship between the uncertainty of output growth and output growth. Whereas, Ramey and Ramey (1995) and Kneller and Young (2001) concludes the negative relationship and Dawson and Stephenson (1997) leads to have zero effect of both variables.

3.5. Impact of Output Growth Uncertainty on Inflation

Deveraux (1989) points out the impact of output growth uncertainty on inflation by announcing the wage indexation as exogenous variable in the model of Barro and Gordon (1983). He talks about the optimal inflation rate conveyed by the policy maker and the impact of exogenous rise in output growth uncertainty on the degree of wage indexation. He shows that optimal amount of wage indexation is being decreased by output growth uncertainty that indicates the policy makers to plan more inflation surprises in order to gain favorable effects. According to the above statement: first, output growth uncertainty have positive effect on inflation and second, output growth uncertainty leads to inflation uncertainty because of generating more shocks to inflation. Cukierman and Gerlach (2003) favor the predictions of Deveraux (1989).

Theoretically, output growth uncertainty may reduce the inflation rate. This is known as Taylor (1979) effect, if Cukierman-Meltzer (1986) hypothesis grips, the rate of inflation. Further, Black (1987) shows the negative relationship between output growth uncertainty and inflation. Grier and Perry (2000) fail to find any evidence to support the Deveraux (1989) hypothesis and support Black (1987). Fountas *et al.* (2002) fails to support the Black (1987) hypothesis i.e., output growth uncertainty have no impact on inflation. Naryan and Naryan (2013) support the Black (1987) hypothesis i.e., output growth uncertainty reduces inflation.

3.6. Impact of Output Growth on Inflation

Output growth may have some impact on inflation as discussed by many researchers. Briault (1995) argues that there is a positive relationship between output growth and inflation. Bruno and Easterly (1996) and Klump (2003) also support the positive relationship between output growth and inflation. Barro (1995) concludes the negative relationship between both output growth and inflation by taking into account the panel survey of 100 countries (30 years). Khan and Senhadji (2001) use the panel data of 140 developing and industrial countries. They conclude the negative effect of output growth on inflation. Malik and Chowdhury (2001) find the long run association between output growth and inflation of 4 South East Asian countries. They conclude that modest inflation is hazardous to growth and higher economic growth give back to inflation. Caporin and Di Maria (2002) empirically investigate the association between output growth and inflation and determine the negative association between both the variables.

3.7. Impact of Output Growth on Inflation Uncertainty

Pourgerami's and Maskus (1987) establish a negative relationship between output growth and the uncertainty of inflation. Brunner (1993) concludes that output growth decreased due to the uncertainty of policy response, it may also increase the inflation uncertainty. Ungar and Zilberfarb (1993) also concludes that output growth leads to decrease the uncertainty of inflation. Fountas *et al.* (2002) find no causality from output growth to the uncertainty of inflation for Japan. Fountas and Karanasos (2007) find partial support that outgrowth is affected by uncertainty of inflation by taking into account G-7 countries.

3.8. Impact of Output Growth on Output Growth Uncertainty

Theoretical background also examines the opposite connection i.e., impact of output growth on output growth uncertainty and sign of this connection is very unclear. By taking into account the negative impact, an increase of output growth clues to increase the inflation (short-run 'Phillips curve').which leads to increase inflation uncertainty as proposed by Friedman (1977). Taylor (1979) discusses the tradeoff between uncertainty of inflation and uncertainty of output growth that leads to decrease the output growth uncertainty. Macroeconomic theory summarizes the positive impact on uncertainty of output growth. Brunner (1993) finds that as output growth falls and in the response of monetary policy, unable to control the uncertainty of inflation. Again, use the Taylor (1979) effect and concludes that uncertainty of output growth falls. Fountas *et al.* (2002) found positive relationship between output growth and its uncertainty for Japan. Fountas and Karanasos (2006) find the negative relationship between output growth and its uncertainty for USA and Germany.

3.9. Impact of Inflation on Output Growth

The high inflation always leads to increase the prices, creating the uncertain situation of future investment projects. That may leads to decrease the output growth discussed by many researchers. Naqvi and Khan (1989) find the negative relationship between inflation and output growth by using data of Pakistan. They also conclude that Pakistan must take necessary measures to control the inflation up to single digit. Sarel (1995) concludes the positive relationship between inflation and output growth, if the rate of inflation is modest. If inflation rate increased, it leads to the negative relationship between inflation and output growth. Bruno and Easterly (1995) also find no sign of any steady relationship between inflation and output growth.

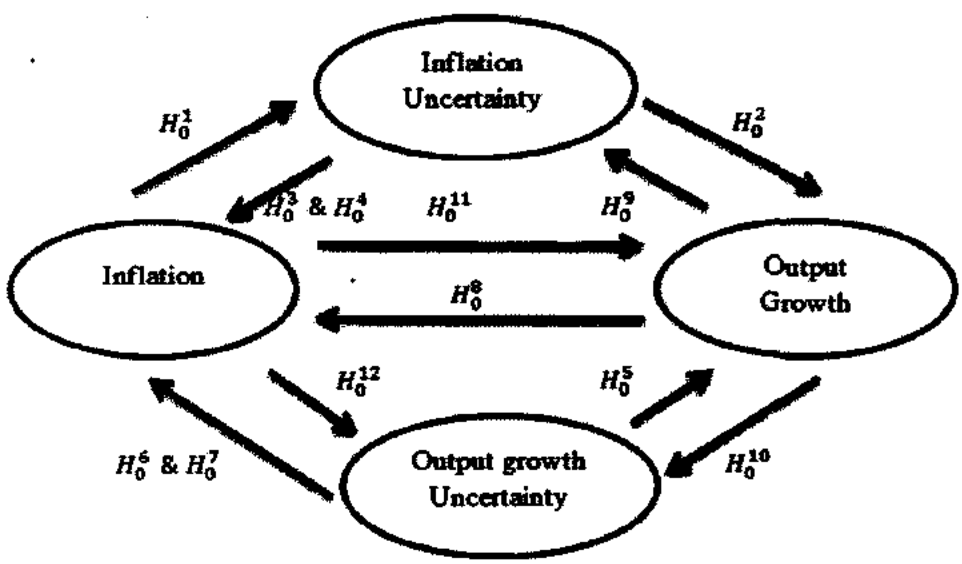
De Gregorio (1996) finds the negative relationship between inflation and output growth by taking into account some developing countries and OECD. He also concludes that growth is not only affected by the rate of inflation, it is also affected by level of investment. Dostey and sarte (2000) finds significant negative relationship between the inflation and output growth. By using different technologies and physical and human capital, Gillman and Kajak (2005) find the foremost negative effects of inflation on output growth. Ayyoub *et al.* (2011) finds that high prices are the main cause of inflation in Pakistan that leads to decrease the overall growth of the economy.

3.10. Impact of Inflation on Output Growth Uncertainty

Theoretically, the reverse relationship of impact of inflation on output growth uncertainty is very vague. The sign of such relationship is also very unclear. Inflation might possible to have negative impact on output growth uncertainty via the collaboration of Friedman (1977) hypothesis with Taylor (1979) effects. Therefore, Conrad and Karanasos (2008) conclude that high inflation directly affect the output growth, and indirectly affect the output growth uncertainty. However, Balaji (2014) find positive significant effect of inflation on output growth uncertainty by using Granger causality test for India. He divides the data into whole and sub-period ranging from 1980-01 to 2011-04.

The dynamic relationship among inflation, output growth and their uncertainties are shown through the Figure 3.1.

Figure 3.1. The Dynamic Relationship among Inflation, Output Growth and their Uncertainties



On the basis of hypotheses and previous studies, we are in better position to understand the ambiguous relationship of variables, that is, inflation, output growth and their uncertainties. Some empirical studies show the negative relationships between or among the above mentioned variables, whereas the other finds out the positive relationships. These differences may be due to the variations across the countries and data sets. In this research study, the above mentioned causality relations between inflation, output growth and their uncertainties are examined all together by using bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model.

returns. Autoregressive Moving Average (ARMA) model is used to identify the conditional mean equation. In this study, inflation and output growth series is approximated by ARMA (p,q) as:

$$X_t = c + \sum_{i=1}^{p} \delta_i X_{t-i} + \sum_{j=1}^{q} \varphi_j \varepsilon_{t-j} + \varepsilon_t \quad (4.1)$$

Equation (4.1) is the mean equation, where X_t shows inflation and output growth at time *t-i* and *t* respectively and ε_t is residual.

4.1.2 Conditional Variance Specifications

4.1.2.1 Univariate GARCH (1,1) models

The Generalized Autoregressive Conditional heteroskedasticity (GARCH) model are proposed by Bollerslev (1986). The GARCH Models consider the conditional variances to depend not only on the past squared error terms but also on their past conditional variances.

GARCH (1, 1)

The most widely used model in practice is GARCH (1, 1) containing three parameters for conditional variance equation. The model is very parsimonious and shown to be adequate to capture the volatility clustering in data without the requirement of higher order models (Brooks, 2002). As GARCH (1,1) is found to be the most appropriate of the symmetric GARCH models for return data, this model is employed in this research study to find the conditional variances if inflation and output growth.

$$\sigma_{Xt}^2 = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{X(t-1)}^2 \quad (4.2)$$

Equation (4.2) is conditional variance equation, where σ_{Xt}^2 shows conditional variances of inflation rate and output growth respectively, ε_{t-1}^2 is past shocks (ARCH term) and $\sigma_{X(t-1)}^2$ is past variance (GARCH term). For the positivity of conditional variance $\omega_0 > 0$, $\alpha_1 \geq 0$ and $\beta_1 \geq 0$.). First, for the existence of the second moment of ε_t , the necessary and sufficient condition is $\alpha_1 + \beta_1 < 1$ required for stationarity and unconditional variance, $Var(\varepsilon_t) = E(\varepsilon^2_t) = E(h_t) = \omega_0 /(1-\alpha_1 - \beta_1)$. Second, for the existence of the fourth moment of ε_t, the necessary and sufficient condition is $3\alpha_1^2 + 2\alpha_1\beta_1 + \beta_1^2 < 1$ and a kurtosis value greater than 3.

GARCH-M (1, 1)

Engle, Lilien and Robins (1987) have extended the GARCH model to GARCH-M model, agrees the conditional mean be a function of conditional variance so that the conditional volatility can generate uncertainties being part of the specified model.

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

$$X_t = c + \sum_{i=1}^{p} \delta_i X_{t-i} + \sum_{j=1}^{q} \varphi_j \varepsilon_{t-j} + \lambda\sigma_{Xt}^2 + \varepsilon_t \qquad (4.3)$$

$$\sigma_{Xt}^2 = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{X(t-1)}^2 \qquad (4.4)$$

Equation (4.3) describes the mean equation, where X_t shows inflation and output growth at time t-i and t respectively, $\lambda\sigma_{Xt}^2$ shows conditional variances of inflation and output growth and ε_t is residual. Equation (4.4) describes the conditional variances of inflation and output growth.

EGARCH (1, 1)

The Exponential GARCH model proposed by Nelson (1991) incorporates skewness or asymmetric effects. EGARCH model overwhelms two foremost drawbacks of symmetric GARCH model. This model is specified to capture the leverage effect and abolish the non- negativity constraint.

In EGARCH (1, 1) model, the conditional variance equation is specified as follows:

$$ln\sigma^2_{Xt} = \omega_0 + \alpha_1 \left[\theta_1 \frac{\varepsilon_{t-1}}{\sqrt{\sqrt{\sigma^2_{Xt-1}}}} + \theta_2 \left\{ \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma^2_{Xt-1}}} - E\left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma^2_{Xt-1}}}\right) \right\} \right] + \beta_1\, ln\sigma^2_{X(t-1)} \quad (4.5)$$

Equation (4.5) specifies conditional variance in logarithmic form which guaranteed to be positive regardless of the values of the coefficients. The θ_1 reflects the sign effect and θ_2 reflects the magnitude effect. If the asymmetry effect is present, then $\theta_1 < 0$, while there is no asymmetry effect, if $\theta_1 = 0$. When $\theta_1 < 0$, positive shock increases volatility less than negative shock. When $\theta_1 > 0$, negative shock increases volatility less than positive shock.

GJR-GARCH (1, 1)

The GJR- GARCH model proposed by Glosten, Jagannathan and Runkle (1993) incorporates asymmetric effects. The GJR-GARCH model considers positive shocks and negative shocks and both have different effect on uncertainties.

The GJR-GARCH (p,q) model is specified as

$$\sigma^2_{Xt} = \omega_0 + \sum_{i=1}^{q}(\alpha_i \varepsilon^2_{t-i} + \gamma_i \varepsilon^2_{t-i} S_{t-i}) + \sum_{j=1}^{p} \beta_1\, \sigma^2{}_{X(t-1)} \quad (4.6)$$

Equation (4.6) specifies S_t (dummy variable) = 1 if $\gamma_i < 0$, and 0 if $\gamma_i > 0$, in the model, good news ($\varepsilon_{t-1} > 0$), and bad news ($\varepsilon_{t-1} < 0$), acts differentially on the conditional variance. If $\gamma_i > 0$, bad news increases volatility (uncertainties) and leverage effect exists. The news impact is symmetric if $\gamma_i = 0$, i.e. past bad news (negative shocks) impacts similarly on current volatility as good news (positive shocks). For the existence of the second moment, the regularity condition is $(\alpha_1 + \beta_1 + \gamma_1) / 2 < 1$.

4.1.2.2 Multivariate GARCH (1, 1) Models

The most obvious application of Multivariate GARCH (MGARCH) models is the study of relations between the volatilities and co-volatilities of different variables. The generalization of univariate GARCH models to the multivariate case is straightforward as presented by Bollerslev, Engle and Wooldridge (1988). However, some drawbacks of multivariate extension are the large number of parameters to estimate the difficulties to obtain a stationary covariance process, and the problems to get a positive -definite variance-covariance matrix. Many of these problems are circumvented by the BEKK model (Baba, Engle, Kraft and Kroner) proposed by Engle and Kroner (1995). This study employs the BEKK model to capture the any co-movement relationship that exists between the inflation and output growth. The BEKK model for the multivariate GARCH (1, 1) is as follows:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + B'H_{t-1}B \qquad (4.7)$$

with

H_t= positive definite of conditional covariance matrix

C= parameter n x n matrix

A= parameter n x n matrix

B= parameter n x n matrix

ε_t= error terms matrix

In eq. (4.7), matrix A captures the effect of shocks or unanticipated events on conditional variances, whereas matrix B shows how current levels of conditional variances are affected by past conditional variances.

Bi-variate diag-BEKK GARCH (1, 1) Model

The general form of bi-variate diag-BEKK GARCH (1, 1) is as follows:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + B'H_{t-1}B \tag{4.8}$$

with

$$C = \begin{bmatrix} c_{\pi\pi} & c_{\pi y} \\ c_{\pi y} & c_{yy} \end{bmatrix}, A = \begin{bmatrix} a_{\pi\pi} & a_{\pi y} \\ a_{\pi y} & a_{yy} \end{bmatrix}, \text{ and } B = \begin{bmatrix} b_{\pi\pi} & b_{\pi y} \\ b_{\pi y} & b_{yy} \end{bmatrix}$$

The bi-variate diag-BEKK GARCH (1, 1) model represented in the equ. (4.8) is unique if all diagonal elements of the C matrix are positive and $a_{\pi\pi}, b_{\pi\pi}>0$. For the stationary condition, Engle and Korner (1995) show that the diagonal BEKK model is covariance stationary if and only if $(a_{\pi\pi})^2 + (b_{\pi\pi})^2 < 1$.

In order to assess the association between inflation and its uncertainty together with the connection between output growth and its uncertainty, bi-variate ARMA(p,q) diag-BEKK GARCH-M (1,1) models of inflation and output growth are specified. The bi-variate framework of model dictates to specify whole covariance matrices which change over time.

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

To estimate the connection among inflation, output growth and their uncertainties, bi-variate diag-BEKK GARCH-M (1, 1) model of inflation and output growth is used. This model allows the conditional mean be a function of conditional variance so that the conditional volatility can generate uncertainties being part of the specified model.

preliminarily procedure is made with the help of over-fitting tests on the residuals and the AIC (Akaike Information Criteria), SC (Schwartz Criteria). However, further investigation of the adequate number of lags is applied as volatility models are based on modeling simultaneously the conditional mean and the conditional variance.

4.1.5 Estimation of GARCH Models

The maximum-likelihood estimation is employed in the estimation of GARCH models. Under this approach, a set of parameters is chosen that have most likely generated observed data, using an iterative computer algorithm. The estimates that maximize the conditional log-likelihood are called the maximum likelihood (ML) estimates. The ML estimates are consistent and asymptotically normally distributed provided the conditional mean and variance functions of the GARCH model are correctly specified. The Broyden–Fletcher–Goldfarb-Shanno (Fletcher, 1987) numerical optimization algorithm is used to obtain the ML estimates of the parameters. For the estimation of Bi-variate GARCH models, Diag- BEKK model condition for inflation and output growth is used.

4.1.6 Diagnostic Testing

In the ARCH- type model, there are number of different possible outcomes. To select the best fit model, must start with the possible simple model to end with advance by checking the properties through different diagnostic tests. In this study, GARCH (1,1), EGARCH(1,1) and GJR-GARCH(1,1) is used with normal and student's t-distribution to find the conditional variances of inflation and output growth. Also employ the ARMA (p,q) model simultaneously with the GARCH(1,1) models for mean equation with the variance equation. The best fit GARCH model is based on the diagnostic testing, exhibiting the all dynamic aspect of mean and variance equation.

Theoretically, standardized residual series must have zero mean and unit variance. The value of co-efficient of skewness and excess kurtosis is close to zero for a specified GARCH model. Jarque-Bera (JB) is used to test the normality of the residual series under the assumption of null hypothesis that both Co-efficient of skewness and kurtosis is close to zero. JB is significant at 5% level of significance, if its critical value is greater than 5.99. Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC), Shibata Criterion, Hannan-Quin Criterion and log likelihood is used to test the properties of best fit model. To check the absence of autocorrelation, Ljung-Box pierce Q-statistics and Ljung-Box pierce Q^2 -statistics is used under the null hypothesis that there is no autocorrelation. Q^2 -statistics must be insignificant in order to reject the null hypothesis i.e., autocorrelation is still present in the residual series. To check the presence or absence of heteroskedasticity in the data, we use Residual Based Diagnostic (RBD) testing with the null hypothesis that there is heteroskedasticity in the series. To check the ARCH effect, again use the LM ARCH test with the null hypothesis that there is ARCH effect in the series. After full filling the above diagnostic properties, the best model is used.

4.2 Data and Preliminary Findings

Description of data, sources and descriptive statistics for investigating the nature and characteristics of data set are presented below:

4.2.1 Data Description and Sources

In this study, we use monthly data of developing countries which are listed in General Assembly resolution, 2013. Monthly data of 27 developing countries are selected for empirical testing. From 27 countries, only 12 countries having ARCH effects are selected for further empirical testing. The data is obtained from

For Inflation:

$$\pi_t = ln\left(\frac{x_t}{x_{t-1}}\right) = ln(x_t) - ln(x_{t-1}) \quad (4.14)$$

Where; π_t = Inflation and x_t = Consumer Price Index (CPI)

For Output Growth:

$$Y_t = ln\left(\frac{z_t}{z_{t-1}}\right) = ln(z_t) - ln(z_{t-1}) \quad (4.15)$$

Where; Y_t = Output Growth and z_t = Manufacturing Production/ Industrial Production

Because uncertainties of Inflation and output growth cannot be directly observable, therefore monthly squared returns series are used as proxies of realized uncertainties.

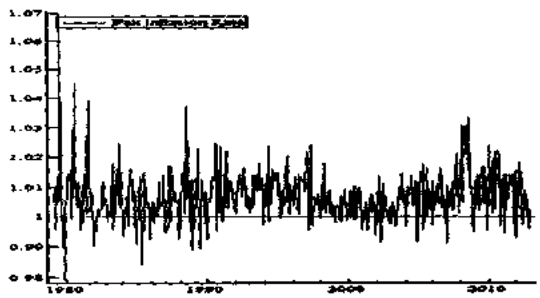
4.2.2 Graphical Analysis

The plots of the monthly inflation (inf) and output growth series (ip) are shown below in Figure 4.1 for 4 countries named: Pakistan, India, South Africa and Nigeria. Remaining 8 countries graphical analysis is shown in the appendix named Figure-A 4.1. It indicates no definite patterns for both inflation and output growth; also they revert quickly to their means. It also reveals that the variances change over time and volatility tends to cluster. High volatility periods can be distinguished from low volatility periods. It also shows the presence of ARCH effect in the both series, that is, inflation and output growth.

Figure 4.1. Return Series of Inflation and Output Growth:

The return series of both Inflation and Output Growth show no definite patterns, indicating mean reverting and volatility clustering stylized facts in the graphs.

Pakistan



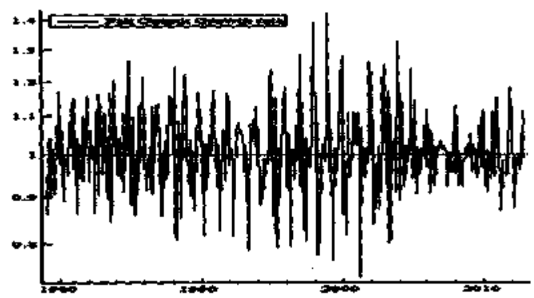
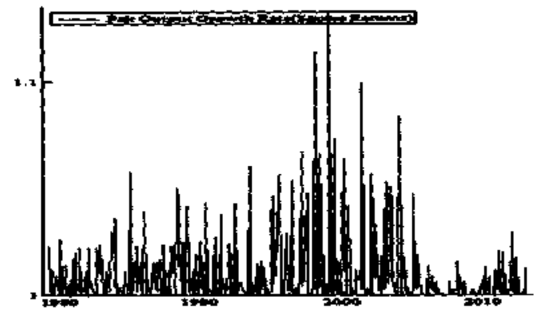


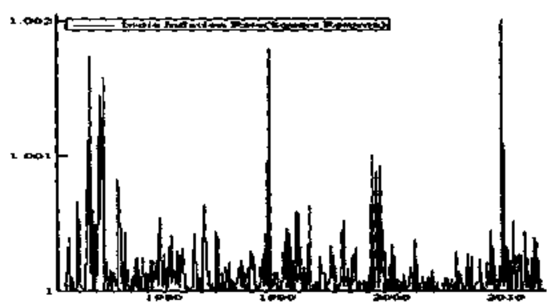
Figure 4.2. Squared Return Series of Inflation and Output Growth:

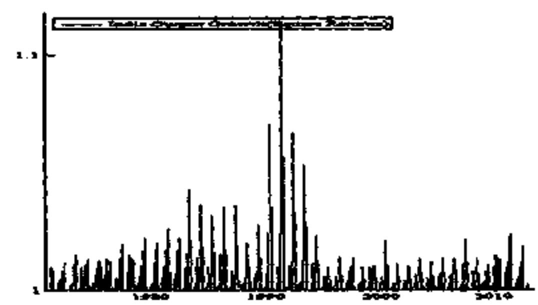
The Monthly squared Inflation and Output Growth Returns series showing variation in uncertainties more clearly with high and low volatility.

Pakistan

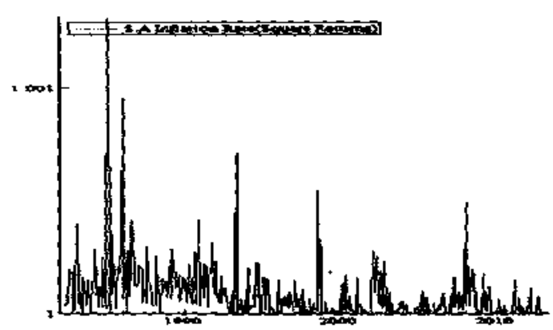


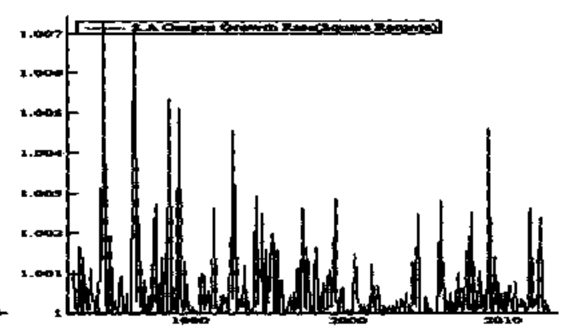
India



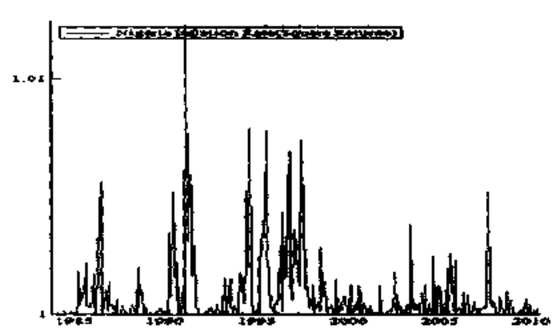


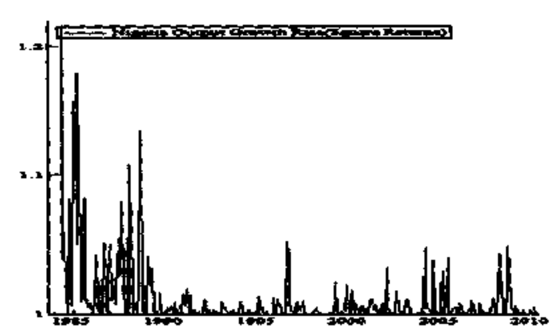
South Africa





Nigeria



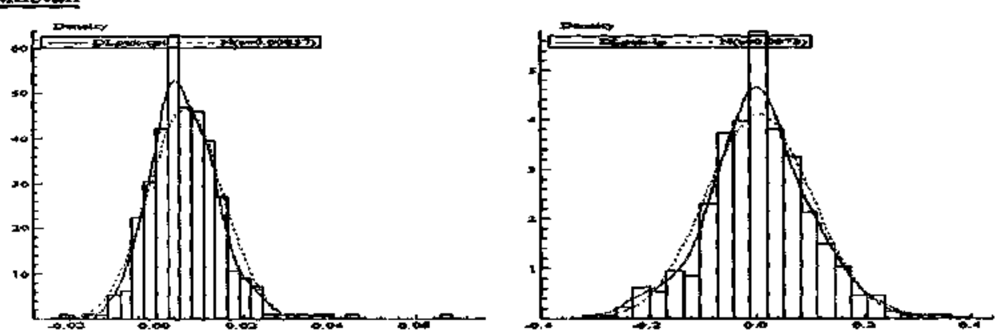


Histograms of inflation and output growth return series show more clearly some properties of data. The figure 4.3., histogram plots of inflation and output growth returns which exhibit non- normal distribution having fat tails, and high peakedness (in appendix with named Figure-A 4.3.). Mean and Median are not significantly dissimilar from zero for both series (inflation and output growth), indicating increasing trend overtime.

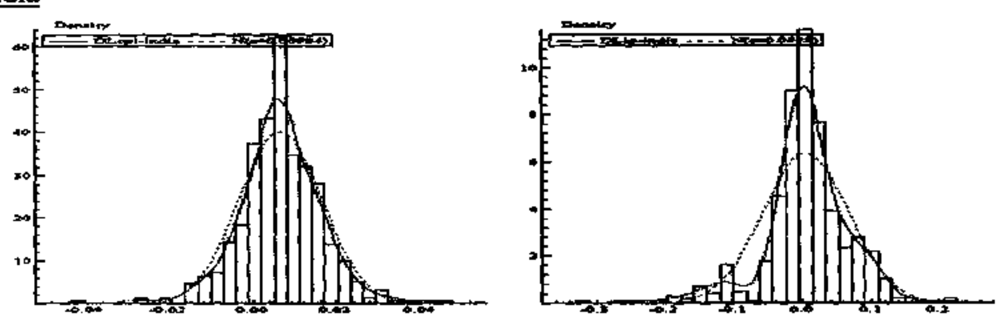
Figure 4.3. Histogram of Inflation and Output Growth Return Series

The Monthly Inflation and Output Growth Returns Distribution exhibiting the features of skewness, and leptokurtosis. Dotted line shows the series of normal distribution and non-normal distribution is shown by solid lines. Non-normal distribution is more peaked than normal distribution.

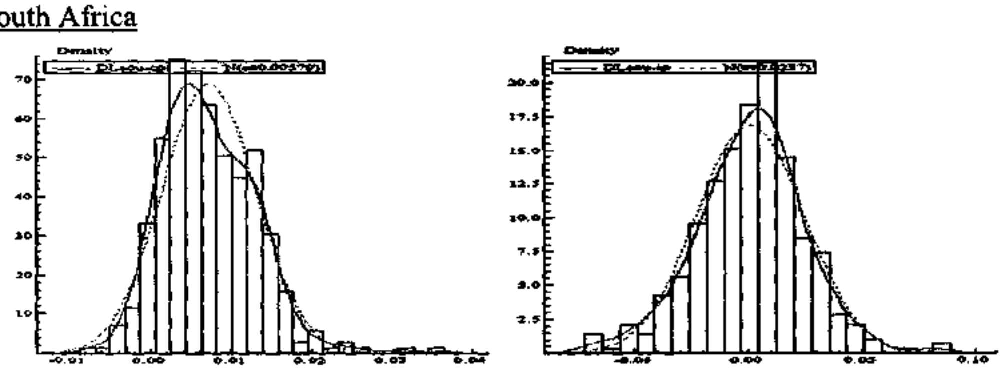
Pakistan



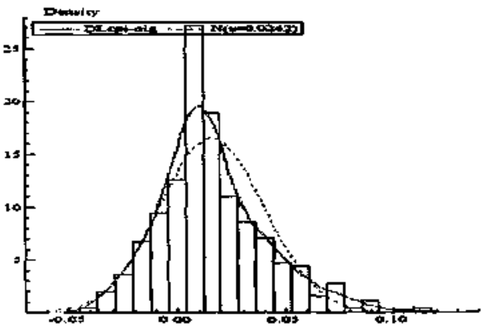
India

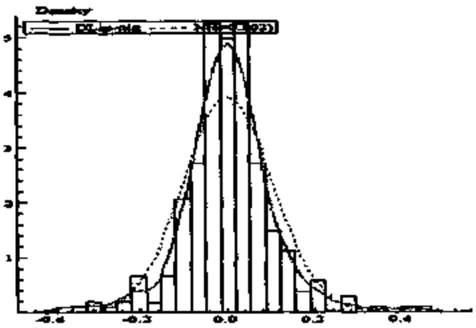


South Africa



Nigeria





4.2.3 Descriptive Statistics

The descriptive statistics of data show some indications about Inflation and Output growth of developing countries for further empirical analysis. The distribution of both variables exhibits the features of skewness, leptokurtosis and uncertainty.

The descriptive statistics for the monthly inflation and output growth return series of 12 developing countries are empirically tested. The mean of both inflation and output growth series are positive as well as negative for different countries. The minimum and maximum values are also given in the table. Total number of observations and standard deviation is also given in the table. The value of standard deviation is basically presenting that how much the value is deviated from its center. If the standard deviation is almost close to zero, it means values are not very much deviated from its center. All these values are shown in the Table 4.2(a).

Table 4.2(a) Descriptive Statistics

	Mean	Max.	Min.	Std. Dev.	Obs.
Pak-Inf	0.006702	0.036368	-0.015585	0.0076042	368
Pak-Ip	0.004658	0.35336	-0.30762	0.099134	368
India-Inf	0.006490	0.044774	-0.042302	0.009935	503
India-Ip	0.004879	0.21476	-0.32879	0.062842	503
SA-Inf	0.007262	0.0362	-0.007390	0.005789	368
SA-Ip	0.001032	0.085139	-0.071208	0.023668	368
Nigeria-Inf	0.01594	0.11063	-0.037504	0.024227	312
Nigeria-Ip	0.002824	0.44181	-0.38044	0.10173	312
Indo-Inf	0.007640	0.12013	-0.010505	0.012327	368
Indo-Ip	-0.001248	0.25028	-0.28503	0.06528	368
Mex-Inf	0.018171	0.14397	-0.007363	0.023226	368
Mex-Ip	0.001722	0.11306	-0.10584	0.041455	368
Alg-Inf	0.007523	0.10784	-0.051145	0.021068	368
Alg-Ip	0.001725	0.35717	-0.63051	0.07246	368
Euc-Inf	0.019654	0.14126	-0.21734	0.04003	368
Euc-Ip	0.002593	0.75138	-0.81093	0.09283	368
Boliv-Inf	0.02006	1.0217	-2.3026	0.15812	368
Boliv-Ip	0.001620	0.21464	-0.3279	0.063663	368
Bra-Inf	0.027688	0.69315	-2.3026	0.17266	263
Bra-Ip	0.002026	0.06613	-0.12998	0.021743	263
Iran-Inf	0.01464	0.069796	-0.030064	0.013912	284
Iran-Ip	-0.000235	0.89813	-0.89571	0.091608	284
Malawi-Inf	0.016174	0.13424	-0.092521	0.031659	308
Malawi-Ip	0.001725	0.56343	-0.48356	0.1218	308

Note: Inf- denotes inflation and Ip- denotes industrial production/ manufacturing production

Skewness is the nonexistence of symmetry in a distribution round specific central value (mean, median or mode). When distributions depart from symmetry and have positive value than it is known as positive skewness. If exhibits negative value than it is known as negative skewness. In case of Pakistan, both inflation and output growth are positive means that both have positive trends. In case of India, both are negative presenting negative trends. In case of Indonesia, inflation is positively skewed and output growth is negatively skewed. The value of skewness, Excess Kurtosis, Jarque-Bera and its p-value are given in the Table 4.2(b).

Table 4.2(b) Descriptive Statistics

	Skewness	Excess Kurtosis	J-B Stats	P-Values of J-B stats
Pak-Inf	0.48819	0.85265	25.765	2.5418e-006
Pak-Ip	0.063900	0.80503	10.188	0.0061347
India-Inf	-0.12051	2.3421	116.18	5.8994e-026
India-Ip	-0.89038	3.5356	328.45	4.7636e-072
SA-Inf	0.79140	1.9047	94.044	3.7895e-021
SA-Ip	-0.051709	0.88251	12.106	0.0023510
Nigeria-Inf	0.71138	0.87305	36.224	1.3618e-008
Nigeria-Ip	0.12899	3.2381	137.18	1.6315e-030
Mex-Inf	2.1318	5.1473	684.99	1.8034e-149
Mex-Ip	0.40074	-0.020590	9.8560	0.0072409
Alg-Inf	0.55708	1.8394	70.914	3.9931e-016
Alg-Ip	-1.6425	17.449	4833.8	0.00000
Euc-Inf	-1.6200	7.5764	1041.1	8.3367e-227
Euc-Ip	-0.38831	30.752	14510.	0.00000
Boliv-Inf	-7.0229	130.82	26544.	0.00000
Boliv-Ip	-0.41558	2.7335	125.16	6.6313e-028
Bra-Inf	-8.7393	124.66	17365.	0.00000
Bra-Ip	-1.5422	8.8203	956.79	1.7206e-208
Iran-Inf	0.88676	2.5428	113.73	2.0132e-025
Iran-Ip	0.033432	62.001	45489.	0.00000
Malawi-Inf	0.36599	1.2118	25.721	2.5992e-006
Malawi-Ip	0.31821	3.1612	133.45	1.0535e-029

Note: Inf- denotes inflation and Ip- denotes industrial production/ manufacturing production

Kurtosis is the degree of peakedness of a distribution usually taken relative to a normal distribution. Excess kurtosis value is equal to zero, if its value is positive it means leptokurtic distribution and if its value is negative it means platykurtic distribution. If the value is equal to zero, it means the distribution is mesokurtic. The excess kurtosis is significant and positive (except the value of Mexico-ip) for both inflation and output growth returns which indicate that both returns are heavy tailed and have leptokurtic distribution.

The Jarque-Bera (JB) statistic is basically a goodness-of-fit test based on the sample skewness and sample kurtosis. This test is also used to check the normality of a distribution and to indicate the characteristics of the distribution of inflation and output growth return series. The null hypothesis under consideration for JB is that both inflation rate returns and output growth rate returns series are normally distributed via alternative hypothesis that both series are non-normal. If JB critical value is greater than 5.99, it means statistically significant at 5% significance level.

4.2.4 Unit Root Tests

To test the stationarity of time series in this study, Kwiatkowski-Phillips-Schmidt-Shin (KPSS; 1992) test is used. KPSS statistic tests the null hypothesis (H_0) that series is stationary and alternative hypothesis (H_1) as series is non-stationary. On the other hand, Augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) test the null hypothesis (H_0) series is non-stationary and alternative hypothesis (H_1) as series is stationary. The KPSS (1992) test is used with constant and trend terms. KPSS test is the most recent and appropriate test and this test have some advantages over ADF and PP test. ADF test do not work, if data is small and PP test also only works, if data is large. Whereas, KPSS works in both conditions, that is, either data is small or large. This test also works for structural breaks. The results in Table 4.3 show non-stationarity of all the variables in level form and stationarity of all the variables in first difference form.

Table 4.3 Unit Root Tests

Variables	KPSS test statistic					
	Level			First Difference		
	With Constant	With Constant and Trend	Results	With Constant	With Constant and Trend	Results
Pak-Inf	13.4781***	0.766226**	Non-Stationary	0.275902***	0.190788*	Stationary
Pak-Ip	12.5617***	0.517952*	Non-Stationary	0.00713298***	0.006066***	Stationary
India-Inf	16.8115***	1.89462***	Non-Stationary	0.122217***	0.0630655***	Stationary
India-Ip	16.7983***	1.23829***	Non-Stationary	0.0147188***	0.0069205***	Stationary
SA-Inf	11.7902***	2.91033***	Non-Stationary	0.706939*	0.199044*	Stationary
SA-Ip	11.1399***	0.887672*	Non-Stationary	0.0497337***	0.0311652***	Stationary

Nigeria-Inf	10.3717***	1.66759***	Non-Stationary	0.649863*	0.215407*	Stationary
Nigeria-Ip	7.8125***	0.615608*	Non-Stationary	0.0495854***	0.010695***	Stationary
Indo-Inf	12.4019***	1.15322***	Non-Stationary	0.233548**	0.19192*	Stationary
Indo-Ip	9.0055***	2.60441***	Non-Stationary	0.105368***	0.017868***	Stationary
Mex-Inf	10.2296***	2.58939***	Non-Stationary	0.713862*	0.204702*	Stationary
Mex-Ip	11.8795***	1.12134***	Non-Stationary	0.0295359***	0.029465***	Stationary
Alg-Inf	11.4738***	2.75344***	Non-Stationary	0.581825*	0.204142*	Stationary
Alg-Ip	10.3714***	0.770116*	Non-Stationary	0.0214075***	0.021609***	Stationary
Euc-Inf	11.9691***	2.69783***	Non-Stationary	0.715983*	0.166444*	Stationary
Euc-Ip	10.8089***	0.153182*	Non-Stationary	0.0153318***	0.009410***	Stationary
Boliv-Inf	8.27194***	1.10276***	Non-Stationary	0.554861*	0.208636*	Stationary
Boliv-Ip	8.81445***	0.89193*	Non-Stationary	0.0422018***	0.0349495***	Stationary
Bra-Inf	4.4885***	1.26834***	Non-Stationary	0.675963*	0.151107*	Stationary
Bra-Ip	8.38491***	0.193007 *	Non-Stationary	0.0363525***	0.019942***	Stationary
Iran-Inf	9.33511***	1.89757***	Non-Stationary	0.26483***	0.117137**	Stationary
Iran-Ip	1.00950***	0.939612*	Non-Stationary	0.0898113***	0.0127624***	Stationary
Malawi-Inf	10.4159***	1.03567***	Non-Stationary	0.184242***	0.180927*	Stationary
Malawi-Ip	0.749034*	0.717548*	Non-Stationary	0.015343***	0.0095459***	Stationary
Critical Values (KPSS)						
	1%	**5%**	**10%**			
No Trend	0.739	0.463	0.347			
With Trend	0.216	0.146	0.119			

Note: Level represents the Lag value of Monthly Consumer Price Index and Industrial Production/Manufacturing Production and First Difference represents the difference operator of both considered variables. *** shows Stationary/Non-Stationary at 1% level of significance, ** at shows Stationary/Non-Stationary at 5% level of significance and * shows Stationary/Non-Stationary at 1% level of significance, at level and 1st difference with trend and without trend.

4.2.5 Test for ARCH Effects

In order to test conditional heteroskedasticity, there are two appropriate tests to apply. Tsay (2005) proposed these tests, one is Lagrange Multiplier test and the second is Ljung-Box-Peirce to check the correlation and volatility of data. In this study, both tests are employed on inflation and output growth return series with specified time limit of different countries to test the presence of conditional heteroskedasticity. Ljung-Box–Pierce Q- statistics are carried out to detect the presence of high-order serial correlation where the null hypothesis is no serial correlation in the residuals up to the specified order. The Q^2 statistics are carried out for testing the volatility clustering, where the null hypothesis is no serial correlation in the squared residuals up to the specified order. Furthermore the ARCH LM test is also employed for the existence of ARCH effect. The F-test is carried out for testing the ARCH effect where null hypothesis is no ARCH effects in square residuals.

The Table 4.4. represents the Ljung-Box–Pierce Q-statistics and Q^2-statistics of inflation and output growth return series and ARCH LM test. The Ljung-Box–Pierce Q-statistics are calculated for lags 5, 10, 15 and 20 which are highly significant, showing there is no serial correlation in residuals and square residuals. Q^2-statistics shows evidence of ARCH effect. For inflation rate and output growth rate series, the statistics are calculated for lags up to 20 months and only those lags are presented in the Table 4.4 which are highly significant i.e., 5, 10, 15 and 20. Mostly values are highly significant till 20 lags. The LM test shows solid confirmation that an ARCH effect is present in the squared residuals. These results also support the valuation of a conditional heteroskedasticity model for both inflation and output growth return series for 12 developing countries.

Table 4.4 ARCH Test

	Q-Statistics on Raw data				Q-Statistics on Squared data				ARCH LM test (F-Statistics)		
Lags	5	10	15	20	5	10	15	20	ARCH1-2	ARCH1-5	ARCH1-10
Pak-Inf	35.4528 [0.0000012]**	46.5227 [0.0000012]**	97.7371 [0.0000000]**	268.389 [0.0000000]**	86.6129 [0.0000000]**	96.3921 [0.0000000]**	108.322 [0.0000000]**	185.418 [0.0000000]**	17.017 [0.0000]**	12.682 [0.0000]**	6.9216 [0.0000]**
Pak-IP	57.7664 [0.0000000]**	132.759 [0.0000000]**	444.015 [0.0000000]**	1064.59 [0.0000000]**	15.7810 [0.0074978]**	32.2272 [0.0003670]**	196.880 [0.0000000]**	495.220 [0.0000000]**	2.8060 [0.0618]	3.0829 [0.0097]**	3.2353 [0.0005]**
India-Inf	173.144 [0.0000000]**	223.833 [0.0000000]**	525.962 [0.0000000]**	1058.16 [0.0000000]**	105.904 [0.0000000]**	121.301 [0.0000000]**	175.826 [0.0000000]**	205.514 [0.0000000]**	33.825 [0.0000]**	14.895 [0.0000]**	8.8382 [0.0000]**
India-IP	125.524 [0.0000000]**	153.883 [0.0000000]**	689.371 [0.0000000]**	2095.62 [0.0000000]**	55.9936 [0.0000000]**	85.3325 [0.0000000]**	536.237 [0.0000000]**	1300.53 [0.0000000]**	33.610 [0.0000]**	16.420 [0.0000]**	10.908 [0.0000]**
SA-Inf	178.934 [0.0000000]**	330.910 [0.0000000]**	547.967 [0.0000000]**	1003.59 [0.0000000]**	58.2316 [0.0000000]**	129.732 [0.0000000]**	241.643 [0.0000000]**	390.222 [0.0000000]**	16.805 [0.0000]**	8.2496 [0.0000]**	6.9250 [0.0000]**
SA-IP	87.9651 [0.0000000]**	115.764 [0.0000000]**	159.837 [0.0000000]**	310.171 [0.0000000]**	27.7950 [0.0000399]**	31.7790 [0.0004358]**	37.8284 [0.0092929]**	89.9591 [0.0004538]**	15.144 [0.0000]**	6.7201 [0.0000]**	3.6940 [0.0001]**
Nigeria-Inf	147.876 [0.0000000]**	175.136 [0.0000000]**	286.713 [0.0000000]**	450.106 [0.0000000]**	117.440 [0.0000000]**	138.181 [0.0000000]**	188.397 [0.0000000]**	258.708 [0.0000000]**	38.729 [0.0000]**	16.639 [0.0000]**	10.577 [0.0000]**
Nigeria-IP	33.0149 [0.0000037]**	44.2022 [0.0000030]**	90.8523 [0.0000000]**	210.457 [0.0000000]**	126.201 [0.0000000]**	208.645 [0.0000000]**	239.120 [0.0000000]**	351.219 [0.0000000]**	42.153 [0.0000]**	20.931 [0.0000]**	12.646 [0.0000]**
Mex-Inf	1083.53 [0.0000000]**	1780.23 [0.0000000]**	2691.28 [0.0000000]**	4237.16 [0.0000000]**	563.734 [0.0000000]**	814.289 [0.0000000]**	1067.18 [0.0000000]**	1362.58 [0.0000000]**	226.08 [0.0000]**	98.716 [0.0000]**	62.317 [0.0000]**
Mex-IP	175.695 [0.0000000]**	248.447 [0.0000000]**	645.742 [0.0000000]**	1454.38 [0.0000000]**	37.1181 [0.0000006]**	44.0128 [0.0000033]**	148.959 [0.0000000]**	336.820 [0.0000000]**	16.030 [0.0000]**	7.7853 [0.0000]**	4.3007 [0.0000]**
ALg-Inf	14.2467 [0.0141160]*	33.6820 [0.0002091]**	163.079 [0.0000000]**	359.285 [0.0000000]**	18.0801 [0.0028477]**	54.4987 [0.0000000]**	127.225 [0.0000000]**	296.273 [0.0000000]**	3.5427 [0.0299]*	3.1619 [0.0083]**	3.5398 [0.0002]**
ALg-IP	76.9449 [0.0000000]**	99.3017 [0.0000000]**	291.779 [0.0000000]**	805.156 [0.0000000]**	42.8640 [0.0000000]**	43.0773 [0.0000048]**	45.7742 [0.0008656]**	53.9585 [0.3255748]	20.046 [0.0000]**	8.4981 [0.0000]**	4.4332 [0.0000]**
Euc-Inf	48.4308 [0.0000000]**	58.3804 [0.0000000]**	84.2247 [0.0000000]**	152.832 [0.0000000]**	30.7538 [0.0000105]**	34.1738 [0.0001726]**	38.9197 [0.0068224]**	92.1070 [0.0002670]**	6.9769 [0.0011]**	4.3601 [0.0007]**	2.4379 [0.0081]**
Euc-IP	20.9188 [0.0008392]**	28.9116 [0.0012878]**	56.3280 [0.0000259]**	146.796 [0.0000000]**	164.980 [0.0000000]**	165.187 [0.0000000]**	165.892 [0.0000000]**	197.271 [0.0000000]**	73.725 [0.0000]**	35.374 [0.0000]**	18.346 [0.0000]**
Boliv-Inf	74.6950 [0.0000000]**	89.6418 [0.0000000]**	125.896 [0.0000000]**	142.871 [0.0000000]**	89.8019 [0.0000000]**	91.2951 [0.0000000]**	94.6919 [0.0000000]**	96.4093 [0.0000892]**	86.833 [0.0000]**	47.320 [0.0000]**	27.802 [0.0000]**
Boliv-IP	62.2589	124.983	270.475	553.138	15.5525	17.7524	24.1606	82.9637	6.2320	3.5452	2.0524

	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0082450]**	[0.0592859]	[0.2354481]	[0.0023379]**	[0.0022]**	[0.0038]**	[0.0277]*
Bra-Inf	67.2092 [0.0000000]**	86.9717 [0.0000000]**	98.9178 [0.0000000]**	125.798 [0.0000000]**	0.00886583 [0.9999996]	2.69436 [0.9877308]	3.08861 [0.9999947]	4.61498 [1.0000000]	0.0017877 [0.9982]	0.0017411 [1.0000]	241.76 [0.0000]**
Bra-IP	9.01305 [0.1085449]	12.7416 [0.2384774]	26.5647 [0.1479609]	65.3728 [0.0710176]	22.4837 [0.0004236]**	22.7644 [0.0116503]*	27.0734 [0.1332125]	40.1384 [0.8393445]	11.487 [0.0000]**	5.5047 [0.0001]**	2.7310 [0.0034]**
Iran-Inf	85.4604 [0.0000000]**	99.1931 [0.0000000]**	196.004 [0.0000000]**	376.744 [0.0000000]**	129.196 [0.0000000]**	141.596 [0.0000000]**	211.212 [0.0000000]**	318.971 [0.0000000]**	56.218 [0.0000]**	22.984 [0.0000]**	12.226 [0.0000]**
Iran-IP	72.7472 [0.0000000]**	75.2927 [0.0000000]**	89.0060 [0.0000000]**	128.920 [0.0000000]**	69.7980 [0.0000000]**	69.8851 [0.0000000]**	70.0197 [0.0000002]**	70.1195 [0.0316871]*	68.180 [0.0000]**	38.267 [0.0000]**	21.855 [0.0000]**
Malawi-Inf	65.6458 [0.0000000]**	114.230 [0.0000000]**	335.703 [0.0000000]**	702.620 [0.0000000]**	38.1896 [0.0000003]**	60.2140 [0.0000000]**	131.943 [0.0000000]**	235.170 [0.0000000]**	13.636 [0.0000]**	6.3930 [0.0000]**	6.4689 [0.0000]**
Malawi-IP	50.4169 [0.0000000]**	135.791 [0.0000000]**	356.488 [0.0000000]**	756.016 [0.0000000]**	16.0929 [0.0065839]**	22.7220 [0.0118207]*	128.002 [0.0000000]**	229.219 [0.0000000]**	0.43023 [0.6508]	3.2472 [0.0072]**	2.6587 [0.0041]**

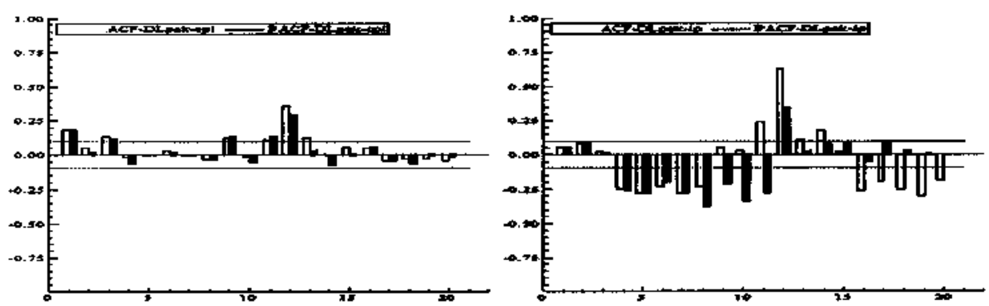
Note: Inf- denotes inflation and Ip- denotes industrial production/ manufacturing production,
p – **values** are in parentheses ** indicates significant at 1% and * significant at 5% level of significance.

The plots of autocorrelation functions and partial autocorrelation functions for monthly inflation rate and output growth rate and also their squared returns are given in Figure 4.4. and 4.5., that helped in the selection of p and q lags for conditional mean and conditional variance equations. The values of ACF and PACF that lie outside the confidence interval will identify the order for ARMA models and also shows that the return series are characterized with short memory. ACF and PACF of the squared return series shows non persistent autocorrelations for long term that dies out very rapidly. Figures of Pakistan, India, South Africa and Nigeria are given in Figure 4.4. and 4.5., and remaining 8 countries figures are given in appendix named Figure-A 4.4. and Figure-A 4.5.

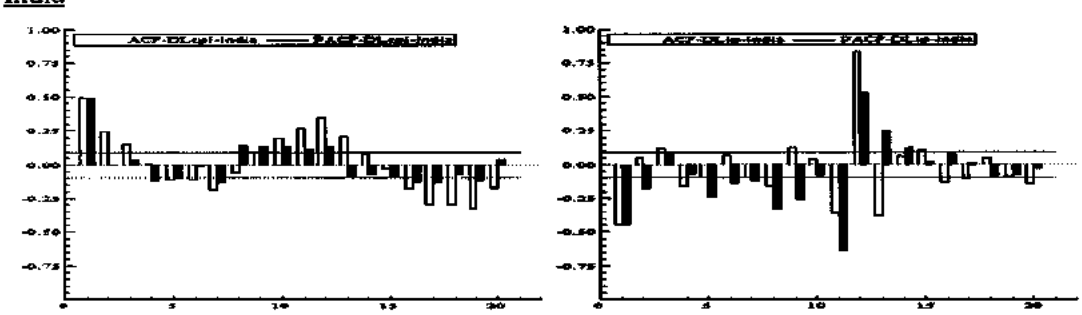
Figure 4.4. The Autocorrelations (ACF) and Partial Autocorrelations (PACF) of Inflation and Output Growth Return Series

At 5% level of significance, both inflation and output growth return series demonstrate the short memory process.

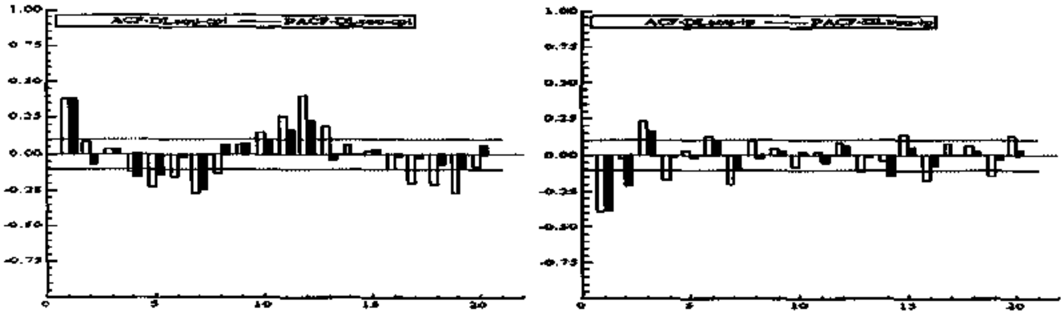
Pakistan



India



South Africa



Nigeria

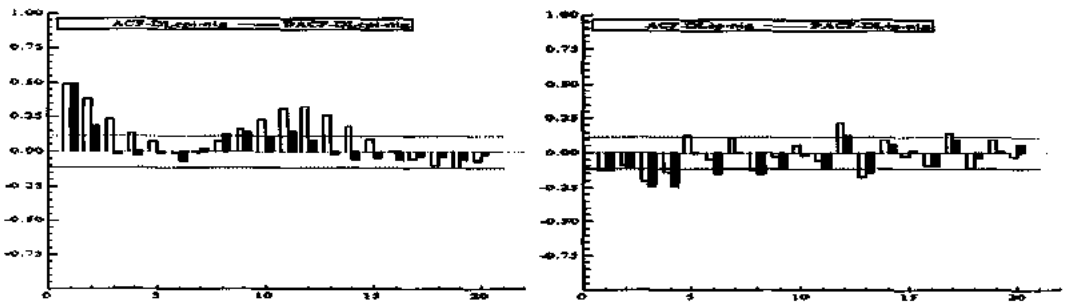
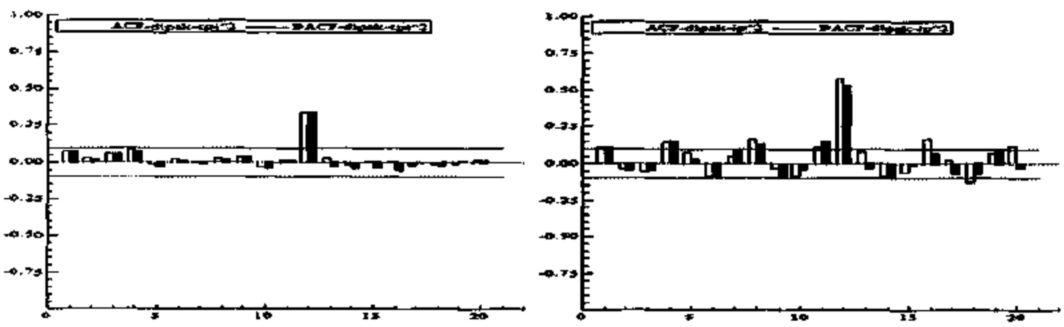


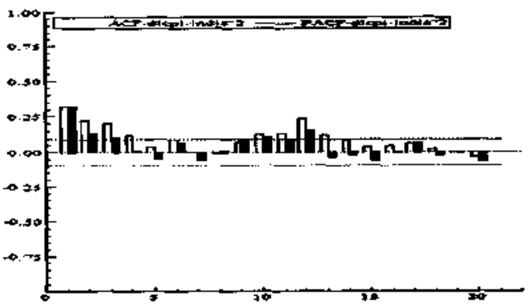
Figure 4.5. The Autocorrelations (ACF) and Partial Autocorrelations (PACF) of Inflation and Output Growth Squared Return Series

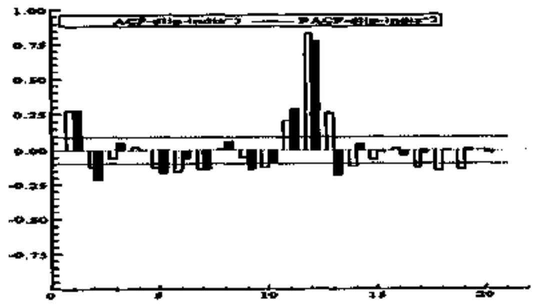
At 5% level of significance, plots of both series, that is, Inflation and Output Growth squared return series are not determined by autocorrelations and expire very fast

Pakistan

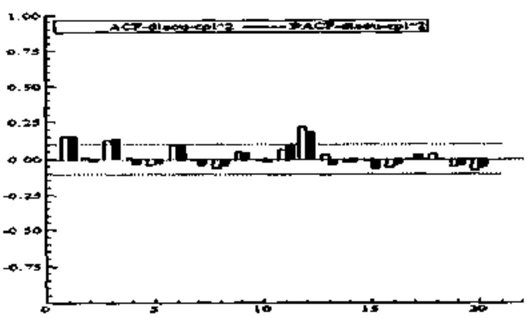


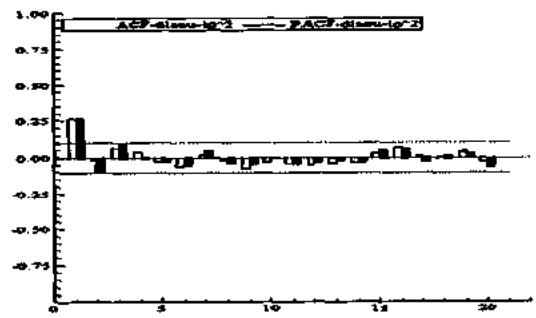
India



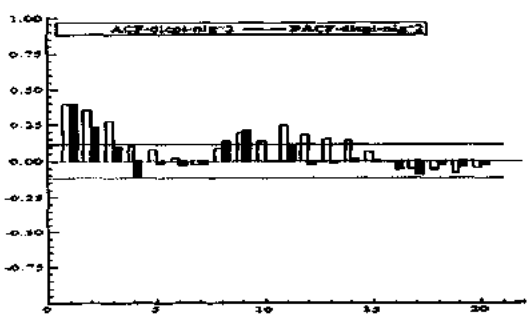


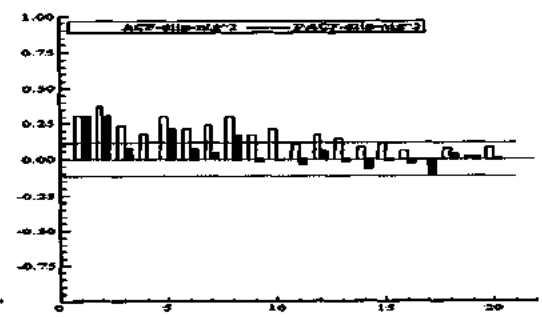
South Africa





Nigeria





Overall, in this chapter we discuss the model specification and econometric framework to be used for the analysis. First we discuss different methods of uni-variate GARCH models to be used in estimating the conditional variances of inflation and output growth being used as uncertainties for inflation and output growth. Secondly, we discuss the multivariate GARCH models to be used as for final estimation with diagonal BEKK specifications. After this, we discuss the data and preliminary findings, graphical analysis, descriptive statistics, unit root tests and test for ARCH effects.

Chapter 5
Estimation and Discussion of Results

In this chapter, firstly we find the conditional variances of both variables (inflation rate and output growth rate) by using family of GARCH models, that is, GARCH (1, 1), EGARCH (1, 1) and GJR-GARCH (1, 1). These conditional variances are then used as proxies for uncertainties of inflation and output growth (Grier and Perry,2000; Fountas, et al., 2002; Apregis,2004; Fountas & Karanasos,2006; Chan, et al.,2008; Narayan & Narayan,2013). After finding out the best conditional variances of both variables (inflation rate and output growth rate), we apply the bi-variate ARMA(p,q)-GARCH(1,1) model to examine the association among inflation rate, output growth rate and their uncertainties for 12 developing countries for the period ranging from 1982-M1 to 2012-M12.

This chapter consists of two parts; in the first part we find the conditional variances of 12 developing countries, whereas in the second part we estimate the final model.

5.1. Estimation of Conditional Variances

In order to find the best fitted model for each return series of inflation and output growth rate, we estimate the GARCH, EGARCH and GJR-GARCH models with both normal and student's t-distribution. The results of GARCH (1, 1), EGARCH (1, 1) and GJR-GARCH (1,1) model with normal distribution for 12 developing countries and factors affecting their volatilities are described in Table-A 5.1(a), 5.1(b), 5.3 (a) , 5.3(b), 5.5(a) and 5.5(b). The diagnostic tests for GARCH (1,1), EGARCH (1, 1) and GJR-

GARCH (1,1) model with normal distribution is displayed in Table-A 5.2(a), 5.2(b), 5.4(a), 5.4(b), 5.6(a) and 5.6(b). The outcomes of GARCH (1, 1), EGARCH (1, 1) and GJR-GARCH (1, 1) models with Student-t distribution are described in Table-A 5.7(a), 5.7(b), 5.9(a), 5.9(b), 5.11(a), and 5.11(b). Further, the post estimation diagnostic test results for t-GARCH (1, 1), EGARCH (1, 1) and GJR-GARCH (1, 1) are shown in Table-A 5.8(a), 5.8(b), 5.10 (a), 5.10(b), 5.12(a), and 5.12(b) respectively.

After finding out the conditional variances, we are able to apply the final bi-variate ARMA (p,q)-GARCH(1,1) model for each country. Detailed discussion estimation of conditional variances of each country is discussed in the section 5.2 of this chapter and the final model of each country is discussed in the section 5.3 of this chapter.

5.2. Country wise Estimation of GARCH (1, 1) Models

GARCH (1,1) models are very parsimonious and able to capture the volatility clustering in data without the requirement of higher order models (Brooks, 2002). Mostly these models are used to capture the conditional variances of the parameters. In this study, family of GARCH (1, 1) models is used to find the conditional variances of inflation and output growth. These conditional variances are then used as proxies for both variables (inflation and output growth) in our final model.

Before finding the conditional variances of both variables, firstly to compute the covariance matrix, maximum likelihood method is to be used. By considering ACF, PACF and minimum information criterion, we use different ARMA (p,q) specification for different countries to find out the conditional variances as proxies for inflation and output growth uncertainties with GARCH (1,1) models. Detail of each country is given below:

5.2.1. Pakistan

Estimation of conditional variances of both (inflation and output growth) series depends upon the basis of Maximum Likelihood (ML) and the Akaike Information Criteria (AIC). The Autoregressive (AR) and Moving Average (MA) by Least Squares (LS) are also used. By applying different ARMA(p,q)-GARCH(1,1) models, ARMA(1,1)-GJR(1,1) with normal distribution is used for estimating the conditional variance of inflation rate used as proxy for its uncertainty in case of Pakistan by considering the ACF, PACF and minimum information criterion (reported in Table-A 5.1(a)). By examining all other models such as GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GARCH-t is the best among all. Parameters are statistically significant at 1%, 5% and 10% for both mean and variance co-efficient and $\alpha + \beta = 0.0.94719$ is less than 1 satisfying the stationarity condition. The values of α and β are also statistically significant at 1%, 5% and 10% and the maximum Log Likelihood value is 1403.95. For the conditional variance of output growth rate to be used as proxy for output growth uncertainty, ARMA (4, 5)-GJR(1,1) with normal distribution is used (reported in Table-A 5.9(a)). The value of $\alpha + \beta + \Upsilon = 0.983152$ is less than 1 satisfying the stationarity condition and they are significant. The maximum Log Likelihood value is 507.422. Both series (inflation and output growth rate) contains 2^{nd} and 4^{th} moments of inflation for Pakistan.

By examining the diagnostic tests (reported in Table-A 5.2(a) for inflation and 5.10(a) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been found by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The

Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.2. India

Estimation of conditional variances of both (inflation and output growth) series depends upon the basis of Maximum Likelihood (ML) and the Akaike Information Criteria (AIC). The Autoregressive (AR) and Moving Average (MA) by Least Squares (LS) are also used. By applying different ARMA(p,q)-GARCH(1,1) models, ARMA (1,2)-GARCH(1,1) with student's t-distribution is used for estimating conditional variance of inflation rate used as proxy for inflation uncertainty (reported in Table-A 5.3(a)) of India by considering the ACF, PACF and minimum information criterion. By examining all other models such as GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GARCH-t is the best among all. Parameters are statistically significant at 1%, 5% and 10% for both mean and variance co-efficients and $\alpha + \beta = 0.93788$ is less than 1 satisfying the stationarity condition. The values of α and β are significant and the maximum Log Likelihood value is 1696.69. For the conditional variance of output growth rate as proxy for output growth uncertainty, ARMA (2,5)-GARCH(1,1) with normal distribution is used (reported in Table-A 5.1(a)). The value of $\alpha + \beta = 0.69133$ is less than 1 satisfying the stationarity condition and they are significant. The maximum Log Likelihood value is 802.685. Both series (inflation and output growth rate) contains 2^{nd} and 4^{th} moments of inflation for India.

By examining the diagnostic tests (reported in Table-A 5.4(a) for inflation and 5.2(a) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been found by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.3. South Africa

For the proxy of both (inflation and output growth) uncertainties, applying different ARMA(p,q)-GARCH(1,1) models, ARMA (2,3)-GJR(1,1) with student's t-distribution is used as conditional variance for inflation rate (reported in Table-A 5.11(a)) and ARMA(0,2)-GJR(1,1) with student's t-distribution is used as conditional variance for output growth rate (reported in Table-A 5.11(a)) for South Africa. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1, 1), GJR-t is the best for both among all. Co-efficient of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta + \Upsilon = 0.882377$ and Log Likelihood is 1442.96 for inflation rate series. The value of $\alpha + \beta + \Upsilon = 0.612286$ and Log Likelihood is 902.879 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for both series. Negative value of Υ shows asymmetric effect and absence of leverage for inflation rate series. Presence of 2nd and 4th moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.12(a) for inflation and 5.12(a) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been examined by applying LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.4. Nigeria

By using ARMA(0,1)-GJR(1,1) and ARMA(0,2)-GJR(1,1) with normal distribution is used to evaluate the conditional variance for inflation rate (reported in Table-A 5.9(b)) and output growth rate (reported in Table-A 5.9(b)) after applying different ARMA(p,q)-GARCH(1,1) models. These conditional variances being used as proxies for both variables (inflation and output growth) for further analysis of Nigeria. By examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1) and considering ACF, PACF and minimum information criterion, GJR-n is the best for both among all. Values of α, β, Υ and co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10%. The value of $\alpha + \beta + \Upsilon = 0.849479$ and Log Likelihood is 758.873 for inflation rate series. The value of $\alpha + \beta + \Upsilon = 0.929868$ and Log Likelihood is 345.691 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for both series. Inflation series have asymmetric effect and no leverage because of negative value of ϒ. Presence of 2nd and 4th moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.10(b) for inflation and 5.10(b) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been tested by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.5. Indonesia

For the proxy of both uncertainties (inflation and output growth), applying different ARMA(p,q)-GARCH(1,1) models, ARMA(1,1)-GARCH(1,1) with normal distribution is used to estimate the conditional variance for inflation rate (reported in Table-5.1(a)) and ARMA(0,1)-GJR(1,1) with student's t-distribution is used to find the conditional variance for output growth rate(reported in Table-A 5.11(a)) for Indonesia. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GARCH-N and GJR-t is the best among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α, β and ϒ are also statistically significant. The value of $\alpha + \beta = 0.96497$ and Log Likelihood is 1212.3 for inflation rate series. The value of $\alpha + \beta + \Upsilon = 0.89003$ and Log Likelihood is 594.241 for output growth rate series. Negative value ϒ show the absence of leverage and have asymmetric effect. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$.

By investigating the diagnostic tests (reported in Table-A 5.2(a) for inflation and 5.12(a) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been found by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.6. Mexico

For the proxies of both (inflation and output growth) uncertainties, applying different ARMA(p,q)-GARCH(1,1) models, ARMA(1,0)-GARCH(1,1) with normal distribution is used as conditional variance for inflation rate(reported in Table-A 5.1(a)) and ARMA(0,5)-GARCH(1,1) with student's t-distribution is used as conditional variance for output growth rate(reported in Table-A 5.3(a)) for Mexico. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1, 1), GARCH-n is the best for inflation and GARCH-t for output growth rate among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α and β are also statistically significant. The value of $\alpha + \beta = 0.96388$ and Log Likelihood is 1305.406 for inflation rate series. The value of $\alpha + \beta = 0.94981$ and Log Likelihood is 713.625 for output growth rate series. Negative value of Υ shows the absence of leverage and has asymmetric effect for inflation rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for inflation rate and $\alpha + \beta < 1$ for output growth rate.

By investigating the diagnostic tests (reported in Table-A 5.2(a) for inflation and 5.4(a) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been found by using LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags for both series. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.7. Algeria

For the proxy of both (inflation and output growth) uncertainties, applying different ARMA(p,q)-GARCH(1,1) models, ARMA(4,0)-GJR(1,1) with student's t-distribution is used as conditional variance for inflation rate (reported in Table-A 5.11(a)) and ARMA(0,2)-GARCH(1,1) with student's t-distribution is used as conditional variance for output growth rate (reported in Table-A 5.3(a)) for Mexico. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GJR-t is the best for inflation and GARCH-t for output growth rate among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta + \Upsilon =$ 0.996574 and Log Likelihood is 949.993 for inflation rate series. The value of $\alpha + \beta =$

0.97024 and Log Likelihood is 609.683 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for inflation rate and $\alpha + \beta < 1$ for output growth rate. Presence of 2^{nd} and 4^{th} moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.12(a) for inflation and 5.4(a) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been found by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.8. Eucador

For the proxy of both uncertainties (inflation and output growth), applying different ARMA(p,q)-GARCH(1,1) models, ARMA(1,0)-GJR(1,1) with student's t-distribution is used as conditional variance for inflation rate (reported in table-A 5.11(b)) and ARMA(1,0)-GJR(1,1) with student's t-distribution is used as conditional variance for output growth rate (reported in table-A 5.11(b)) for South Africa. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GJR-t is the best for both among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta + \Upsilon = 0.974802$ and Log Likelihood is 721.176 for inflation rate series. The value of $\alpha + \beta + \Upsilon = 0.658896$ and Log Likelihood is 548.226 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for both series. Presence of 2nd and 4th moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.12(b) for inflation and 5.12(b) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been examined by applying LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.9. Bolivia

For the proxy of both uncertainties (inflation and output growth), applying different ARMA(p,q)-GARCH(1,1) models, ARMA(4,2)-GJR(1,1) with normal distribution is used as conditional variance for inflation rate (reported in Table-A 5.9(b)) and ARMA(0,1)-GARCH(1,1) with student's t-distribution is used as conditional variance for output growth rate (reported in Table-A 5.3(b)) for Bolivia. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GJR-n is the best for inflation and GARCH-t for output growth rate among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta + \Upsilon =$

0.999198 and Log Likelihood is 1136.157 for inflation rate series. The value of $\alpha + \beta =$ 0.97031 and Log Likelihood is 484.603 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for inflation rate and $\alpha + \beta < 1$ for output growth rate. The negative value of Υ shows asymmetric effect and absence of leverage. Presence of 2nd and 4th moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.10(b) for inflation and 5.4(b) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been examined by applying LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.10. Brazil

By estimating ARMA(2,0)-GARCH(1,1) with normal distribution for inflation (reported in table-A 5.1(b)) and ARMA(0,3)-GJR(1,1) with student's t-distribution for output growth (reported in table-A 5.11(b)) is used as finding out the conditional variances, further to be used as proxies for inflation uncertainty and output growth uncertainty for Brazil by applying different ARMA(p,q)-GARCH(1,1) models. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GARCH-n is the best for inflation and GJR-t for output growth rate among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10%

and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta = 0.89253$ and Log Likelihood is 789.523 for inflation rate series. The value of $\alpha + \beta + \Upsilon = 0.436443$ and Log Likelihood is 684.322 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta < 1$ for inflation rate and $\alpha + \beta + \Upsilon < 1$ for output growth rate. Presence of 2^{nd} and 4^{th} moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.2(b) for inflation and 5.12(b) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been tested by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.11. Iran

For the proxies of both (inflation and output growth) uncertainties, we estimate the conditional variances of inflation and output growth rate by ARMA(0,1)-GJR(1,1) with normal distribution (reported in Table-A 5.9(b)) and ARMA(0,1)-GARCH(1,1) with student's t-distribution (reported in Table-A 5.3(b)) for Iran by applying different ARMA(p,q)-GARCH(1,1) models. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1,1), GJR-n is the best for inflation and GARCH-t for output growth rate among all. Co-efficients of mean and variance equations are statistically significant at 1%, 5% and 10% and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta + \Upsilon = 0.785716$ and Log Likelihood is 873.015 for inflation rate series. The value of $\alpha + \beta = 0.94981$ and Log Likelihood is 713.625 for output growth rate series. Stationarity condition is also fulfilled because of value less than 1 i.e., $\alpha + \beta + \Upsilon < 1$ for inflation rate and $\alpha + \beta < 1$ for output growth rate. The negative value of Υ shows asymmetric effect and absence of leverage. Presence of 2^{nd} and 4^{th} moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.10(b) for inflation and 5.4(b) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been found by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.2.12. Malawi

For the proxy of both (inflation and output growth) uncertainties by applying different ARMA(p,q)-GARCH(1,1) models, ARMA(0,1)-GJR(1,1) with normal distribution (reported in Table-A 5.9(b)) and ARMA(5,1)-GARCH(1,1) with normal distribution (reported in Table-A 5.1(b)) is used to find the conditional variance of inflation and output growth rate for Malawi. By considering ACF, PACF and minimum information criterion and examining other models like GARCH-n, GARCH-t, EGARCH-n, EGARCH-t, GJR-n and GJR-t with order (1, 1), GJR-n is the best for inflation and GARCH-n for output growth rate among all. Parameters are statistically significant for mean and variance equations at 1%, 5% and 10% and values of α, β and Υ are also statistically significant. The value of $\alpha + \beta + \Upsilon = 0.912269$ and Log Likelihood is 642.398 for inflation rate series. The value of $\alpha + \beta = 0.95934$ and Log Likelihood is 290.104 for output growth rate series. The values of $\alpha + \beta + \Upsilon < 1$ for inflation rate and $\alpha + \beta < 1$ for output growth rate fulfills the stationarity condition. Presence of 2nd and 4th moments also observed for both series.

By investigating the diagnostic tests (reported in Table-A 5.10(b) for inflation and 5.2(b) for output growth), values of skewness and kurtosis indicates significant declines by the expected specification. No ARCH effect has been tested by examining LM-ARCH effect and J-B test shows the non-normality of standardized residuals of both series. The Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags. Absence of heteroskedasticity is found by Residual Based Diagnostic (RBD).

5.3. Estimation of country wise final Bi-Variate Model

After finding the conditional variances for both inflation and output growth series, on the basis of Log likelihood ratio (LR), the Akaike Information Criteria (AIC) and Schwartz Criteria (SC) being used as proxies for both (inflation and output growth) uncertainties. Now, we are able to investigate the influence of inflation and output growth series with their explanatory variables by using bi-varaiate ARMA (p,q)- GARCH-M (1,1) model. By adding explanatory variables in both mean and variance equations of both (inflation and output growth) series simultaneously, we are able to find out the above stated 12 hypothesis. A detail of each and every country is given below and the diagnostic testing of all countries is given in the Table-A 5.25(a) and 5.25(b).

5.3.1. Pakistan

To empirically investigate the bi-variate diag-BEKK GARCH-M model by Engle and Korner (1995), we employ the Broyden-Fletcher-Goldfarb-Shanno (Fletcher, 1987) numerical optimization algorithm to obtain the maximum likelihood estimates of the parameters. To obtain the final estimated model, use series of different tests based on the maximum likelihood ratio (LR) and ARMA (p,q) to obtain the lag structures of Eqs. (4.9 to 4.13). By testing the model with different lags and regressors in mean and variance equations; finally get the results with positive and significant ARCH (past shocks) and GARCH (past variance). We also find that $\alpha < \beta$ means, it is an indication that a shockwave to uncertainty remains for longer period and $\alpha + \beta$ are greater than zero satisfying the positivity constraint of GARCH modeling. For the stationary condition in case of bi-variate diag-BEKK GARCH-M model, $\alpha^2 + \beta^2 < 1$. AR and MA terms of both (inflation and output growth) series are significant.

In case of Pakistan, we employ series of different tests on the base of likelihood ratio (LR) to find the best fitted model to present the results for the all stated hypotheses, data ranging from 1979-M1 to 2012-M12. We use bi-variate GARCH-M (1, 1) model with t-distribution and ARMA (0, 3) with four explanatory variables in mean equation and two variables in variance equation. The Log likelihood value is 2524. The results from the bi-variate diag-BEKK MGARCH (1, 1) model for both (inflation and output growth) series are given below:

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

$$\pi_t = \underset{(0.0397)^{**}}{0.0000678} + \underset{(0.0000)^{***}}{0.961978}\pi_{t-1} - \underset{(0.0000)^{***}}{0.824557}\varepsilon_{t-1} - \underset{(0.0286)^{**}}{0.185198}\varepsilon_{t-2} + \underset{(0.0284)^{**}}{0.117053}\varepsilon_{t-3} - \underset{(0.0965)^{*}}{3.928042}\sigma_{\pi t}^2 - \underset{(0.1331)}{0.047700}\sigma_{yt}^2 - \underset{(0.0002)^{***}}{0.008934}Y_{t-1} + \varepsilon_t \quad (5.1)$$

$$\sigma_{\pi t}^2 = \underset{(0.1783)}{0.001019} + \underset{(0.9998)}{0.000039}\varepsilon_{t-1}^2 + \underset{(0.0000)^{***}}{0.883098}\sigma_{\pi(t-1)}^2 + \underset{(0.0000)^{***}}{0.038447}\pi_{t-2} - \underset{(0.8207)}{0.0000002}Y_{t-2} \quad (5.2)$$

$$Y_t = \underset{(0.4226)}{-0.019820} - \underset{(0.0000)^{***}}{0.579618}Y_{t-1} + \underset{(0.0000)^{***}}{0.611562}\varepsilon_{t-1} \underset{(0.0085)^{***}}{0.176073}\varepsilon_{t-2} + \underset{(0.0019)^{***}}{0.205595}\varepsilon_{t-3} + \underset{(0.1355)}{7.845047}\sigma_{Yt}^2 + \underset{(0.4480)}{77.567640}\sigma_{\pi t}^2 - \underset{(0.0007)^{***}}{1.632303}\pi_{t-1} + u_t \quad (5.4)$$

$$\sigma_{Yt}^2 = \underset{(0.5366)}{0.000011} + \underset{(0.0000)^{***}}{0.302292}\varepsilon_{t-1}^2 + \underset{(0.0000)^{***}}{0.952580}\sigma_{Y(t-1)}^2 + \underset{(0.7590)}{0.0000004}Y_{t-2} - \underset{(0.1225)}{0.048741}\pi_{t-2} \quad (5.5)$$

$$COV = \underset{(0.0984)^{*}}{-0.009032}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.6)$$[1]

In equation (5.1) and (5.2), results of mean inflation and inflation uncertainty are stated. Our results are steady with the findings of Friedman (1977) hypothesis i.e., higher inflation increases inflation uncertainty as Daal *et al.* (2005) also supported the Friedman (1977) hypothesis for Pakistan. Second part of Friedman (1977) hypothesis that is, higher inflation increases its uncertainty is insignificant in our study. Cukierman-Meltzer (1986) hypothesis is also accepted in case of Pakistan means higher inflation uncertainty increases inflation. Whereas, Rizvi and Naqvi (2009) and Javed *et al.* (2012) do not support the Cukierman-Meltzer (1986) Hypothesis. Holland (1995) hypothesis is not accepted in case of Pakistan. In equation (5.3) and (5.4), results of output growth and its

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[1] Note: This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.1) to (5.5) for Pakistan. π_t denotes inflation, $\sigma_{\pi t}^2$ denotes conditional variances/uncertainty of inflation, σ_{Yt}^2 denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε_{t-1}^2 denotes ARCH(past shocks) effect, $\sigma_{\pi(t-1)}^2$ denotes GARCH(past variance of inflation), $\sigma_{Y(t-1)}^2$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[1]

uncertainty are stated. Black (1987) hypothesis is also accepted that is, Higher output uncertainty reduces inflation. Results also supports that higher output growth reduces inflation and higher inflation reduces output growth. Also suggested by Ayyoub *et al.* (2011) in his study that in case of Pakistan, higher prices leads to increase the inflation and decrease the overall growth of the economy. Equation (5.5) represents the constant conditional correlation model of the covariance between the residuals of equations (5.2) and (5.4). For both (inflation and output growth) series β (past variance means GARCH term) is significant at 1%, 5% and 10% level of significance but α (past shocks means ARCH term) is insignificant for inflation series. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.779862 for inflation series and 0.998789 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.13. Diagnostic testing of final model, the Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 10 lags.

5.3.2. India

To obtain the final estimated model, use series of different tests based on likelihood ratio and ARMA (p,q) to obtain the lag structures of Eqs. (4.9 to 4.13). To get the results with positive and significant ARCH (past shocks) and GARCH (past variance), test the model with different lags and regressors in mean and variance equations. We also find that $\alpha < \beta$ means indication that a shockwave to uncertainty remains for long period and $\alpha + \beta$ are greater than zero satisfying the positivity constraint of GARCH modeling. For the stationary condition in case of bi-variate diag-BEKK

GARCH-M model, $\alpha^2 + \beta^2 < 1$. AR and MA terms of both (inflation and output growth) series are significant.

In case of India, we employ different tests to find out the best fitted model and the results of all stated hypotheses. We use bi-variate normal distribution with Log Likelihood=2524 and ARMA (0,4) with five explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

An ARMA (0,4)- diag-BEKK GARCH-M (1,1) is specified as follows:

$$\begin{aligned}\pi_t = {} & \underset{(0.0374)^{**}}{0.01546} + \underset{(0.0000)^{***}}{1.496250}\pi_{t-1} - \underset{(0.000)^{***}}{0.815418}\pi_{t-2} - \underset{(0.0000)^{***}}{1.170868}\varepsilon_{t-1} + \underset{(0.0000)^{***}}{0.406921}\varepsilon_{t-2} \\ & + \underset{(0.0034)^{***}}{0.226493}\varepsilon_{t-3} + \underset{(0.9025)}{0.006926}\varepsilon_{t-4} + \underset{(0.5535)}{4.913059}\sigma^2_{\pi t} + \underset{(0.5301)}{0.111703}\sigma^2_{yt} \\ & - \underset{(0.0467)^{**}}{0.023343}Y_{t-1} + \varepsilon_t \end{aligned} \qquad (5.6)$$

$$\begin{aligned}\sigma^2_{\pi t} = {} & \underset{(0.7002)}{0.000781} + \underset{(0.4964)}{0.174695}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.921783}\sigma^2_{\pi(t-1)} + \underset{(0.0009)^{***}}{0.027913}\pi_{t-3} \\ & - \underset{(0.2854)}{0.0000001}Y_{t-2} \end{aligned} \qquad (5.7)$$

$$\begin{aligned}Y_t = {} & \underset{(0.0001)^{***}}{0.007711} - \underset{(0.0523)^{*}}{0.325823}Y_{t-1} - \underset{(0.0000)^{***}}{1.037879}\varepsilon_{t-1} + \underset{(0.0157)^{**}}{0.306248}\varepsilon_{t-2} - \underset{(0.8792)}{0.010888}\varepsilon_{t-3} \\ & - \underset{(0.0228)^{**}}{0.157905}\varepsilon_{t-4} - \underset{(0.4445)}{0.563871}\sigma^2_{Yt} - \underset{(0.0031)^{***}}{40.381066}\sigma^2_{\pi t} - \underset{(0.0205)^{**}}{0.908091}\pi_{t-1} \\ & + \underset{(0.0289)^{**}}{0.941324}\pi_{t-2} + u_t \end{aligned} \qquad (5.8)$$

$$\begin{aligned}\sigma^2_{Yt} = {} & \underset{(0.7994)}{0.022022} + \underset{(0.0018)^{***}}{0.393433}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.606589}\sigma^2_{Y(t-1)} - \underset{(0.0000)^{***}}{0.0000003}Y_{t-2} \\ & - \underset{(0.2349)}{0.055277}\pi_{t-3} \end{aligned} \qquad (5.9)$$

$$COV = \underset{(0.6988)}{-0.026466}\sigma_{\varepsilon t}\sigma_{\mu t} \qquad (5.10)^2$$

Results of mean inflation and its uncertainty are reported in equation (5.6) and (5.7). Our results do not support the findings of Friedman (1977) hypothesis that is, higher inflation increases inflation uncertainty contrary to the findings of Chowdhury

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[2] **Note:** This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH (1,1) model from eqs. (5.6) to (5.10) for India. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[2]

(2014), as in his study Friedman (1977) hypothesis does not hold for India. Second part of the Friedman (1977) hypothesis, that is, uncertainty of inflation reduces output growth is supported in this study. Cukierman-Meltzer (1986) hypothesis is also accepted in case of India means higher inflation uncertainty increases inflation as also supported for India by Naryan and Naryan (2013) and Chowdhury (2014). Holland (1995) hypothesis is also not accepted in this study for India. Results of output growth and its uncertainty are reported in equation (5.8) and (5.9). Black (1987) hypothesis is also accepted that is, higher output uncertainty reduces inflation as suggested by Naryan and Naryan (2013) in their study. Also found that higher output growth reduces inflation as well as inflation uncertainty. Higher output growth inflation uncertainty also reduces output growth. Equation (5.10) represents the constant conditional correlation model of the covariance between the residuals of equations (5.7) and (5.9). For both (inflation and output growth) series β (past variances) is significant at 1%, 5% and 10% significance level but α (past shocks) is insignificant for inflation series. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.880202 for inflation series and 0.522739 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.14. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 10 lags.

5.3.3. South Africa

In case of South Africa, we employ different tests to find out the best fitted model and results for all the stated hypotheses. We use bi-variate normal distribution with Log Likelihood=2319.91 and ARMA (0, 2) with four explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

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

$$\pi_t = \underset{(0.9456)}{0.000015} + \underset{(0.0000)^{***}}{0.990050}\pi_{t-1} - \underset{(0.0000)^{***}}{0.861784}\varepsilon_{t-1} - \underset{(0.6086)}{0.036264}\varepsilon_{t-2} - \underset{(0.5734)}{3.090621}\sigma^2_{\pi t} + \underset{(0.7389)}{0.183069}\sigma^2_{yt} + \underset{(0.0337)^{**}}{0.017233}Y_{t-1} + \varepsilon_t \quad (5.11)$$

$$\sigma^2_{\pi t} = \underset{(0.1489)}{0.001400} + \underset{(0.0000)^{***}}{0.247399}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.916496}\sigma^2_{\pi(t-1)} - \underset{(0.7433)}{0.001992}\pi_{t-2} + \underset{(0.7123)}{0.003679}Y_{t-2} \quad (5.12)$$

$$Y_t = \underset{(0.9915)}{-0.000044} + \underset{(0.1733)}{0.199211}Y_{t-1} - \underset{(0.0000)^{***}}{0.691308}\varepsilon_{t-1} + \underset{(0.0306)^{**}}{0.211571}\varepsilon_{t-2} + \underset{(0.3554)}{8.318372}\sigma^2_{Yt} - \underset{(0.9995)}{0.035890}\sigma^2_{\pi t} - \underset{(0.0138)^{**}}{0.335445}\pi_{t-1} + u_t \quad (5.13)$$

$$\sigma^2_{Yt} = \underset{(0.0090)^{***}}{0.011239} + \underset{(0.0000)^{***}}{0.473813}\varepsilon^2_{t-1} + \underset{(0.0825)^{*}}{0.549773}\sigma^2_{Y(t-1)} - \underset{(0.74974)}{0.005158}Y_{t-2} - \underset{(0.0003)^{***}}{0.113503}\pi_{t-2} \quad (5.14)$$

$$COV = \underset{(0.7638)}{-0.001109}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.15)$$ [3]

Mean inflation and its uncertainty are reported in equations (5.11) and (5.12). Our results do not support the findings of Friedman (1977) i.e., higher inflation increases inflation uncertainty but stable with the findings that uncertainty of inflation reduces output growth. Whereas, Naryan and Naryan (2013) supports the Friedman (1977) hypothesis in their study. Cukierman-Meltzer (1986) hypothesis is not accepted in case of South Africa means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted that is, uncertainty of inflation leads to reduce the inflation. Equations (5.13) and (5.14) show the output growth and their uncertainty. Deveraux (1989) i.e., inflation is being increased by higher output uncertainty is accepted here.

[3] **Note:** This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.11) to (5.15) for South Africa. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[3]

Also find that higher output growth reduces inflation and higher inflation reduces output growth. Equation (5.15) represents the constant conditional correlation model of the covariance between the residuals of equations (5.12) and (5.14). For both (inflation and output growth) series β and α is significant at 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.901171 for inflation series and 0.526749 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.15. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

5.3.4. Nigeria

In case of Nigeria, we employ different tests to find the best fitted model and try the results for all stated hypotheses. We use bi-variate normal distribution with Log Likelihood=1124.95 and ARMA (0,1) with five explanatory variables in mean and two variables in variance equation. The results of bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

An ARMA (0,1)- GARCH-M (1,1) is specified as follows:

$$\pi_t = \underset{(0.0465)^{**}}{0.003449} + \underset{(0.0000)^{***}}{0.689138}\pi_{t-1} - \underset{(0.0029)^{***}}{0.328163}\varepsilon_{t-1} + \underset{(0.6603)}{1.77487}\sigma_{\pi t}^2 + \underset{(0.4143)}{0.049524}\sigma_{yt}^2 - \underset{(0.7237)}{0.004028}Y_{t-1} + \underset{(0.9941)}{0.000088}Y_{t-2} + \varepsilon_t \quad (5.16)$$

$$\sigma_{\pi t}^2 = \underset{(0.2615)}{0.007632} + \underset{(0.4288)}{0.106962}\varepsilon_{t-1}^2 + \underset{(0.0069)^{***}}{0.674025}\sigma_{\pi(t-1)}^2 + \underset{(0.0000)^{***}}{0.091726}\pi_{t-2} + \underset{(0.7422)}{0.001994}Y_{t-3} \quad (5.17)$$

$$Y_t = \underset{(0.3470)}{-0.002303} + \underset{(0.0363)^{**}}{0.421748}Y_{t-1} + \underset{(0.5462)}{0.096387}Y_{t-2} - \underset{(0.0000)^{***}}{0.869263}\varepsilon_{t-1} + \underset{(0.3431)}{0.123093}\sigma_{Yt}^2 + \underset{(0.2899)}{4.687965}\sigma_{\pi t}^2 - \underset{(0.9424)}{0.005625}\pi_{t-1} + u_t \quad (5.18)$$

$$\sigma_{Yt}^2 = \underset{(0.0159)^{**}}{0.020488} + \underset{(0.0002)^{***}}{0.432475}\varepsilon_{t-1}^2 + \underset{(0.0000)^{***}}{0.850621}\sigma_{Y(t-1)}^2 + \underset{(0.7174)}{0.046683}Y_{t-3} - \underset{(0.5039)}{0.020388}\pi_{t-2} \quad (5.19)$$

$$COV = \underset{(0.5707)}{-0.004527}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.20)^{4}$$

Mean inflation and its uncertainty are reported in equations (5.16) and (5.17). Results do not support the findings of Friedman (1977) i.e., higher inflation increases uncertainty of inflation and also its uncertainty reduces output growth. Cukierman-Meltzer (1986) hypothesis is accepted in case of Nigeria means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is not accepted. Output growth and its uncertainty are reported in equations (5.17) and (5.19). Balck (1987) that is, inflation is being reduced by higher output uncertainty is accepted and Deveraux (1989) hypothesis is not accepted for Nigeria. Equation (5.20) represents the constant conditional correlation model of the covariance between the residuals of equations (5.16) and (5.19). For both (inflation and output growth) series β is significant at 1%, 5% and 10% significance level and α is insignificant of inflation series. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.465751 for inflation series and 0.910591 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.16. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

[4] **Note:** This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.16) to (5.20) for Nigeria. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, $\sigma^2_{Y_t}$ denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[4]

5.3.5. Indonesia

In case of Indonesia, we employ series of different tests to find the best fitted model and the results for all stated hypotheses. We use bi-variate normal distribution with Log Likelihood=1778.92 and ARMA (0, 2) with four explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

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

$$\pi_t = \underset{(0.2722)}{0.001241} + \underset{(0.0065)***}{0.712833}\pi_{t-1} - \underset{(0.4974)}{0.145593}\varepsilon_{t-1} - \underset{(0.0002)***}{0.51355}\varepsilon_{t-2} + \underset{(0.4432)}{2.873065}\sigma^2_{\pi t} - \underset{(0.6047)}{0.066759}\sigma^2_{yt} - \underset{(0.0010)***}{0.024969}Y_{t-1} + \varepsilon_t \quad (5.21)$$

$$\sigma^2_{\pi t} = \underset{(0.0069)***}{0.002625} + \underset{(0.0000)***}{0.540527}\varepsilon^2_{t-1} + \underset{(0.0000)***}{0.841320}\sigma^2_{\pi(t-1)} + \underset{(0.2789)}{0.011595}\pi_{t-2} - \underset{(1.0000)}{0.0000000}Y_{t-2} \quad (5.22)$$

$$Y_t = \underset{(0.5196)}{-0.001981} - \underset{(0.0705)*}{0.407040}Y_{t-1} - \underset{(0.3632)}{0.337347}\varepsilon_{t-1} - \underset{(0.0910)*}{0.179562}\varepsilon_{t-2} + \underset{(0.0663)*}{1.621177}\sigma^2_{Yt} + \underset{(0.5404)}{8.769121}\sigma^2_{\pi t} - \underset{(0.0263)**}{0.980711}\pi_{t-1} + u_t \quad (5.23)$$

$$\sigma^2_{Yt} = \underset{(1.0000)}{0.000000} + \underset{(0.0000)***}{0.480373}\varepsilon^2_{t-1} + \underset{(0.0000)***}{0.486373}\sigma^2_{Y(t-1)} + \underset{(1.0000)}{0.0000000}Y_{t-2} - \underset{(0.0000)***}{0.424870}\pi_{t-2} \quad (5.24)$$

$$COV = \underset{(0.2387)}{0.021761}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.25)^5$$

Results of mean inflation and its uncertainty are reported in equation (5.21) and (5.22). Results do not support the findings of Friedman (1977) that is; higher inflation increases uncertainty of inflation and also its uncertainty reduce output growth dissimilar to the findings of Daal *et al.* (2005). Cukierman-Meltzer (1986) hypothesis is not accepted in case of Indonesia means higher inflation uncertainty increases inflation and

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[5] Note: This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.21) to (5.25) for Indonesia. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[5]

Holland (1995) hypothesis is accepted i.e., higher inflation uncertainty reduces inflation. Results of output growth and its uncertainty are reported in equation (5.23) and (5.24). Deveraux (1989) hypothesis is also accepted that is, Higher output growth uncertainty increases inflation. Also find that higher output growth reduces inflation, higher output growth increases its uncertainty and higher inflation reduces output growth. Equation (5.25) represents the constant conditional correlation model of the covariance between the residuals of equations (5.22) and (5.24). For both (inflation and output growth) series β (past variances) and α (past shocks) are significant at 1%, 5% and 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.999988 for inflation series and 0.467317 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.17. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

5.3.6. Mexico

In case of Mexico, we employ different tests to find out the best fitted model and try to find the results for the stated hypotheses. We use bi-variate normal distribution with Log Likelihood=2103.38 and ARMA (0,3) with six explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

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

$$\begin{aligned}\pi_t = & \underset{(0.2321)}{0.002908} + \underset{(0.0000)^{***}}{0.591059}\pi_{t-1} + \underset{(0.0022)^{***}}{0.340963}\pi_{t-2} + \underset{(0.3622)}{0.112451}\varepsilon_{t-1} - \underset{(0.0004)^{***}}{0.334650}\varepsilon_{t-2} \\ & - \underset{(0.0056)^{***}}{0.228990}\varepsilon_{t-3} - \underset{(0.9346)}{0.504296}\sigma^2_{\pi t} - \underset{(0.2883)}{1.912842}\sigma^2_{yt} + \underset{(0.1321)}{0.011012}Y_{t-1} \\ & - \underset{(0.9346)}{0.013036}Y_{t-2} + \varepsilon_t \qquad (5.26)\end{aligned}$$

$$\sigma^2_{\pi t} = \underset{(0.1188)}{0.000859} + \underset{(0.0006)***}{0.523809}\varepsilon^2_{t-1} + \underset{(0.0000)***}{0.749794}\sigma^2_{\pi(t-1)} + \underset{(0.0034)***}{0.024754}\pi_{t-3} + \underset{(0.8773)}{0.0000001}Y_{t-3} \quad (5.27)$$

$$Y_t = \underset{(0.3948)}{0.01007} + \underset{(0.0352)**}{0.414935}Y_{t-1} + \underset{(0.0225)**}{0.243452}Y_{t-2} - \underset{(0.0000)***}{1.127345}\varepsilon_{t-1} + \underset{(0.0137)**}{0.376823}\varepsilon_{t-2} - \underset{(0.0375)**}{0.150975}\varepsilon_{t-3} - \underset{(0.3998)}{7.548836}\sigma^2_{Yt} - \underset{(0.3110)}{8.291138}\sigma^2_{\pi t} - \underset{(0.0069)***}{0.527821}\pi_{t-1} + \underset{(0.0111)**}{0.578046}\pi_{t-2} + u_t \quad (5.28)$$

$$\sigma^2_{Yt} = \underset{(0.3033)}{0.0000001} + \underset{(0.6261)}{0.028782}\varepsilon^2_{t-1} + \underset{(0.0000)***}{0.988347}\sigma^2_{Y(t-1)} - \underset{(0.8632)}{0.00000012}Y_{t-3} - \underset{(0.0096)***}{0.016447}\pi_{t-3} \quad (5.29)$$

$$COV = \underset{(0.0277)}{-0.005284}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.30)$$[6]

Equations (5.26) and (5.27) report the results of mean inflation and its uncertainty. Results do not support the findings of Friedman (1977), but Cukierman-Meltzer (1986) hypothesis is accepted in case of Mexico means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is not accepted. Equations (5.28) and (5.29) report the results of output growth and their uncertainty. Deveraux (1989) hypothesis is also accepted that is, Higher output uncertainty increases inflation. Also found that higher output growth reduces inflation and higher inflation increases output growth uncertainty. Equation (5.30) represents the constant conditional correlation model of the covariance between the residuals of equations (5.27) and (5.29). For both (inflation and output growth) series β (past variance) is significant at 1%, 5% and 10% and α (past shocks) is insignificant for output growth series. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.836567 for inflation series and 0.977658 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.18. After employing the

[6] **Note:** This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.25 to (5.30) for Mexico. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1%, ** at 5% and * at 10% significance level.[6]

diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 10 lags.

5.3.7. Algeria

In case of Algeria, we employ different tests to find out the best fitted model and the results for all stated hypotheses. We use bi-variate normal distribution with Log Likelihood=1591.47 and ARMA (0, 5) with six explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1, 1) model for both (inflation and output growth) series are given below:

An ARMA (0,5)- diag-BEKK GARCH-M (1,1) is specified as follows:

$$\begin{aligned}\pi_t = {} & \underset{(0.6535)}{0.001718} - \underset{(0.0004)^{***}}{0.494709}\pi_{t-1} - \underset{(0.0000)^{***}}{0.617602}\pi_{t-2} + \underset{(0.0001)^{***}}{0.502563}\varepsilon_{t-1} + \underset{(0.0000)^{***}}{0.743658}\varepsilon_{t-2} \\ & + \underset{(0.5635)}{0.059480}\varepsilon_{t-3} + \underset{(0.9776)}{0.003490}\varepsilon_{t-4} + \underset{(0.2160)}{0.123945}\varepsilon_{t-5} + \underset{(0.0040)^{***}}{38.304771}\sigma^2_{\pi t} \\ & + \underset{(0.0302)^{**}}{0.111539}\sigma^2_{yt} + \underset{(0.1844)}{0.014301}Y_{t-1} + \underset{(0.6187)}{0.007438}Y_{t-2} \\ & + \varepsilon_t \qquad (5.31)\end{aligned}$$

$$\begin{aligned}\sigma^2_{\pi t} = {} & \underset{(0.9471)}{0.0000078} + \underset{(0.0006)^{***}}{0.191205}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.881580}\sigma^2_{\pi(t-1)} - \underset{(0.6859)}{0.016010}\pi_{t-3} \\ & + \underset{(0.7164)}{0.0000002}Y_{t-3} \qquad (5.32)\end{aligned}$$

$$\begin{aligned}Y_t = {} & \underset{(0.0836)^{*}}{0.012359} - \underset{(0.0000)^{***}}{1.608051}Y_{t-1} - \underset{(0.0000)^{***}}{0.881613}Y_{t-2} + \underset{(0.0000)^{***}}{1.125826}\varepsilon_{t-1} + \underset{(0.5195)}{0.087837}\varepsilon_{t-2} \\ & - \underset{(0.0000)^{***}}{0.520607}\varepsilon_{t-3} - \underset{(0.9854)}{0.001295}\varepsilon_{t-4} + \underset{(0.0530)^{**}}{0.071882}\varepsilon_{t-5} - \underset{(0.9185)}{0.030860}\sigma^2_{Yt} \\ & - \underset{(0.6924)}{5.978780}\sigma^2_{\pi t} - \underset{(0.8609)}{0.010500}\pi_{t-1} + \underset{(0.1253)^{**}}{0.08123}\pi_{t-2} + u_t \qquad (5.33)\end{aligned}$$

$$\begin{aligned}\sigma^2_{Yt} = {} & \underset{(0.9616)}{0.000485} + \underset{(0.0552)^{**}}{0.301820}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.793028}\sigma^2_{Y(t-1)} - \underset{(0.0000)^{***}}{0.000012}Y_{t-3} \\ & - \underset{(0.1396)}{0.134403}\pi_{t-3} \qquad (5.34)\end{aligned}$$

$$COV = \underset{(0.0000)^{***}}{0.026874}\sigma_{\varepsilon t}\sigma_{\mu t} \qquad (5.35)^{7}$$

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[7] [7] Note: This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.31) to (5.35) for Algeria. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[7]

Equations (5.31) and (5.32) represent the mean inflation and inflation uncertainty. Results support the findings of Friedman (1977) that is, higher inflation increases its uncertainty and but do not accept that inflation uncertainty reduces output growth. Cukierman-Meltzer (1986) hypothesis is not accepted in case of Mexico means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted that is, uncertainty of inflation leads to reduce the inflation. Output growth and its uncertainty are reported in equations (5.33) and (5.34). Mirman (1971) and Black (1987) concludes that uncertainty of output growth increases output growth, is accepted in case of Algeria and also our findings are consistent with Black (1987) that is, inflation is being reduced by higher output uncertainty. We also find that higher inflation increases output growth uncertainty. Equation (5.35) represents the constant conditional correlation model of the covariance between the residuals of equations (5.32) and (5.34).For both (inflation and output growth) series β and α is significant at 1%, 5% and 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.813742 for inflation series and 0.719988 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.19. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation for 15 and 20 lags.

5.3.8. Eucador

For Eucador, we employ different tests to find the best fitted model and the results for all stated hypotheses. We use bi-variate normal distribution with Log Likelihood=1310.61 and ARMA (0,5) with four explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

An ARMA (0,5)- diag-BEKK GARCH-M (1,1) is specified as follows:

$$\pi_t = \underset{(0.5055)}{0.000607} + \underset{(0.0000)^{***}}{0.974036}\pi_{t-1} - \underset{(0.0001)^{***}}{0.895739}\varepsilon_{t-1} + \underset{(0.7495)}{0.025517}\varepsilon_{t-2} - \underset{(0.0195)^{**}}{0.129704}\varepsilon_{t-3}$$
$$+ \underset{(0.7475)}{0.042210}\varepsilon_{t-4} + \underset{(0.8061)}{0.021000}\varepsilon_{t-5} - \underset{(0.6604)}{0.092694}\sigma^2_{\pi t} + \underset{(0.0961)^{*}}{0.015894}\sigma^2_{yt}$$
$$+ \underset{(0.4205)}{0.013095}Y_{t-1} + \varepsilon_t \quad (5.36)$$

$$\sigma^2_{\pi t} = \underset{(0.0384)^{**}}{0.003190} + \underset{(0.0000)^{***}}{0.226703}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.873959}\sigma^2_{\pi(t-1)} - \underset{(1.0000)}{0.000000}\pi_{t-2}$$
$$+ \underset{(0.9880)}{0.000030}Y_{t-2} \quad (5.37)$$

$$Y_t = \underset{(0.0412)^{**}}{0.008343} - \underset{(0.0000)^{***}}{0.975027}Y_{t-1} + \underset{(0.0000)^{***}}{0.685846}\varepsilon_{t-1} - \underset{(0.0000)^{***}}{0.384618}\varepsilon_{t-2} + \underset{(0.0171)^{**}}{0.184434}\varepsilon_{t-3}$$
$$+ \underset{(0.0132)^{**}}{0.103660}\varepsilon_{t-4} - \underset{(0.0000)^{***}}{0.227740}\varepsilon_{t-5} + \underset{(0.7200)}{0.007267}\sigma^2_{Yt} - \underset{(0.7430)}{0.383354}\sigma^2_{\pi t}$$
$$- \underset{(0.0000)^{***}}{0.154040}\pi_{t-1} + u_t \quad (5.38)$$

$$\sigma^2_{Yt} = \underset{(1.0000)}{0.0000007} + \underset{(0.0000)^{***}}{0.469572}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.712889}\sigma^2_{Y(t-1)} + \underset{(0.0000)^{***}}{0.152261}Y_{t-2}$$
$$- \underset{(1.0000)}{0.000000}\pi_{t-4} \quad (5.39)$$

$$COV = \underset{(0.7955)}{-0.004209}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.40)^{8}$$

Mean inflation and its uncertainty are reported in equations (5.36) and (5.40). Results do not support the findings of Friedman (1977) that is, higher inflation increases its uncertainty and uncertainty of inflation cuts output growth. Cukierman-Meltzer (1986) hypothesis is not accepted in case of Eucador means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted that is, uncertainty of inflation leads to reduce the inflation. An equation (5.38) and (5.39) reports the output growth and their uncertainties. Mirman (1971) and Black (1987) find that uncertainty of output growth increases output growth is accepted in case of Eucador and also our

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[8] **Note:** This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.36) to (5.40) for Eucador. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[8]

findings are consistent with Balck (1987) that is, inflation is being reduced by higher output uncertainty. We also find that higher output growth reduces inflation and higher inflation increases output growth uncertainty. Equation (5.40) represents the constant conditional correlation model of the covariance between the residuals of equations (5.37) and (5.39). For both (inflation and output growth) series β and α is significant at 1%, 5% and 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.815199 for inflation series and 0.728709 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.20. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

5.3.9. Bolivia

For Bolivia, we employ different tests to find out the best fitted model and try to find out the results for the stated hypothesis. We use bi-variate normal distribution with Log Likelihood=1602.4 and ARMA (0,5) with six explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

An ARMA (0,5)- diag-BEKK GARCH-M (1,1) is specified as follows:

$$\begin{aligned}\pi_t = {} & \underset{(0.0340)**}{0.000697} + \underset{(0.0000)***}{1.580216}\pi_{t-1} - \underset{(0.0000)***}{0.730424}\pi_{t-2} - \underset{(0.0000)***}{1.263093}\varepsilon_{t-1} \\ & + \underset{(0.0000)***}{0.409493}\varepsilon_{t-2} + \underset{(0.4227)}{0.079344}\varepsilon_{t-3} - \underset{(0.3627)}{0.071228}\varepsilon_{t-4} + \underset{(0.0517)**}{0.100889}\varepsilon_{t-5} \\ & + \underset{(0.5199)}{0.845435}\sigma^2_{\pi t} - \underset{(0.7127)}{0.031965}\sigma^2_{yt} + \underset{(0.0902)*}{0.007401}Y_{t-1} + \underset{(0.7285)}{0.001642}Y_{t-2} \\ & + \varepsilon_t \end{aligned} \qquad (5.41)$$

$$\begin{aligned}\sigma^2_{\pi t} = {} & \underset{(0.4623)}{0.000224} + \underset{(0.0000)***}{0.577852}\varepsilon^2_{t-1} + \underset{(0.0000)***}{0.675832}\sigma^2_{\pi(t-1)} - \underset{(0.0000)***}{0.052012}\pi_{t-3} \\ & + \underset{(1.0000)}{0.0000000}Y_{t-3} \end{aligned} \qquad (5.42)$$

$$Y_t = \underset{(0.9485)}{-0.002426} - \underset{(0.0000)***}{1.502485} Y_{t-1} - \underset{(0.0000)***}{0.827629} Y_{t-2} + \underset{(0.0000)***}{1.226600} \varepsilon_{t-1} + \underset{(0.0000)***}{0.550845} \varepsilon_{t-2}$$
$$- \underset{(0.3885)}{0.099843} \varepsilon_{t-3} + \underset{(0.2723)}{0.137546} \varepsilon_{t-4} + \underset{(0.0199)**}{0.158068} \varepsilon_{t-5} + \underset{(0.8300)}{2.284612} \sigma^2_{Yt}$$
$$- \underset{(0.4482)}{2.220336} \sigma^2_{\pi t} - \underset{(0.91902)}{0.011424} \pi_{t-1} - \underset{(0.6191)}{0.037378} \pi_{t-2}$$
$$+ u_t \qquad (5.43)$$
$$\sigma^2_{Yt} = \underset{(1.0000)}{0.000000} + \underset{(0.0007)***}{0.302758} \varepsilon^2_{t-1} + \underset{(0.0916)*}{0.641535} \sigma^2_{Y(t-1)} - \underset{(1.0000)}{0.000000} Y_{t-3}$$
$$+ \underset{(0.9365)}{0.001987} \pi_{t-3} \qquad (5.44)$$
$$COV = \underset{(0.0338)**}{-0.039680} \sigma_{\varepsilon t} \sigma_{\mu t} \qquad (5.45)^{9}$$

Mean inflation and its uncertainty are reported in equations (5.41) and (5.42). Results do not support the findings of Friedman (1977) that is, higher inflation increases its uncertainty and uncertainty of inflation lessens output growth. Cukierman-Meltzer (1986) hypothesis is not accepted in case of Brazil means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted. Output growth and its uncertainty are reported in equations (5.43) and (5.44). Black (1987) that is, inflation is being reduced by higher output uncertainty. Also find that higher inflation reduces output growth at 10% level of significance. Equation (5.45) represents the constant conditional correlation model of the covariance between the residuals of equations (5.42) and (5.44). For both (inflation and output growth) series β and α is significant at 1%, 5% and 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.790662 for inflation series and 0.503229 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.21. After employing the diagnostic testing, Q-statistic for the

[9] Note: This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.41) to (5.45) for Bolivia. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1%, ** at 5% and * at 10% significance level.[9]

standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

5.3.10. Brazil

In case of Brazil, we employ different tests to find out the best fitted model and the results for all the stated hypotheses. We use bi-variate student's t-distribution with Log Likelihood=1656 and ARMA (0,3) with five explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for both (inflation and output growth) series are given below:

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

$$\pi_t = \underset{(0.7535)}{-0.000088} + \underset{(0.0002)***}{0.876091}\pi_{t-1} + \underset{(0.5433)}{0.14227}\pi_{t-2} - \underset{(0.7054)}{0.082338}\varepsilon_{t-1} - \underset{(0.0072)***}{0.226927}\varepsilon_{t-2} + \underset{(0.0272)**}{0.039039}\varepsilon_{t-3} + \underset{(0.3814)}{0.286714}\sigma^2_{\pi t} - \underset{(0.9865)}{0.004645}\sigma^2_{yt} - \underset{(0.4674)}{0.012409}Y_{t-1} + \varepsilon_t \quad (5.46)$$

$$\sigma^2_{\pi t} = \underset{(0.0348)**}{0.001315} + \underset{(0.01231)**}{0.438391}\varepsilon^2_{t-1} + \underset{(0.0000)***}{0.739286}\sigma^2_{\pi(t-1)} - \underset{(0.0020)***}{0.026201}\pi_{t-3} + \underset{(0.9860)}{0.0000005}Y_{t-2} \quad (5.47)$$

$$Y_t = \underset{(0.3474)}{0.000810} - \underset{(0.0000)***}{0.547235}Y_{t-1} - \underset{(0.0000)***}{0.803169}\varepsilon_{t-1} + \underset{(0.0963)**}{0.176579}\varepsilon_{t-2} - \underset{(0.0539)**}{0.064840}\varepsilon_{t-3} + \underset{(0.3932)}{0.992829}\sigma^2_{Yt} - \underset{(0.0284)**}{0.035809}\sigma^2_{\pi t} - \underset{(0.3044)}{0.009050}\pi_{t-1} + \underset{(0.0195)**}{0.019496}\pi_{t-2} + u_t \quad (5.48)$$

$$\sigma^2_{Yt} = \underset{(0.0000)***}{0.018008} + \underset{(0.2474)}{0.361713}\varepsilon^2_{t-1} + \underset{(0.0930)*}{0.446527}\sigma^2_{Y(t-1)} + \underset{(0.9585)}{0.0000002}Y_{t-2} - \underset{(0.1615)}{0.018571}\pi_{t-3} \quad (5.49)$$

$$COV = \underset{(0.5211)}{-0.002446}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.50)$$ [10]

Mean inflation and its uncertainty are reported in equations (5.46) and (5.47). Results do not support the findings of Friedman (1977) that is, higher inflation increases

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[10] Note: This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.46) to (5.50) for Brazil. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, $\sigma^2_{Y_t}$ denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[10]

its uncertainty and uncertainty of inflation lessens output growth. Cukierman-Meltzer (1986) hypothesis is not accepted in case of Brazil means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted. Output growth and its uncertainty are reported in equations (5.48) and (5.49). Black (1987) that is, inflation is being reduced by higher output uncertainty. In this study, also found that higher output growth reduces inflation at 10% level of significance and inflation uncertainty is also reduced by output growth. Equation (5.50) represents the constant conditional correlation model of the covariance between the residuals of equations (5.47) and (5.49). For both (inflation and output growth) series β is significant at 10% level of significance and α is insignificant for output growth series. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.738731 for inflation series and 0.330223 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.22. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

5.3.11. Iran

For Iran, employ different tests to find the best fitted model and the results for all stated hypotheses. We use bi-variate normal distribution with Log Likelihood=1230.31 and ARMA (0,2) with six explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1, 1) model for both (inflation and output growth) series are given below:

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

$$\pi_t = \underset{(0.0003)***}{0.002412} + \underset{(0.0000)***}{1.359622}\pi_{t-1} - \underset{(0.0342)**}{0.615053}\pi_{t-2} - \underset{(0.0025)***}{1.06375}\varepsilon_{t-1} + \underset{(0.2670)}{0.388574}\varepsilon_{t-2} + \underset{(0.0200)**}{3.496578}\sigma_{\pi t}^2 + \underset{(0.0583)**}{0.196970}\sigma_{yt}^2 - \underset{(0.3343)}{0.004801}Y_{t-1} - \underset{(0.2628)}{0.009936}Y_{t-2} + \varepsilon_t \quad (5.51)$$

$$\sigma_{\pi t}^2 = \underset{(0.2825)}{0.003087} + \underset{(0.0007)***}{0.505437}\varepsilon_{t-1}^2 + \underset{(0.0064)***}{0.517680}\sigma_{\pi(t-1)}^2 - \underset{(0.0000)***}{0.057625}\pi_{t-3} - \underset{(0.7193)}{0.006819}Y_{t-3} \quad (5.52)$$

$$Y_t = \underset{(0.5039)}{0.001107} + \underset{(0.0717)*}{0.231589}Y_{t-1} + \underset{(0.4133)}{0.081972}Y_{t-2} - \underset{(0.0000)***}{0.882160}\varepsilon_{t-1} + \underset{(0.3296)}{0.119182}\varepsilon_{t-2} - \underset{(0.0317)**}{0.740517}\sigma_{Yt}^2 + \underset{(0.9601)}{0.261806}\sigma_{\pi t}^2 - \underset{(0.1467)}{0.338659}\pi_{t-1} + \underset{(0.1607)}{0.369263}\pi_{t-2} + u_t \quad (5.53)$$

$$\sigma_{Yt}^2 = \underset{(0.0066)***}{0.062508} + \underset{(0.0000)***}{0.219616}\varepsilon_{t-1}^2 + \underset{(0.0130)**}{0.416913}\sigma_{Y(t-1)}^2 + \underset{(0.6341)}{0.004373}Y_{t-3} + \underset{(0.9589)}{0.000899}\pi_{t-3} \quad (5.54)$$

$$COV = \underset{(0.9453)}{-0.000293}\sigma_{\varepsilon t}\sigma_{\mu t} \quad (5.55)$$[11]

Mean inflation and its uncertainty are reported in equations (5.51) and (5.52). Results do support the findings of Friedman (1977) that is higher inflation increases its uncertainty but do not support that uncertainty of inflation diminishes output growth. Cukierman-Meltzer (1986) hypothesis is not accepted in case of Iran means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted. Output growth and its uncertainty are reported in equations (5.53) and (5.54). Balck (1987) i.e., inflation is being reduced by higher output uncertainty. Also find that higher output growth increases the uncertainty of output growth and, also higher inflation increases uncertainty of output growth at 10% level of significance. Equation (5.55)

[11] Note: This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.51) to (5.55) for Iran. π_t denotes inflation, $\sigma_{\pi t}^2$ denotes conditional variances/uncertainty of inflation, σ_{Yt}^2 denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε_{t-1}^2 denotes ARCH(past shocks) effect, $\sigma_{\pi(t-1)}^2$ denotes GARCH(past variance of inflation), $\sigma_{Y(t-1)}^2$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[11]

represents the constant conditional correlation model of the covariance between the residuals of equations (5.52) and (5.54). For both (inflation and output growth) series β and α is significant at 5% and 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.523459 for inflation series and 0.222048 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.23. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 20 lags.

5.3.12. Malawi

For Malawi, employ different tests to find the best fitted model and the results for all stated hypotheses. We use bi-variate student's t-distribution with Log Likelihood=904.374 and ARMA (0,1) with five explanatory variables in mean and two variables in variance equation. The results from the bi-variate diag-BEKK GARCH-M (1,1) model for inflation and output growth series are given below:

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

$$\pi_t = \underset{(0.0151)^{**}}{0.02330} - \underset{(0.0000)^{***}}{0.506752}\pi_{t-1} + \underset{(0.0000)^{****}}{0.482588}\pi_{t-2} + \underset{(0.0000)^{***}}{0.971046}\varepsilon_{t-1} + \underset{(0.1406)}{2.834150}\sigma^2_{\pi t} - \underset{(0.1922)}{1.132159}\sigma^2_{yt} - \underset{(0.9414)}{0.000316}Y_{t-1} + \varepsilon_t \quad (5.56)$$

$$\sigma^2_{\pi t} = \underset{(0.0000)^{***}}{0.018136} + \underset{(0.0199)^{**}}{0.380396}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.645361}\sigma^2_{\pi(t-1)} - \underset{(0.0610)^{**}}{0.0000001}\pi_{t-3} - \underset{(0.2580)}{0.018636}Y_{t-2} \quad (5.57)$$

$$Y_t = \underset{(0.9868)}{-0.000330} + \underset{(0.0000)^{***}}{0.409252}Y_{t-1} - \underset{(0.0000)^{***}}{0.328670}\varepsilon_{t-1} - \underset{(0.9296)}{0.176909}\sigma^2_{Yt} + \underset{(0.9456)}{0.646256}\sigma^2_{\pi t} - \underset{(0.7784)}{0.063587}\pi_{t-1} + \underset{(0.7864)}{0.052013}\pi_{t-2} + u_t \quad (5.58)$$

$$\sigma^2_{Yt} = \underset{(0.9522)}{0.000127} + \underset{(0.1796)}{0.116877}\varepsilon^2_{t-1} + \underset{(0.0000)^{***}}{0.974758}\sigma^2_{Y(t-1)} + \underset{(0.0320)^{**}}{0.071339}Y_{t-2} + \underset{(0.7251)}{0.0000011}\pi_{t-3} \quad (5.59)$$

$$COV = \underset{(0.2937)}{0.006331}\sigma_{\varepsilon t}\sigma_{\mu t} \qquad (5.60)^{12}$$

The equation's (5.56) and (5.57) contains the mean inflation and its uncertainty results. Results do not support the findings of Friedman (1977) that is, higher inflation increases its uncertainty and uncertainty of inflation lessens output growth. Cukierman-Meltzer (1986) hypothesis is not accepted in case of Malawi means higher inflation uncertainty increases inflation and Holland (1995) hypothesis is accepted. Output growth and its uncertainty results are reported in equations (5.58) and (5.59). Mirman (1971) and Black (1987) found that uncertainty of output growth increases output growth is accepted in case of Malawi and also our findings are consistent with Deveraux (1989) that is, inflation is increased by higher output uncertainty. Equation (5.60) represents the constant conditional correlation model of the covariance between the residuals of equations (5.57) and (5.59). For both (inflation and output growth) series β and α is significant at 1%, 5% and 10% level of significance. The values of $\alpha^2 + \beta^2 < 1$ i.e., 0.561193 for inflation series and 0.963813 for output growth series, satisfying the stationary condition. Details of results are given in Table-A 5.24. After employing the diagnostic testing, Q-statistic for the standardized residuals indicates presence of serial autocorrelation. Q^2-statistic for the squared standardized residuals indicates absence of serial autocorrelation up to 10 lags.

[12] **Note:** This table displays estimates of bi-variate ARMA (p,q) diag-BEKK GARCH-M (1,1) model from eqs. (5.56) to (5.60) for Malawi. π_t denotes inflation, $\sigma^2_{\pi t}$ denotes conditional variances/uncertainty of inflation, σ^2_{Yt} denotes conditional variances/uncertainty of output growth, Y_t denotes output growth, ε^2_{t-1} denotes ARCH(past shocks) effect, $\sigma^2_{\pi(t-1)}$ denotes GARCH(past variance of inflation), $\sigma^2_{Y(t-1)}$ denotes GARCH(past variance of output growth). Lags of π_t and Y_t denotes autoregressive (AR) and moving average components by ε_{t-j}.The numbers without parenthesis are robust standard errors. The numbers in parenthesis are p-values. *** indicates significant at 1% , ** at 5% and * at 10% significance level.[12]

Summary of the results on hypotheses of all 12 developing countries are shown in the table given below:

Table-5.14 Summary of the results on Hypotheses tests

	Friedman (1977)	**Friedman (1977)**	**Cukierman-Meltzer (1986)**	**Holland (1995)**	**Mirman(1971) & Black(1987)**	**Deveraux (1989)**	**Black (1987)**
	$\pi_t \uparrow \Rightarrow \uparrow \sigma^2_{\pi t}$	$\sigma^2_\pi \uparrow \Rightarrow \downarrow Y_t$	$\sigma^2_\pi \uparrow \Rightarrow \uparrow \pi_t$	$\sigma^2_\pi \uparrow \Rightarrow \downarrow \pi_t$	$\sigma^2_{Yt} \uparrow \Rightarrow \uparrow Y_t$	$\sigma^2_{Yt} \uparrow \Rightarrow \uparrow \pi_t$	$\sigma^2_{Yt} \uparrow \Rightarrow \downarrow \pi_t$
Pak	Yes	No	Yes	No	No	No	Yes
India	No	No	yes	No	No	No	Yes
SA	No	Yes	No	Yes	No	Yes	No
Nigeria	No	No	Yes	No	No	No	Yes
Indo	No	No	No	Yes	No	Yes	No
Mexico	No	No	Yes	No	No	Yes	Yes
Algeria	Yes	No	No	Yes	Yes	No	Yes
Eucador	No	No	No	Yes	No	No	Yes
Bolivia	No	No	No	Yes	No	No	Yes
Brazil	No	No	No	Yes	No	No	Yes
Iran	Yes	No	No	Yes	No	No	Yes
Malawi	No	No	No	Yes	Yes	No	Yes

From the above discussion, we have find the ambiguous relationship of inflation, output growth and their uncertainties by using bi-variate ARMA(p,q) diag-BEKK GARCH-M (1,1) model for 12 developing countries.

Chapter 6
Conclusion

This chapter presents the summary of findings, directions for future research and policy suggestions.

6.1. Summary of Findings

In this study, the relationship among inflation, output growth and their uncertainties are investigated for 12 developing countries. Monthly data is used in this study for inflation and output growth with different ranges that depends on the availability of data for 12 different developing countries and the presence of auto regression conditional heteroskedasticity (ARCH) effect. In this study, bi-variate diag-BEKK GARCH-M (1,1) model is used to find the relationship among inflation, output growth and their uncertainties for 12 developing countries. KPSS test is used to examine the stationarity of the data and family of different GARCH models are used to find the conditional variances being used as uncertainties for further analysis. Firstly, find out that inflation is the main reason of causing inflation uncertainty(Pakistan, Algeria and Iran) but do not find any very clear evidence for supporting any consequence of uncertainty of inflation on output growth except South Africa (Friedman,1977). Secondly, find strong evidence for the Cukierman-Meltzer (1986) hypothesis that higher uncertainty of inflation leads to increase the inflation in most of the developing countries (Pakistan, India, Mexico, Indonesia and Nigeria). For Holland (1995) hypothesis, we also find strong evidence supporting that inflation uncertainty negatively relates with the inflation (Algeria, South Africa, Eucador, Bolivia, Brazil, Iran and Malawi). Also do not find very strong evidences supporting the Mirman (1971) and Black (1987) as well as for Deveraux (1989) hypothesis. Thirdly, find strong evidence for Black (1987) hypothesis that is, higher output uncertainty results to decrease the inflation (Pakistan, India, Mexico, Algeria, Eucador, Bolivia, Brazil, Iran, Malawi and Nigeria).

In this study, we also find some other relationship ambiguous relationship among these variables (inflation, output growth and their uncertainties). Firstly, find strong relationship that higher output growth reduces the inflation in developing countries (Pakistan, India, Indonesia, Mexico, Eucador and Brazil) as previously investigated in developing countries by many researchers (Briault, 1995; Klump, 2003). Secondly, higher inflation is the main reason for lower output growth in developing countries (Pakistan, India, Indonesia, South Africa and Bolivia) as previously determined by Naqvi and Khan (1989) for Pakistan. Thirdly, higher inflation also increases output growth uncertainty like Balaji (2014) find positive significant influence of inflation on uncertainty of output growth for India (Algeria, Eucador and Iran). We also find weak confirmation for supporting the hypothesis that uncertainty of inflation is reduced by higher output growth. In conclusion, the governments of developing countries must take into account the inflation rate to lower the inflation because output growth is cruelly disturbed by inflation and its prevailing uncertainty in the economy.

This study unlocks the opportunities for future research with more detailed structural breaks of inflation, output growth as well as their uncertainties of data. Researcher may take into account some other variables like price stability, investment, foreign exchange rate and political instability to get more accurate results that how inflation disturbs the output growth of the economy via different channels. The causality relationship among the variables (inflation, output growth and their uncertainties) may also depend on the political situation of an economy especially for the developing countries.

6.2. Policy Recommendations

From policy maker's point of view, uncertainty of inflation must be controlled in the developing countries because it leads to increased uncertainty of inflation in these countries. Its side effect is exchange rate volatility, which in turn leads very hazardous situation for any developing economy to survive. So price stability must be the main fundamental objective of developing economies. The positive association between inflation and its uncertainty leads to create the uncertainty of future monetary policy in the minds of public and investors. It must be controlled by central banks to ensure the price stability as well as public confidence. Central banks not only have to control the prices but also achieve the goal of higher output growth by considering nominal and real uncertainties. Spillover effects between the real and nominal uncertainties need a policy to stable the negative impressions of inflation and output growth prevailing in the economy. From Pakistan perspective, there is a need of strong monetary policy to ensure the price stability in the economy and overall increase in the output growth of the economy.

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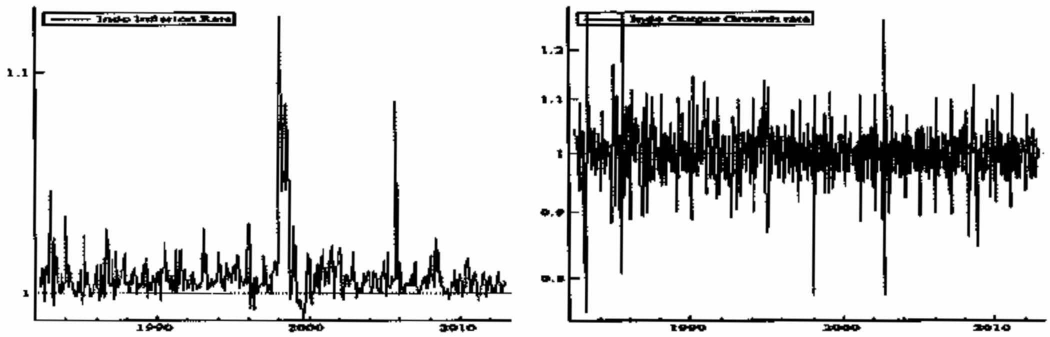
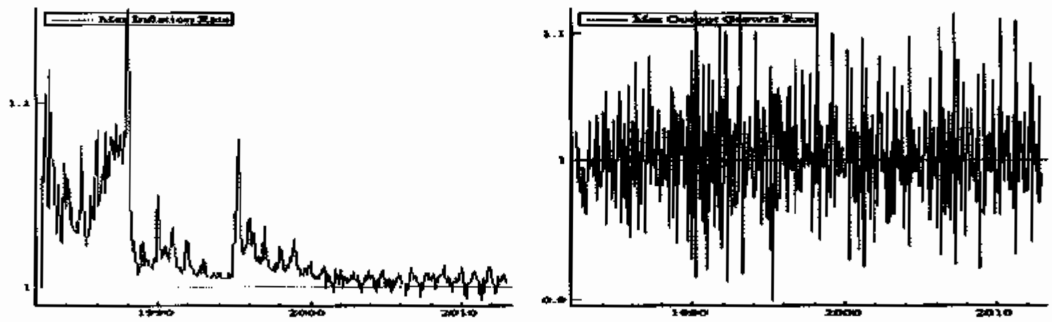
Appendices

Figure-A 4.1: Return Series of Inflation and Output Growth:

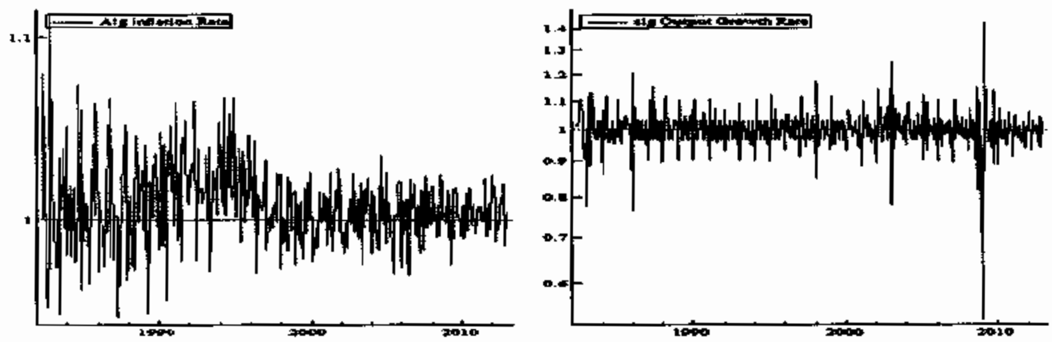
Indonesia



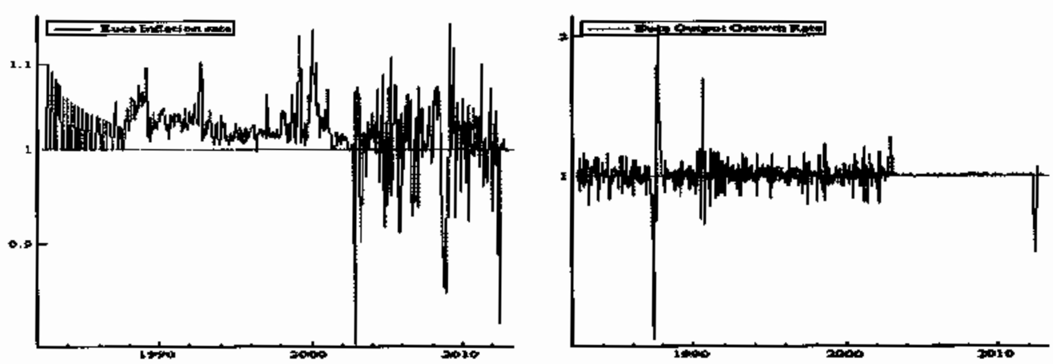
Mexico



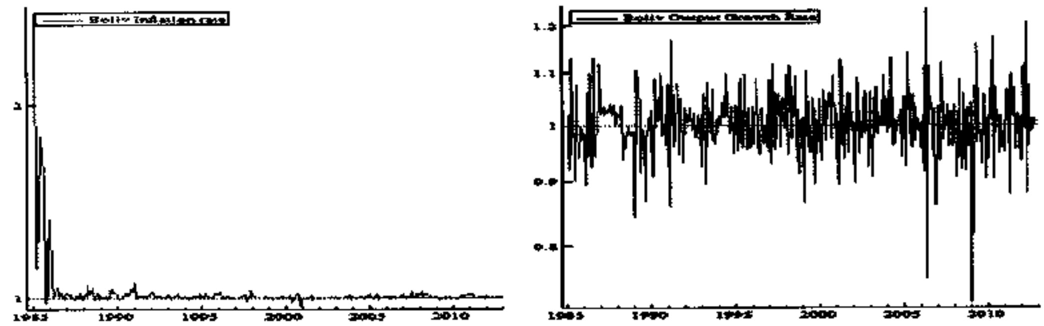
Algeria



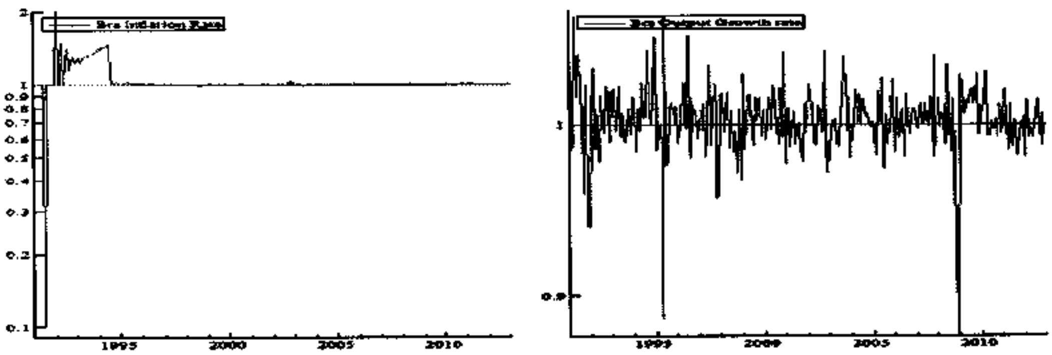
Eucador



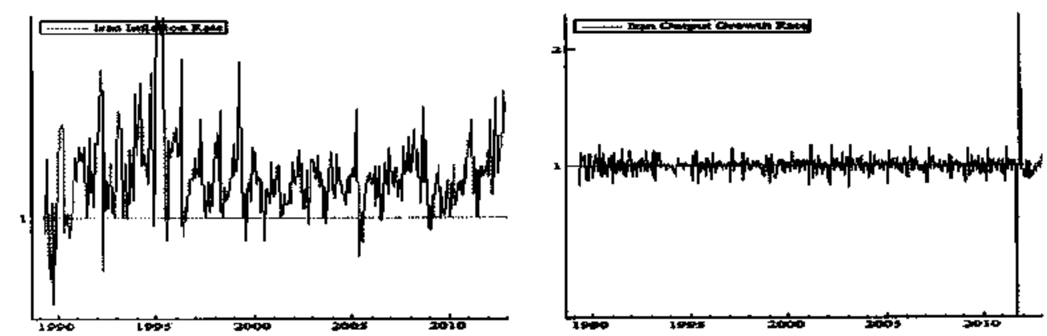
Bolivia



Brazil



Iran



Malawi

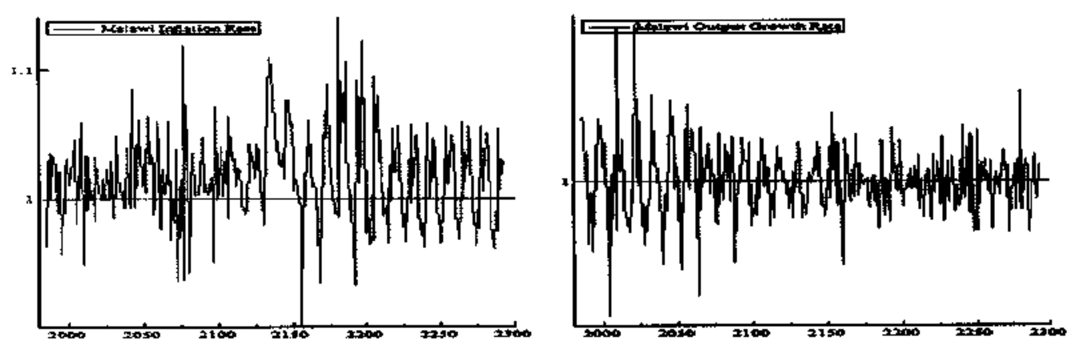
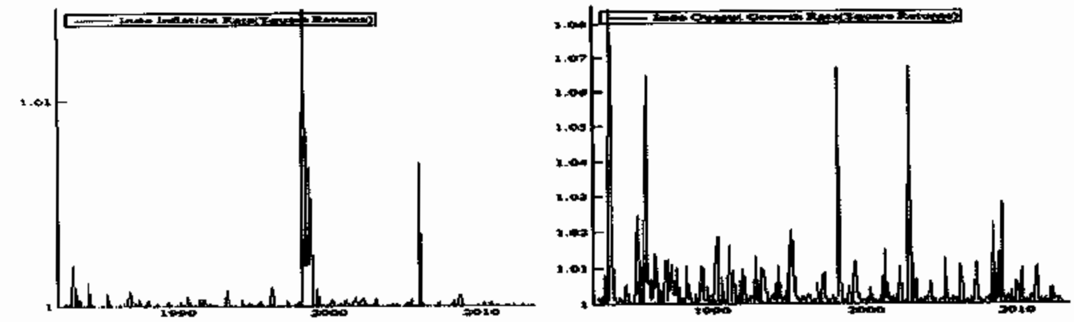
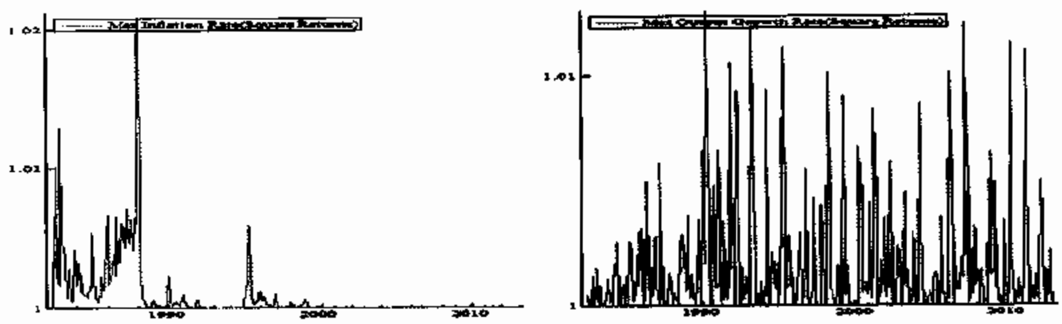


Figure-A 4.2: Squared Return Series of Inflation and Output Growth:

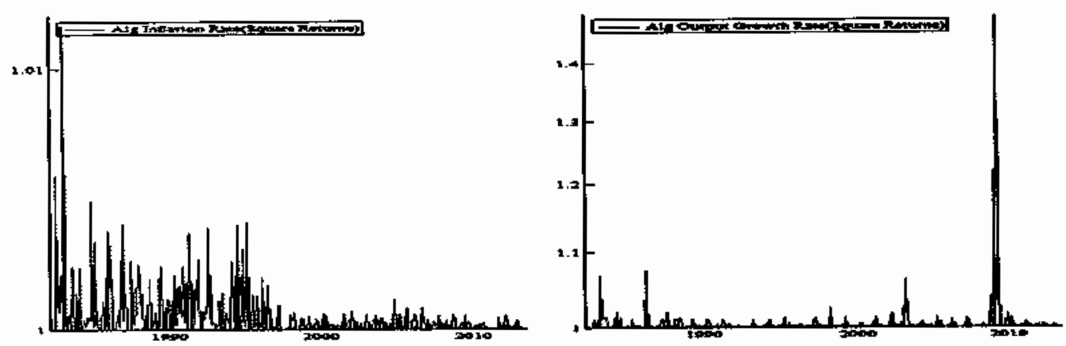
Indonesia



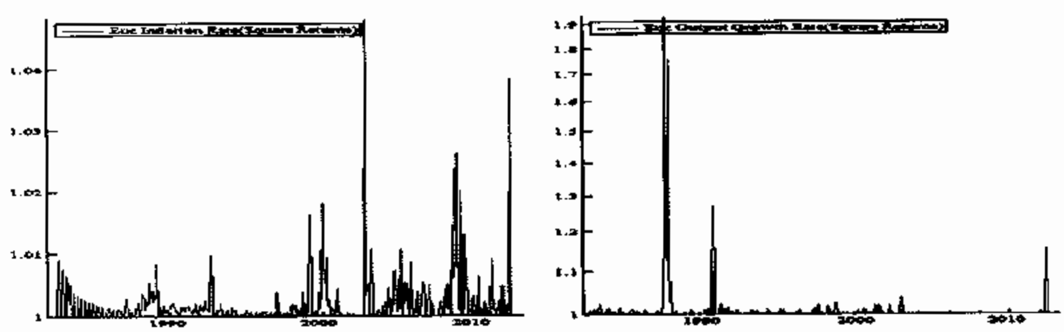
Mexico



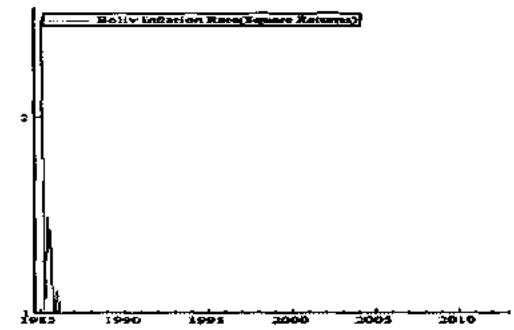
Algeria

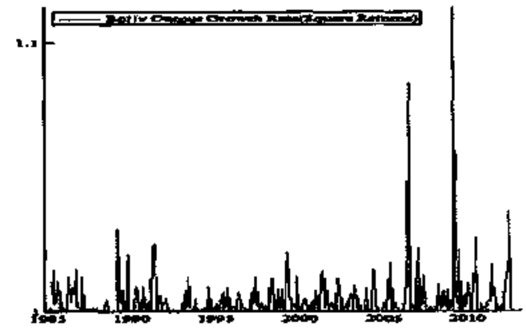


Eucador

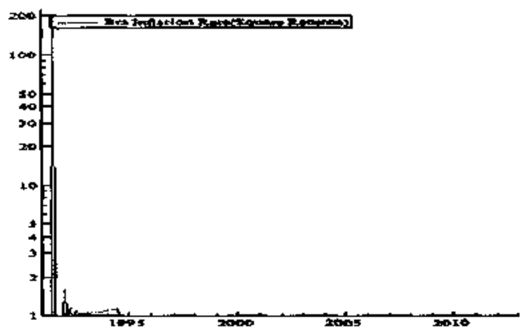


Bolivia

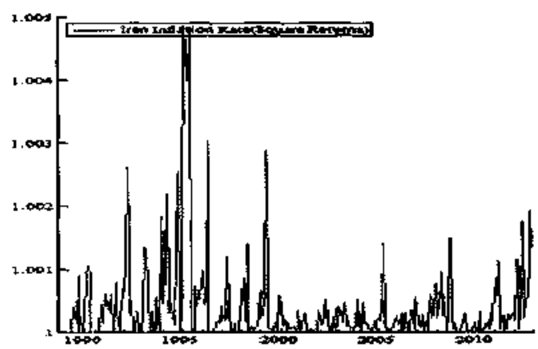


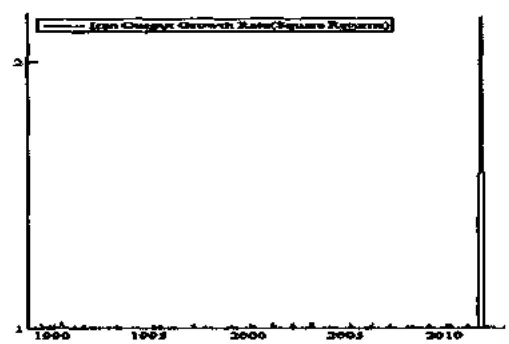


Brazil

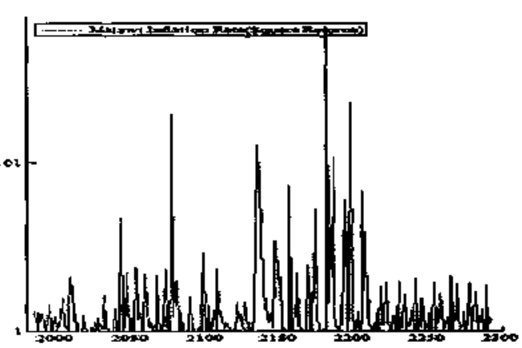


Iran





Malawi



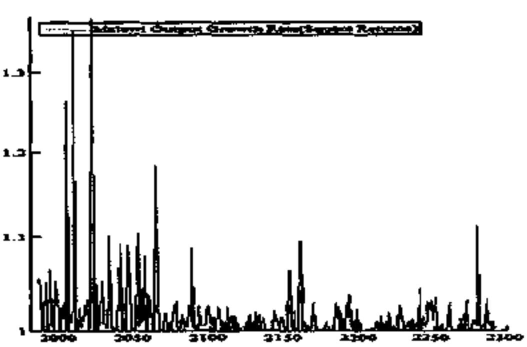
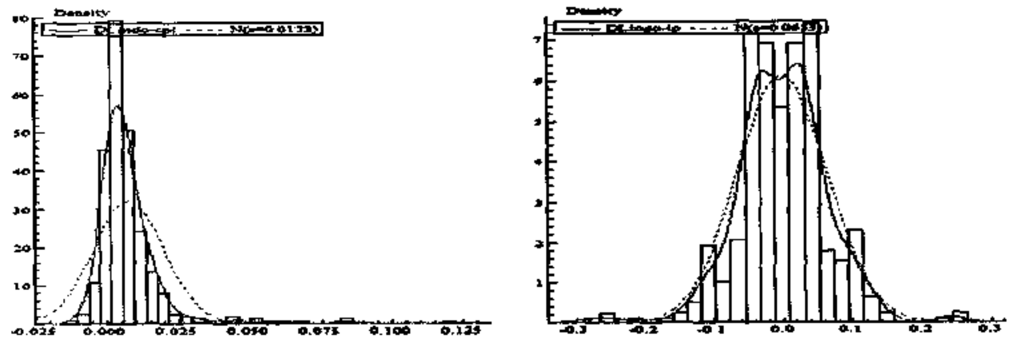
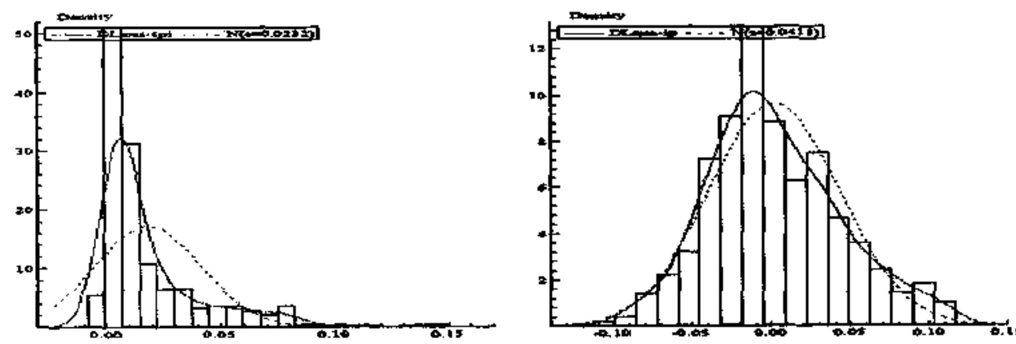


Figure-A 4.3: Histogram of Inflation and Output Growth Return Series

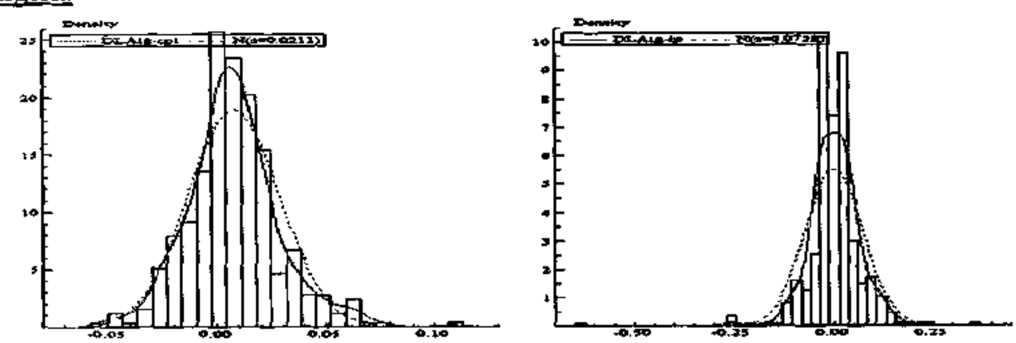
Indonesia



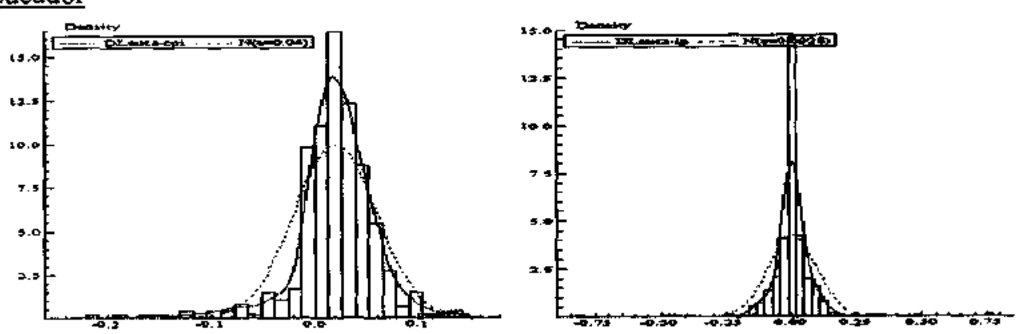
Mexico



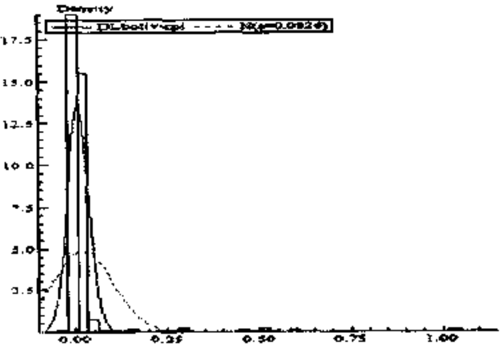
Algeria

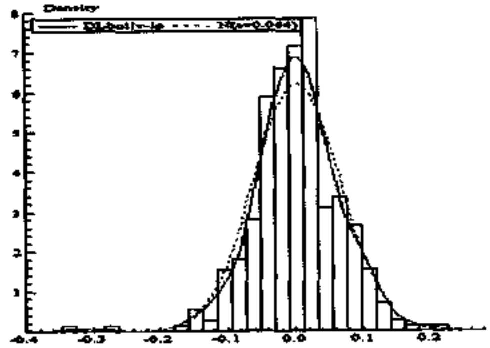


Eucador

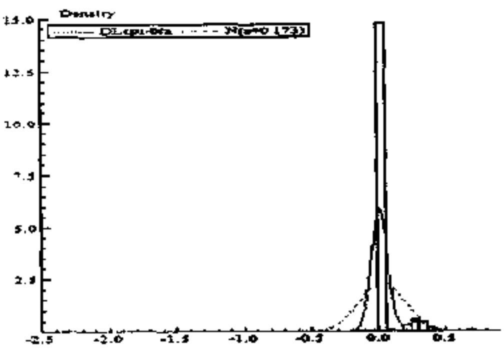


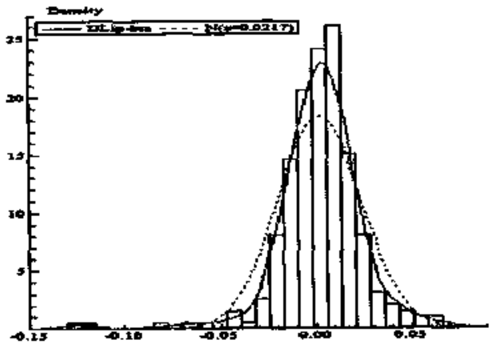
Bolivia



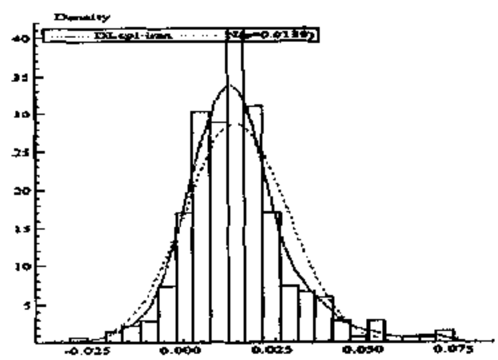


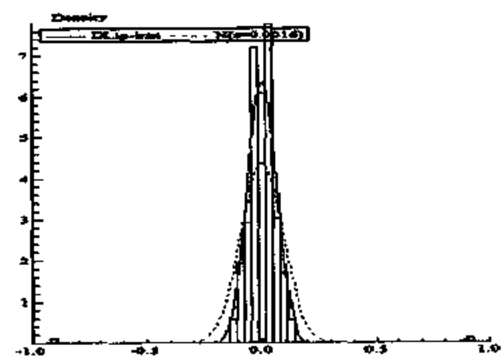
Brazil



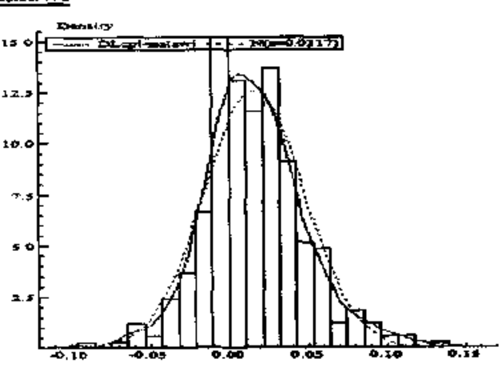


Iran





Malawi



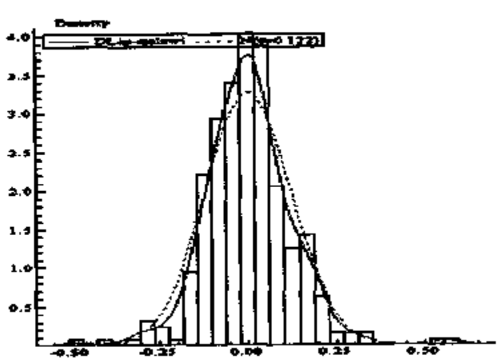
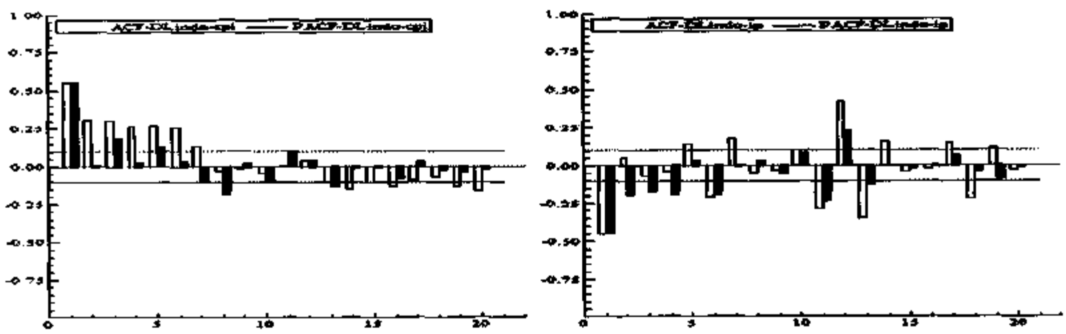
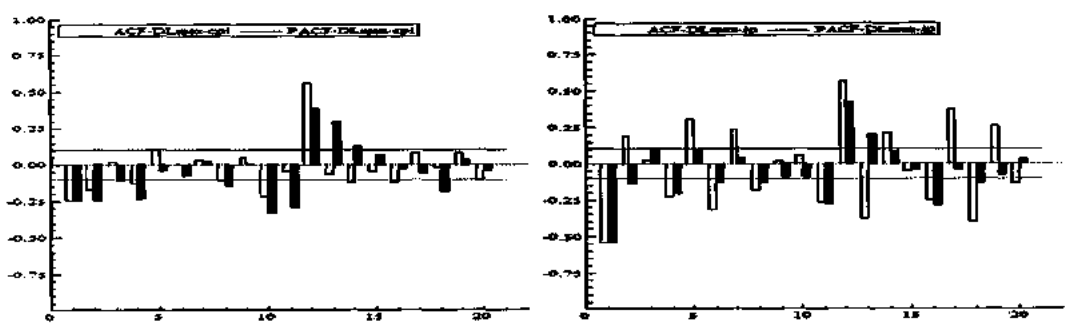


Figure-A 4.4: The Autocorrelations (ACF) and Partial Autocorrelations (PACF) of Inflation and Output Growth Return Series

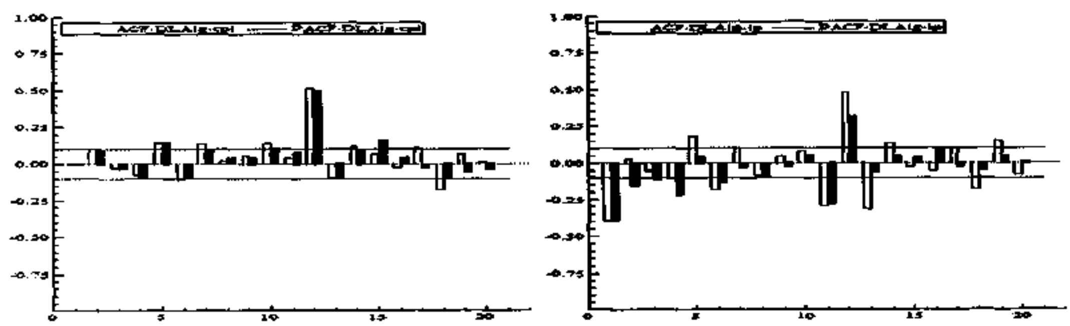
Indonesia



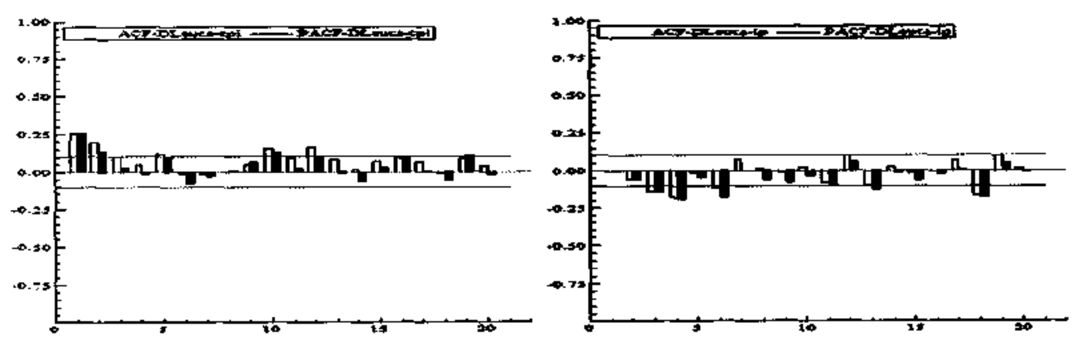
Mexico



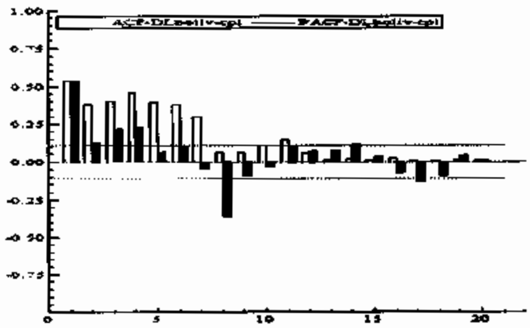
Algeria

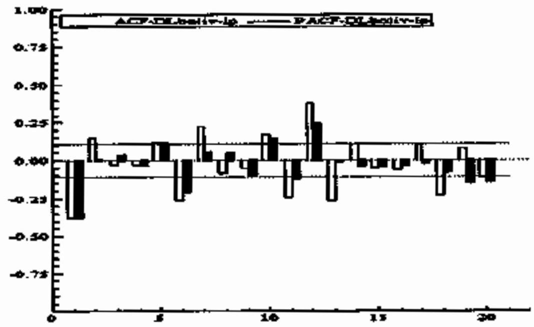


Eucador

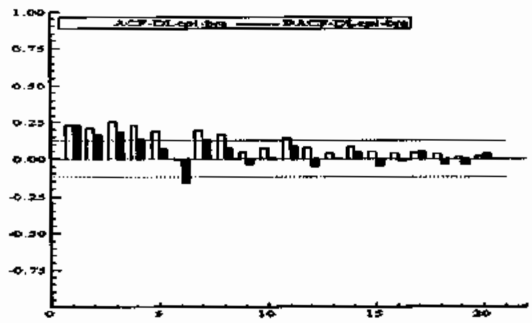


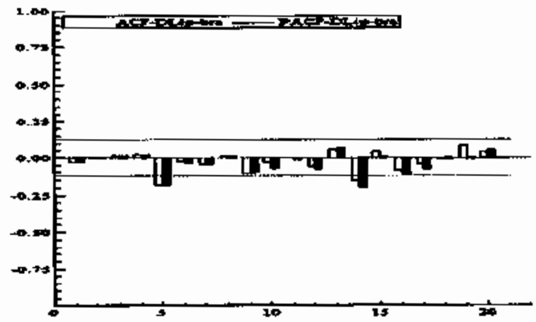
Bolivia



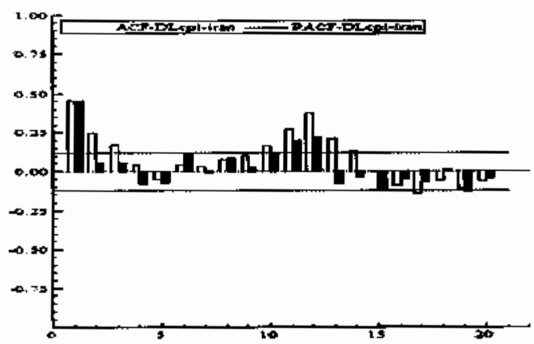


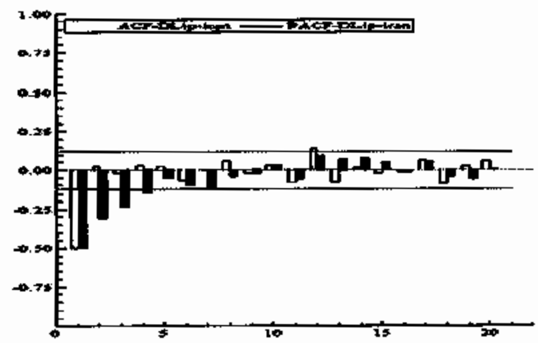
Brazil



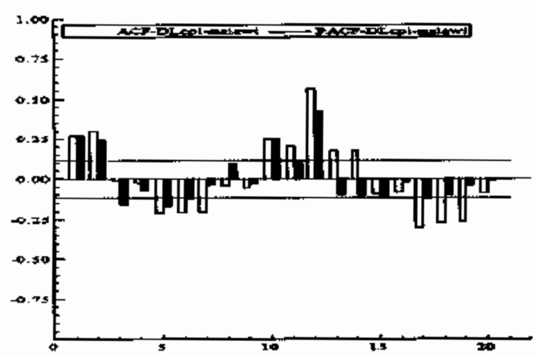


Iran





Malawi



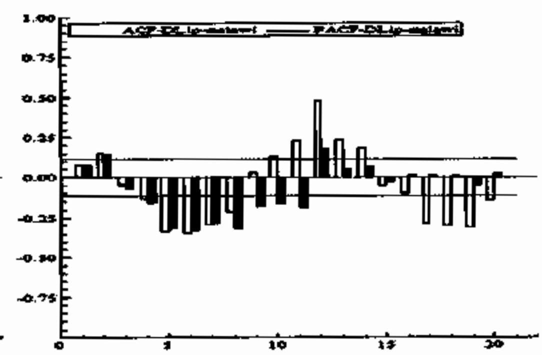
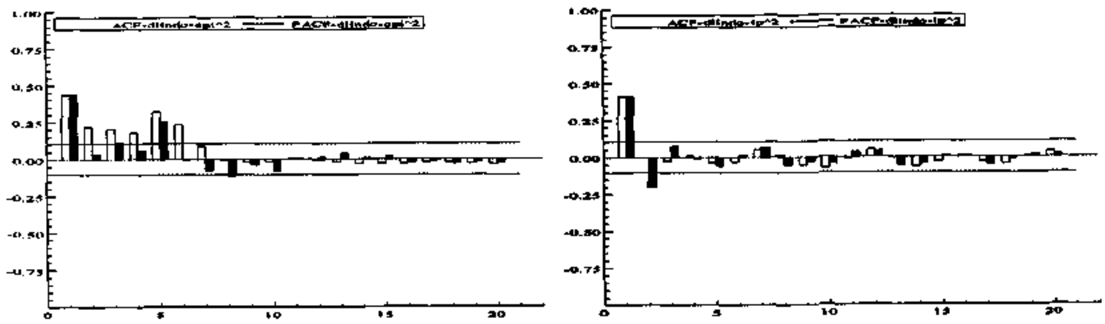
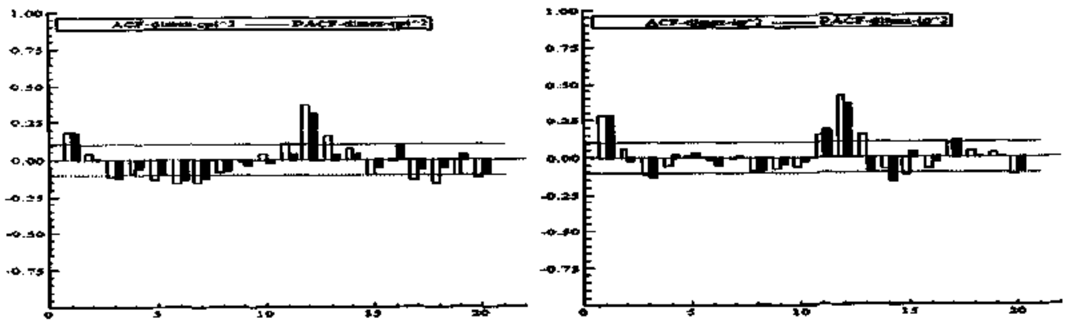


Figure-A 4.5: The Autocorrelations (ACF) and Partial Autocorrelations (PACF) of Inflation and Output Growth Squared Return Series

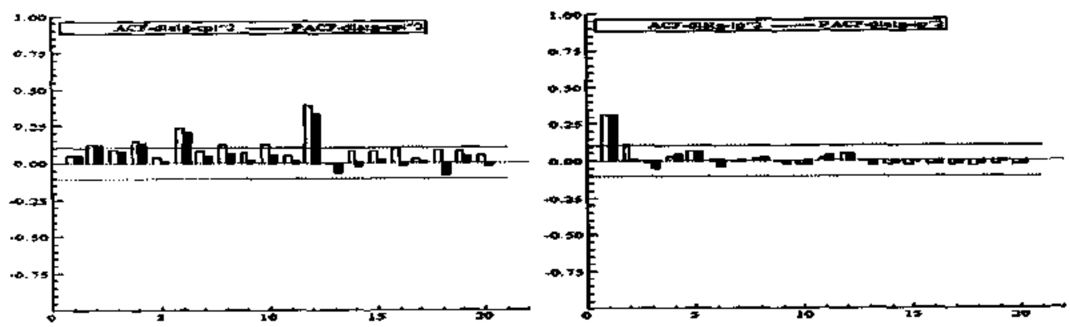
Indonesia



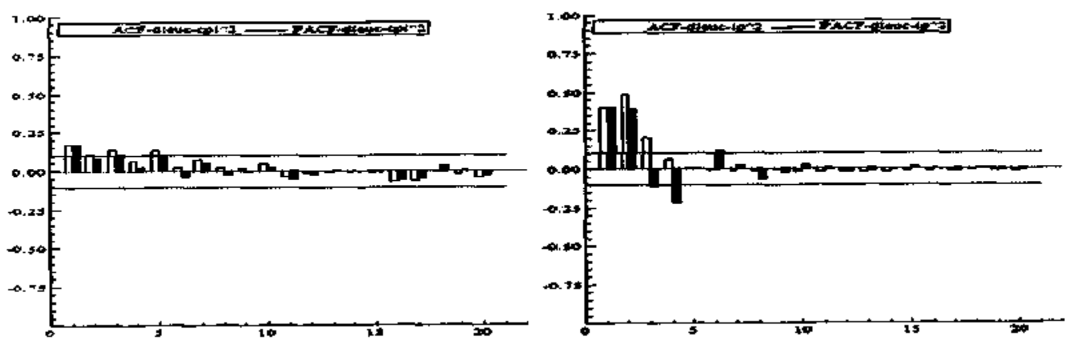
Mexico



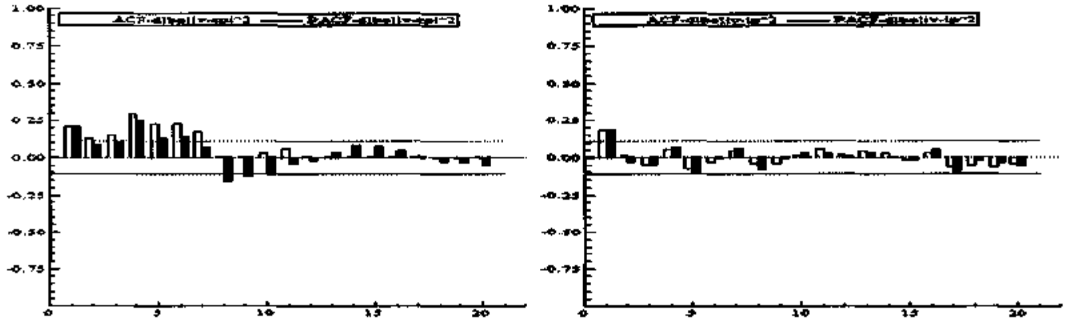
Algeria



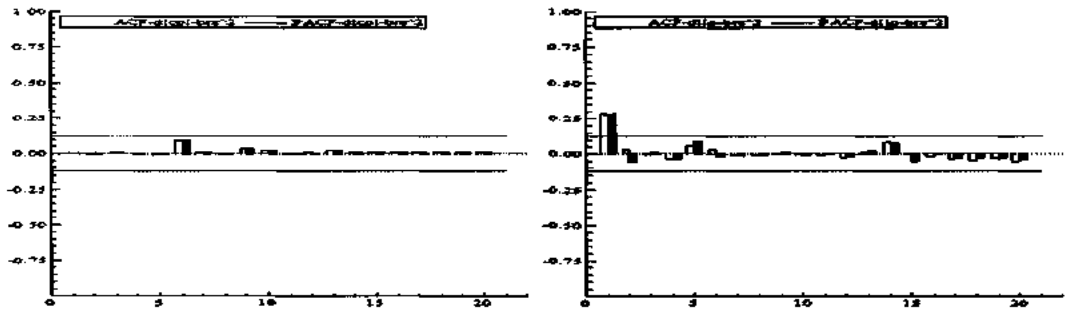
Eucador



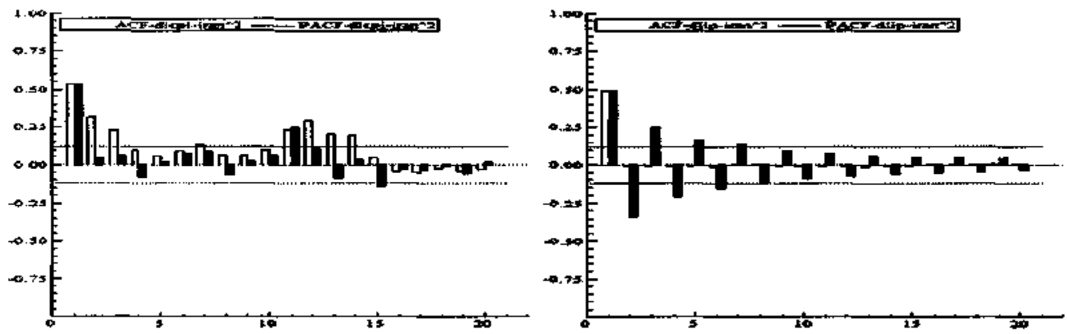
Bolivia



Brazil



Iran



Malawi

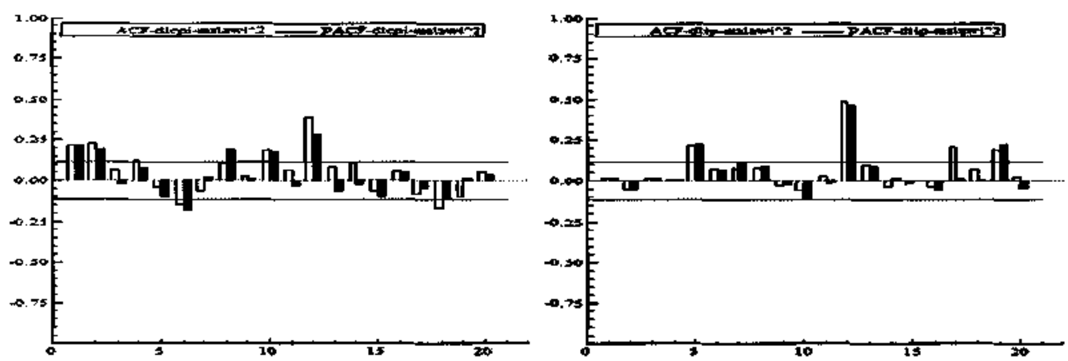


Table-A 5.1(a) GARCH (1, 1) Modeling with Normal distribution

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Model Specifications	ARMA (1,1)	ARMA (4,5)	ARMA (1,2)	ARMA (2,5)	ARMA (1,1)	ARMA (0,1)	ARMA (1,0)	ARMA (0,5)	ARMA (4,0)	ARMA (0,2)	ARMA (2,3)	ARMA (0,2)
	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)
Mean equation												
C	0.006524	0.004622	0.006208	0.004718	0.006076	-0.00219	0.006499	0.001539	0.005193	0.001753	0.006791	0.001256
t-Prob	0	0.3209	0	0	0	0.0185	0.0001	0.1142	0	0.3376	0.0012	0.0682
AR(1)	-0.57552	0.278423	0.505179	-0.73866	-0.21194		0.833326		0.014883		1	
t-Prob	0.0632	0.9703	0	0	0.3520		0		0.8018		0.0375	
AR(2)		0.987607		-0.53232					0.034924		-0.01406	
t-Prob		0.9458		0					0.6240		0.9763	
AR(3)		-0.53833							-0.004304			
t-Prob		0.9576							0.9397			
AR(4)		-0.51399							-0.041461			
t-Prob		0.7161							0.5438			
AR(5)												
t-Prob												
MA(1)	0.742493	-0.74192	-0.023183	0.046398	0.758086	-0.59393		-0.592664		-0.774808	-0.80164	-0.49849
t-Prob	0.0033	0.9240	0.7638	0.3592	0.0015	0		0		0.0048	0.0844	0
MA(2)		-1	-0.026540	0.294839				0.218659		0.139213	-0.07800	0.138088
t-Prob		0.9581	0.6145	0				0.1605		0.4474	0.8351	0.0458
MA(3)		1		-0.33194				-0.085226			-0.01045	
t-Prob		0.9479		0				0.7214			0.8439	
MA(4)		0.287299		0.033626				-0.107303				
t-Prob		0.8498		0.3338				0.6250				

MA(5)		-0.33433		-0.60826				0.038071				
t-Prob		0.8798		0				0.6842				
Variance Equation												
C	0.017788	0.001574	0.071631	7.920139	0.097596	17.86876	0.15220	2.092475	0	18.82505	0.025608	1.938317
t-Prob	0.2635	0.0007	0.3027	0.0018	0.8076	0.0019	0.1787	0.1247	1	0.0979	0.1345	0.0596
α(1)	0.030410	0.070923	0.082341	0.225082	0.268446	0.310953	0.112528	-0.021475	0.035770	0.948559	0.055400	0.169402
t-Prob	0.2834	0.8646	0.1171	0.0008	0.7042	0.1145	0.0358	0.4737	0.0973	0.1968	0.0520	0.0228
β(1)	0.937630	0.898696	0.822319	0.46625	0.696524	0.147372	0.851482	0.845173	0.959899	-0.000005	0.842423	0.405076
t-Prob	0.0000	0.0173	0.0000	0.0005	0.0004	0.4699	0	0	0	1	0	0.1103
α(1)+β(1)	0.96804	0.96962	0.90466	0.69133	-6.555994	0.45832	0.96401	0.82370	0.99567	0.94855	0.89782	0.57448
Log Likelihood	1378.036	506.335	1687.409	802.685	-6.492276	555.051	1305.31	718.851	946.862	530.077	1431.091	899.820
Akaike Criteria	-6.742190	-2.424251	-6.681545	-3.14785	-6.556515	-2.989410	-7.067017	-3.857888	-5.102510	-2.848246	-7.728756	-4.85772
Schwarz Criteria	-6.683092	-2.296205	-6.622809	-3.05555	-6.530679	-2.936311	-7.013918	-3.762310	-5.017552	-2.784527	-7.633177	-4.79400
Shibata Criteria	-6.742616	-2.426208	-6.681925	-3.14878	-6.556515	-2.989772	-7.067380	-3.859047	-5.103429	-2.848767	-7.729914	-4.85824
Hannan-Quinn	-6.718802	-2.373578	-6.658503	-3.11164	-6.530679	-2.968314	-7.045921	-3.819916	-5.068757	-2.822931	-7.690783	-4.83240

Table-A 5.1(b) GARCH(1,1) Modeling with Normal distribution

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Model Specifications	ARMA (1,0)	ARMA (1,0)	ARMA (4,2)	ARMA (0,1)	ARMA (2,0)	ARMA (0,3)	ARMA (0,1)	ARMA (0,1)	ARMA (0,1)	ARMA (5,1)	ARMA (0,1)	ARMA (0,2)
	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)
Mean equation												
C	0.026608	0.001560	0.003614	0.002442	0.005093	0.003624	0.013225	-0.00069	0.016088	0.000025	0.014395	0.001522
t-Prob	0	0.4345	0.0039	0.2698	0.0002	0.0002	0	0.6466	0	0.9809	0	0.3505
AR(1)	0.243857	-0.46852	0.468289		1					0.539024	0.509297	
t-Prob	0	0	0.0001		0					0	0	
AR(2)			0.332081		-0.24467					0.106204		
t-Prob			0		0					0.0975		
AR(3)			-0.43466							-0.07797		
t-Prob			0.0003							0.1949		
AR(4)			0.459270							-0.08835		
t-Prob			0							0.1671		
AR(5)										-0.34744		
t-Prob										0		
MA(1)			0.161692	-0.337300		-0.10531	0.357266	-0.61827	0.156748	-0.83648		-0.44204
t-Prob			0.0043	0		0.2108	0	0	0.0011	0		0
MA(2)			-0.63117			-0.06838						-0.10407
t-Prob			0			0.0407						0.1722
MA(3)						-0.05432						
t-Prob						0.2856						
MA(4)												
t-Prob												

MA(5)												
t-Prob												
Variance Equation												
C	0.097163	16.10159	0.078462	0.788075	0.012373	2.577430	0.423888	41.34531	3.626387	0.000374	0.68904	0.000470
t-Prob	0.0045	0	0.0332	0.3901	0	0	0.0023	0.0971	0.0078	0.0007	0.0199	0.0025
α(1)	0.043861	0.560032	0.485370	0.014128	0.026747	0.551220	0.354234	0.043287	0.21054	0.050348	0.111096	0.174991
t-Prob	0.0001	0	0.0148	0.2121	0	0.0777	0.0044	0.015	0.1164	0.1575	0.0998	0.0034
β(1)	0.956717	0.150282	0.521004	0.964490	0.865786	-0.00001	0.389178	0.140357	0.421225	0.908992	0.740193	0.752347
t-Prob	0	0.0002	0	0	0	0.9999	0.002	0.2518	0.0165	0	0	0
α(1)+β(1)	1.00058	0.71031	1.00637	0.97862	0.89253	0.55121	0.74341	0.18364	0.63176	0.95934	0.85129	0.92734
Log Likelihood	721.015	541.273	1106.310	469.647	789.523	659.578	864.727	349.487	640.169	290.108	765.954	345.435
Akaike Criteria	-3.89139	-2.91453	-6.545137	-2.774013	-5.95835	-4.96256	-6.05442	-2.42596	-4.12448	-1.81889	-4.87791	-2.17586
Schwarz Criteria	-3.83829	-2.86143	-6.431282	-2.717085	-5.87685	-4.86749	-5.99018	-2.36172	-4.06392	-1.69778	-4.81793	-2.10388
Shibata Criteria	-3.89175	-2.91489	-6.546851	-2.774450	-5.95936	-4.96393	-6.05502	-2.42657	-4.12499	-1.82091	-4.87842	-2.17658
Hannan-Quinn	-3.87029	-2.89344	-6.499746	-2.751317	-5.9256	-4.92436	-6.02866	-2.40021	-4.10026	-1.77046	-4.85394	-2.14709

Table-A 5.2(a) Diagnostic Test n-GARCH(1,1)

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Normality Test												
Skewness	1.2853	0.15273	-0.17007	0.32896	3.0415	-1.4543	2.1039	0.17267	0.17727	-1.9649	1.0118	-0.19081
p-value	2.2787e-026	0.20677	0.11834	0.00252	2.0514e-126	2.7737e-030	1.7781e-061	0.17454	0.16333	7.4617e-054	1.7752e-015	0.13351
Excess Kurtosis	7.2316	0.23613	1.4372	-0.41199	18.206	5.5971	11.139	0.33627	0.92486	10.171	3.1742	0.70533
p-value	3.1174e-197	0.32791	3.7850e-011	0.058038	0	6.9108e-108	0	0.18497	0.000266	0	6.3174e-036	0.0054271
Jarque-Bera	998.92	2.5278	45.718	12.629	5649.6	610.08	2173.8	3.5625	15.043	1822.9	217.28	9.8613
p-value	1.2242e-217	0.28254	1.1816e-010	0.00181	0	3.3377e-133	0	0.16843	0.000541	0	6.5699e-048	0.0072218
Q-Statistics on Standard Residuals												
Q(5)	9.53315		14.7889	39.0838	14.0156	6.08729	3.22917		2.89472	8.92806		11.4843
p-value	[0.0229813]*		[0.006147]**	[0.0000000]**	[0.0028840]**	[0.1927233]	[0.5202330]		[0.0888701]	[0.0302629]*		[0.0093759]**
Q(10)	17.4595	33.0217	41.9205	284.549	20.2824	22.4084	5.95389	32.9866	11.9274	20.3220	25.5871	25.2032
p-value	[0.0256645]*	[0.0000000]**	[0.00000005]**	[0.0000000]**	[0.0093188]**	[0.0076710]**	[0.7445242]	[0.00000038]**	[0.0636077]	[0.0091841]**	[0.0001073]**	[0.0014360]**
Q(15)	61.8837	123.046	148.046		58.2003	113.535	58.2824	190.220	129.319	115.352	58.5888	47.8052
p-value	[0.0000010]**	[0.0000000]**	[0.0000000]**		[0.0000040]**	[0.000000]**	[0.0000072]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000004]**	[0.0001609]**
Q(20)	203.503	207.781	365.150		107.928	413.990	167.553	536.137	308.160	389.059	155.734	124.539
p-value	[0.0000000]**	[0.0000000]**	[0.0000000]**		[0.0000017]**	[0.000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.374258	1.71530	2.69858	2.75802	1.11687	0.203262	3.47617	8.2327	1.95470	9.44277	2.26378	1.20505
p-value	[0.9455072]	[0.6335382]	[0.4404680]	[0.4304572]	[0.7730031]	[0.9770610]	[0.3238654]	[0.0414457]*	[0.5818627]	[0.0239480]*	[0.5194950]	[0.7517936]
Q(10)	0.655709	5.87140	6.23238	6.3934	1.64837	4.18781	5.04104	20.4347	2.78123	10.9676	4.38972	4.33355
p-value	[0.999629	[0.661634	[0.6212200	[0.6032546	[0.9899618]	[0.839793	[0.7531812	[0.0088107	[0.947327	[0.203542	[0.820362	[0.825846

	1]	1]	]	]		3]	]	]**	3]	0]	7]	2]
Q(15)	8.58455	25.0712	29.7780		3.02048	7.98383	6.52755		19.8920	21.4927	14.5135	13.5283
p-value	[0.968604 4]	[0.147059 1]	[0.0396615]*		[0.9999708]	[0.978876 3]	[0.9935423]		[0.338933 4]	[0.255288 1]	[0.695058 1]	[0.759280 2]
Q(20)	15.9809	58.2767	67.0009		6.03050	28.8182	20.6298		62.1273	61.8942	28.1233	49.1869
p-value	[0.999996 3]	[0.147059 1]	[0.0362445]*		[1.00000000]	[0.987228 6]	[0.9998118]		[0.082689 7]	[0.085791 3]	[0.990207 9]	[0.425388 8]
					ARCH Test							
ARCH(1-2)	0.006894	0.414132	0.28987	0.25225	0.36435	0.081167	1.5437	0.29512	0.50147	0.26978	0.53404	0.076537
p-value	[0.9931]	[0.6611]	[0.7485]	[0.7772]	[0.6949]	[0.9221]	[0.2150]	[0.7446]	[0.6061]	[0.7637]	[0.5867]	[0.9263]
ARCH(1-5)	0.070260	0.34123	0.48063	0.55704	0.20800	0.039439	0.49071	1.6709	0.37742	1.8400	0.42922	0.23301
p-value	[0.9965]	[0.8878]	[0.7908]	[0.7330]	[0.9590]	[0.9991]	[0.7832]	[0.1408]	[0.8641]	[0.1043]	[0.8282]	[0.9479]
ARCH(1-10)	0.40678	0.61928	0.58244	0.61591	0.16116	0.47722	0.36721	1.9578	0.92656	1.1082	0.35029	0.43755
p-value	[0.9433]	[0.7976]	[0.8287]	[0.8007]	[0.9985]	[0.9045]	[0.9601]	[0.0371]*	[0.5087]	[0.3549]	[0.9662]	[0.9276]
					Residual based diagnostic							
RBD(2)	0.046014	0.692876	-0.583641	1.27067	0.159217	0.205799	7.16121	-1.20185	0.818715	0.236195	1.60981	0.994520
p-value	[0.977255 9]	[0.707202 7]	[1.000000]	[0.5297573]	[0.9234780]	[0.902217 6]	[0.0278588]	[1.0000000]	[0.664076 9]	[0.888609 2]	[0.447130 6]	[0.608195 0]
RBD(5)	1.38828	2.52398	2.07132	4.73335	0.688879	0.234081	8.20070	-9.07962	2.12403	13.4383	2.88490	3.31293
p-value	[0.925591 1]	[0.772879 7]	[0.8391910]	[0.4492815]	[0.9835734]	[0.998702 5]	[0.1455162]	[1.0000000]	[0.831730 2]	[0.019600 1]	[0.717725 1]	[0.651862 6]
RBD(10)	1.16835	7.87862	4.71341	7.20337	1.26433	4.36696	6.62234	7.60856	4.63681	14.6522	4.23409	5.41703
p-value	[0.999650 4]	[0.640691 4]	[0.9094820]	[0.7061165]	[0.9995012]	[0.929278 3]	[0.7605525]	[0.6670117]	[0.914082 9]	[0.145266 6]	[0.936169 2]	[0.861638 4]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.2(b) Diagnostic Test n-GARCH (1, 1)

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Normality Test												
Skewness	-1.6783	-2.4231	0.74627	-0.92796	-5.428	-0.57482	0.48114	-7.7762	0.17568	0.18991	0.57953	-0.56285
p-value	9.0951e-040	6.1218e-081	2.1298e-008	3.2885e-012	5.23E-286	0.00012955	0.000876	0	0.20595	0.17155	2.68E-05	4.5383e-005
Excess Kurtosis	20.687	18.468	2.1365	3.4352	68.973	4.4959	1.1211	98.12	1.5399	0.79908	1.3335	2.4623
p-value	0	0	8.9134e-016	3.0920e-0.38	0	5.2184e-051	0.0001	0	2.69E-08	0.003907	1.26E-06	3.6116e-019
Jarque-Bera	6734.6	5589.9	94.806	212.79	53423	235.98	25.832	1.17E+05	32.014	10.046	40.58	95.290
p-value	0	0	2.5884e-021	6.2062e-047	0.00E+00	5.7083e-052	2.46E-06	0	1.12E-07	0.006586	1.54E-09	2.0324e-021
Q-Statistics on Standard Residuals												
Q(5)	14.8453	6.27747		10.2529	21.9869	13.6124	13.3578	1.81445	36.0575		7.98033	6.78268
p-value	[0.0050332]**	[0.1793628]		[0.0363769]*	[0.0000656]**	[0.0011069]**	[0.0096536]**	[0.7698368]	[0.0000003]**		[0.0923014]	[0.0791567]
Q(10)	22.9608	15.3360	30.4569	37.8224	23.2094	20.2928	23.7979	8.30047	76.7277	17.2875	12.828	14.6650
p-value	[0.0062849]**	[0.0821115]	[0.0000040]**	[0.0000188]**	[0.0031056]**	[0.00429708]**	[0.0046326]**	[0.5041723]	[0.0000000]**	[0.0016994]**	[0.1705456]	[0.0659952]
Q(15)	38.5631	52.4581	49.8509	117.097	25.4126	42.4735	84.0521	19.8473	249.851	35.672	37.6135	48.3442
p-value	[0.0050284]**	[0.0000565]**	[0.0000065]**	[0.0000000]**	[0.1139674]	[0.0005728]**	[0.0000000]**	[0.4038166]	[0.0000000]**	[0.0011681]**	[0.0066437]**	[0.0001338]**
Q(20)	89.9695	115.089	101.177	259.794	52.45	97.4048	200.235	44.1687	575.049	67.1952	94.0881	145.262
p-value	[0.0003255]**	[0.0000003]**	[0.0000021]**	[0.0000000]**	[0.3055669]	[0.0000222]**	[0.0000000]**	[0.6689765]	[0.0000000]**	[0.0137252]*	[0.0001141]**	[0.000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.888854	0.191369	8.60660	6.16174	4.60336		0.586451	0.090583	1.33332	1.46318	3.26569	2.22702
p-value	[0.0003255]**	[0.9789705]	[0.0350056]*	[0.1040010]	[0.2032544]		[0.8995269]	[0.9929431]	[0.7212368]	[0.6907942]	[0.3524464]	[0.5266457]
Q(10)	1.42788	0.539663	13.3297	10.3374	4.66393	8.08645	3.55224	0.149773	7.98758	6.39454	12.9616	8.26716
p-value	[0.993841	[0.999821	[0.1009966	[0.2421394	[0.7928173]	[0.425071	[0.8950977	[0.9999988	[0.434684	[0.603127	[0.113177	[0.407817

	7]	8]	]	]		3]	]	]	7]	6]	2]	8]
Q(15)	2.45748	0.978309	19.1254	14.4386	4.68987	15.1032	35.189	0.197746	33.0245	26.6086	19.9928	13.5545
p-value	[0.9999941]	[1.0000000]	[0.3841407]	[0.7000873]	[0.9992659]	[0.6548660]	[0.0089478]**	[1.0000000]	[0.0165767]*	[0.0866357]	[0.3332278]	[0.7576339]
Q(20)	36.9131	2.98999	51.4648	59.8732	5.59688	40.1366	75.8279	0.331567	93.4455	43.6804	43.0936	31.956
p-value	[0.8776222]	[1.0000000]	[0.3397434]	[0.1168220]	[1.0000000]	[0.7829012]	[0.0063870]**	[1.0000000]	[0.0000943]**	[0.6503251]	[0.6737190]	[0.9637689]
ARCH Test												
ARCH(1-2)	0.066384	0.064259	1.3334	2.0964	2.2684	0.012324	0.088284	0.026996	0.21354	0.40244	0.62412	0.70435
p-value	[0.9358]	[0.9378]	[0.2650]	[0.1245]	[0.1055]	[0.9878]	[0.9155]	[0.9734]	[0.8078]	[0.6690]	[0.5364]	[0.4952]
ARCH(1-5)	0.17026	0.036968	2.0660	1.3452	0.89403	0.93511	0.14902	0.01699	0.26553	0.26752	0.6571	0.30109
p-value	[0.9735]	[0.9993]	[0.0694]	[0.2449]	[0.4856]	[0.4588]	[0.9802]	[0.9999]	[0.9317]	[0.9306]	[0.6563]	[0.9120]
ARCH(1-10)	0.13057	0.11901	1.2203	1.1106	1.497	0.76409	0.40285	0.013314	0.75779	0.61657	1.084	0.63941
p-value	[0.9994]	[0.9996]	[0.2769]	[0.3535]	[0.1410]	[0.6633]	[0.9447]	[1.00000]	[0.6695]	[0.7995]	[0.3743]	[0.7796]
Residual based diagnostic												
RBD(2)	0.129605	0.131483	-4.09410	6.66334	0.081741	0.028203	0.281991	0.055826	1.2099	1.61601	1.28272	1.07394
p-value	[0.9372524]	[0.9363728]	[1.000000]	[0.0357333]	[0.0832230]	[0.9859974]	[0.8684932]	[0.9724731]	[0.5461014]	[0.4457460]	[0.5265751]	[0.5845163]
RBD(5)	0.884078	0.190345	-0.945345	11.5193	4.98376	-0.98017	1.09929	0.090084	1.46371	-0.57112	-0.64074	0.968536
p-value	[0.9713636]	[0.9992143]	[1.000000]	[0.0420023]	[0.4178651]	[1.000000]	[0.9541664]	[0.9998745]	[0.9172188]	[1.0000000]	[1.0000000]	[0.9650634]
RBD(10)	1.42041	1.25883	10.8189	36.2505	0.129197	0.050359	4.05573	0.150298	4.16154	3.29622	2.56285	5.19738
p-value	[0.9991625]	[0.9995108]	[1.000000]	[0.0000762]	[1.0000000]	[1.000000]	[0.9447981]	[1.0000000]	[0.9397653]	[0.9735689]	[0.9899278]	[0.8776085]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 50 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.3(a) EGARCH (1, 1) Modeling with Normal distribution

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Model Specifications	ARMA (1,1)	ARMA (4,5)	ARMA (1,2)	ARMA (2,5)	ARMA (1,1)	ARMA (0,1)	ARMA (1,0)	ARMA (0,5)	ARMA (4,0)	ARMA (0,2)	ARMA (2,3)	ARMA (0,2)
	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)
Mean equation												
C	0.003634		0.0065356	0.005806	0.005308	-0.00504		-0.000154	0.00527		-0.00334	0.000449
t-Prob	0.3039		0	0	0	0.0004		0.9088	0		0.6267	0.6124
AR(1)	0.986863		0.484512	-1	-0.198195				0.019229		-0.00273	
t-Prob	0.0000		0	0	0.3030				0.7077		0.5479	
AR(2)				-0.06426					0.029146		1	
t-Prob				0.5974					0.5779		0	
AR(3)									0.098725			
t-Prob									0.0495			
AR(4)									-0.046501			
t-Prob									0.4021			
AR(5)												
t-Prob												
MA(1)	-0.92269		0.002953	0.501926	0.789756	-0.61671		-0.552611			0.252471	-0.51923
t-Prob	0.0000		0.9745	0	0	0		0			0	0
MA(2)			-0.036217	-0.43812				0.169132			-0.94839	0.167779
t-Prob			0.4615	0				0.0022			0	0.0271
MA(3)				0.241767				0.200304			-0.21923	
t-Prob				0				[0.0036			0	
MA(4)				-0.33561				-0.155441				
t-Prob				0				0.0074				
MA(5)				-0.6489				0.144109				

t-Prob				0				0				
Variance Equation												
C	0.030623		1	0.071382	0	0.097456		0	0.021704		0.049623	0.032523
t-Prob	0.9914		0	1	1	1		1	0.9968		0.9817	1
α(1)	0.782107		0.601864	5.165465	-0.223451	-0.35939		0.215252	0.401562		0.276315	-0.12406
t-Prob	0.1291		0.1492	0.8072	0.3585	0.0117		0.2518	0.3429		0.3823	0.4193
β(1)	0.996213		0.994787	0.997581	0.988035	0.997093		0.994998	0.998026		1.000835	0.993631
t-Prob	0.0000		0	0	0	0		0	0		0	0
θ(1)	0.041498		0.083386	-0.0023	-0.100303	0.196954		-0.412368	0.070056		-0.07288	-0.04172
t-Prob	0.2151		0.0401	0.7739	0.5200	0.0527		0	0.1136		0.2601	0.5286
θ(2)	0.361694		0.391422	0.058853	0.999995	0.653879		0.560245	0.398965		0.680760	0.765762
t-Prob	0.0012		0.0001	0.7721	0.0010	0.0014		0	0.0026		0.0067	0.0001
α(1)+β(1)	1.77832		1.596651	6.163046	0.764584	0.637701		1.21025	1.399588		1.27715	0.869569
Log Likelihood	1354.196	378.674	1617.492	760.003	1182.970	517.134	1322.45	686.912	908	506.015	1372.845	846.403
Akaike Criteria	-6.615213		-6.395596	-2.97019	-6.385706	-2.772465		-3.673433	-4.883004		-7.401331	-4.55653
Schwarz Criteria	-6.536415		-6.320079	-2.86111	-6.300748	-2.698127		-3.556616	-4.776806		-7.284513	-4.47157
Shibata Criteria	-6.615966		-6.396222	-2.97148	-6.386625	-2.773171		-3.675152	-4.884430		-7.403050	-4.55745
Hannan-Quinn	-6.584029		-6.365971	-2.9274	-6.351953	-2.742931		-3.627023	-4.840813		-7.354920	-4.52278

Table-A 5.3(b) EGARCH (1, 1) Modeling with Normal distribution

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Model Specifications	ARMA (1,0)	ARMA (1,0)	ARMA (4,2)	ARMA (0,1)	ARMA (2,0)	ARMA (0,3)	ARMA (0,1)	ARMA (0,1)	ARMA (0,1)	ARMA (5,1)	ARMA (0,1)	ARMA (0,2)
	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)
Mean equation												
C	0.024787	0.013482		0.006510	0.005641		0.012888					
t-Prob	0	0		0.0720	0		0					
AR(1)	0.046363	-0.51449			0.713834							
t-Prob	0.2699	0			0							
AR(2)					-0.00826							
t-Prob					0.8924							
AR(3)												
t-Prob												
AR(4)												
t-Prob												
AR(5)												
t-Prob												
MA(1)				-0.367029			0.384046					
t-Prob				0			0					
MA(2)												
t-Prob												
MA(3)												
t-Prob												
MA(4)												
t-Prob												

MA(5)												
t-Prob												
					Variance Equation							
C	0	0		0.189772	0.050993		0.029161					
t-Prob	1	1		1	1		0.9979					
α(1)	0.466723	-0.46874		0.430747	-0.03993		-0.12206					
t-Prob	0.1551	0		0.2431	0.892		0.5237					
β(1)	0.982390	0.979837		0.991153	1.046386		0.99443					
t-Prob	0	0		0	0		0					
θ(1)	-0.045935	-0.247839		-0.045506	0.036063		0.240908					
t-Prob	0.0708	0.2086		0.3896	0.3609		0.065					
θ(2)	0.452329	0.999995		0.348905	0.307951		0.772031					
t-Prob	0.0001	0		0	0.0112		0					
α(1)+β(1)	1.449113	0.511102		1.4219	1.006456		0.87237					
Log Likelihood	685.274	455.435	1111.675	429.118	930.56	629.708	825.458	280.196	604.752	271.948	693.786	339.236
Akaike Criteria	-3.686274	-2.437145		-2.520107	-7.01566		-5.76379					
Schwarz Criteria	-3.611936	-2.362807		-2.440409	-6.907		-5.67385					
Shibata Criteria	-3.686980	-2.437851		-2.520957	-7.01744		-5.76496					
Hannan-Quinn	-3.656740	-2.407611		-2.488334	-6.972		-5.72773					

Table-A 5.4(a) Diagnostic Test n-EGARCH (1, 1)

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
						Normality Test						
Skewness	0.16248		-0.31826	0.84103	2.0848	-1.9267		0.27842	-0.011078		1.1974	-0.27875
p-value	0.17922		0.0034709	1.13E-14	2.1253e-060	7.5518e-052		0.028574	0.93058		4.7164e-021	0.028387
Excess Kurtosis	0.080429		1.7022	1.5061	9.2628	8.4457		0.35951	0.25835		4.6300	1.8037
p-value	0.00086140		4.8392e-015	4.24E-12	0	4.6885e-243		0.15641	0.59723		1.9832e-074	1.1579e-012
Jarque-Bera	12.761		69.215	106.84	1582.2	1321.4		6.7362	1.0309		416.64	54.648
p-value	0.0016944		9.3363e-016	6.32E-24	0	1.1525e-287		0.034455	0.59723		3.3739e-091	1.3594e-012
						Q-Statistics on Standard Residuals						
Q(5)	8.71254		16.9672	17.8189	15.4779	15.6080			3.19780			5.80186
p-value	[0.0333674]*		[0.0002068]**	[0.0004793]**	[0.0014506]**	[0.0035929]**			[0.0737373]			[0.1216583]
Q(10)	15.9573		40.9490	227.423	23.1796	43.7488		47.2562	6.35682		16.4141	11.6055
p-value	[0.0429952]*		[0.0000008]**	[0.0000000]**	[0.0031411]**	[0.0000016]**		[0.000000]**	[0.3844274]		[0.0057561]**	[0.1696912]
Q(15)	56.7038		150.323		63.5265	179.013		223.093	122.786		41.2448	28.3458
p-value	[0.0000069]**		[0.0000000]**		[0.0000005]**	[0.0000000]**		[0.000000]**	[0.000000]**		[0.0002934]**	[0.0569841]
Q(20)	272.095		387.925		129.608	564.725		592.658	313.317		136.160	104.110
p-value	[0.0000000]**		[0.0000000]**		[0.00000000]**	[0.0000000]**		[0.000000]**	[0.000000]**		[0.000000]**	[0.000050]**
						Q-Statistics on Squared Standard Residuals						
Q(5)	6.42704		5.5138	11.8517	1.26543	1.13573		6.66441	8.64719		2.57320	2.41979
p-value	[0.0925848]		[0.1377125]	[0.0079088]**	[0.7373580]	[0.7684562]		[0.0833992]	[0.0343687]*		[0.4622080]	[0.4899609]
Q(10)	9.73614		9.43754	24.3791	2.58985	5.79373		22.2547	14.6708		3.91954	5.05896
p-value	[0.2840363]		[0.3067393]	[0.0019792]**	[0.9574092]	[0.6703242]		[0.0044652]**	[0.0658726]		[0.8643091]	[0.7512565]

Q(15)	24.9461		35.2102		5.05223	16.8124			41.9098		14.2474	15.5693
p-value	[0.1264083]		[0.0088929]**		[0.9987763]	[0.5360354]			[0.011384]**		[0.7128283]	[0.6225772]
Q(20)	79.9241		102.973		22.6109	39.5645			76.7936		28.6138	46.4297
p-value	[0.0025996]**		[0.00000070]**		[0.9993271]	[0.8018147]			[0.0051931]**		[0.9881718]	[0.5373501]
ARCH Test												
ARCH(1-2)	2.7260		0.84068	0.56191	0.18483	0.24017		1.7620	1.7158		0.69121	0.27753
p-value	[0.0667]		[0.4320]	[0.5705]	[0.8313]	[0.7866]		[0.1732]	[0.1813]		[0.5016]	[0.7578]
ARCH(1-5)	1.4575		1.3001	2.4297	0.25613	0.25248		1.5176	2.1510		0.59391	0.56157
p-value	[0.2028]		[0.2625]	[0.0343]*	[0.9366]	[0.9384]		[0.1835]	[0.0590]		[0.7047]	[0.7295]
ARCH(1-10)	1.1526		1.2382	2.8725	0.25851	0.54899		2.1901	1.9340		0.47385	0.68363
p-value	[0.3218]		[0.2638]	[0.0017]**	[0.9893]	[0.8546]		[0.0180]*	[0.0398]		[0.9066]	[0.7398]
Residual based diagnostic												
RBD(2)	11.2261		5.24696	1.3606	0.587908	1.06409		11.1421	11.8665		1.48341	5.00041
p-value	[0.0036499]		[0.0725499]	[0.5064640]	[0.7453109]	[0.5874027]		[0.0038065]	[0.0026499]		[0.4763004]	[0.0820684]
RBD(5)	14.5708		12.4275	14.476	1.77332	2.27603		19.4555	19.0710		2.65348	10.4110
p-value	[0.0123626]		[0.0293772]	[0.0128524]	[0.8795365]	[0.8097810]		[0.0015805]	[0.001864]		[0.7532240]	[0.0643925]
RBD(10)	17.4632		15.5698	19.4751	3.38262	7.79379		107.958	22.2956		4.01688	11.8145
p-value	[0.0647223]		[0.1126272]	[0.0346268]	[0.9704395]	[0.6489715]		[0.0000000]	[0.0136677]		[0.9465823]	[0.2976621]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.4(b) Diagnostic Test n-EGARCH (1, 1)

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Normality Test												
Skewness	-0.80859	-6.0858		-0.90667	0.962		0.4469					
p-value	2.0412e-010	0		1.0106e-011	6.20E+00		0.001996					
Excess Kurtosis	15.631	76.224		4.0171	6.2033		1.75					
p-value	0	0		1.2098e-051	1.94E-95		1.26E-09					
Jarque-Bera	3786.4	91361.0		271.15	462.26		45.694					
p-value	0	0		1.3221e-059	4.19E-101		1.20E-10					
Q-Statistics on Standard Residuals												
Q(5)	38.4470	1.82928		10.3450	4.54275		11.8411					
p-value	[0.0000001]**	[0.7671209]		[0.0350006]*	[0.2085086]		[0.0185727]*					
Q(10)	62.8043	7.84309		29.8873	13.4168		22.4822					
p-value	[0.0000000]**	[0.5500331]		[0.0004585]**	[0.0982900]		[0.0074701]**					
Q(15)	106.201	24.9273		101.979	31.7647		81.0743					
p-value	[0.0000000]**	[0.1629488]		[0.000000]**	[0.0234396]*		[0.0000000]**					
Q(20)	163.334	60.7800		224.908	86.4686		184.826					
p-value	[0.0000000]**	[0.1205516]		[0.000000]*	[0.0005555]**		[0.0000000]**					
Q-Statistics on Squared Standard Residuals												
Q(5)	0.852681	0.100852		1.39865	2.07989		2.59843					
p-value	[0.8368294]	[0.9917350]		[0.7058516]	[0.5559913]		[0.4577657]					
Q(10)	1.43776	0.139431		4.83752	3.74813		6.50634					

p-value	[0.9936938]	[0.9999991]		[0.7747932]	[0.8791027]		[0.5907042]					
Q(15)	2.47032	0.181368		8.05281	7.77413		24.8954					
p-value	[0.9999939]	[1.0000000]		[0.9778400]	[0.9818124]		[0.1278246]					
Q(20)	50.0188	0.313789		45.3254	35.4119		56.7194					
p-value	[0.3931575]	[1.0000000]		[0.5830852]	[0.9112449]		[0.1818743]					
ARCH Test												
ARCH(1-2)	0.17353	0.017033		0.011669	0.5543		0.82702					
p-value	[0.8408]	[0.9831]		[0.9884]	[0.5752]		[0.4384]					
ARCH(1-5)	0.17507	0.020174		0.28138	0.37056		0.64661					
p-value	[0.9718]	[0.9998]		[0.9232]	[0.8686]		[0.6643]					
ARCH(1-10)	0.15121	0.053555		0.54643	0.42628		1.1943					
p-value	[0.9989]	[1.0000]		[0.8564]	[0.9330]		[0.2949]					
Residual based diagnostic												
RBD(2)	0.689662	0.077359		0.595508	0.901637		6.34282					
p-value	[0.7083400]	[0.9620590]		[0.742480]	[0.6371065]		[0.0419444]					
RBD(5)	1.44804	0.206572		3.47026	1.61567		10.4453					
p-value	[0.9189867]	[0.9990415]		[0.6278925]	[0.8993476]		[0.0635579]					
RBD(10)	2.15262	0.818640		7.08909	3.22374		18.4205					
p-value	[0.9950309]	[0.9999318]		[0.7170087]	[0.9756575]		[0.0482713]					

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.5(a) GJR (1, 1) Modeling with Normal distribution

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Model Specifications	ARMA (1,1)	ARMA (4,5)	ARMA (1,2)	ARMA (2,5)	ARMA (1,1)	ARMA (0,1)	ARMA (1,0)	ARMA (0,5)	ARMA (4,0)	ARMA (0,2)	ARMA (2,3)	ARMA (0,2)
	GJR(1,1)	GJR (1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)
Mean equation												
C	0.006642	0.004392	0.006672	0.005777		-0.00209		0.002306	0.005082	0.000851	0.006992	0.001011
t-Prob	0.0000	0	0	0		0.0109		0.0105	0	0.4452	0.0004	0.1595
AR(1)	-0.67101	0.279459	0.465413	-0.43778					0.014194		0.573562	
t-Prob	0.0000	0.8323	0	0.0404					0.8104		0.0009	
AR(2)		0.987974		0.477969					0.037639		0.403065	
t-Prob		0.6444		0.0002					0.5819		0.0148	
AR(3)		-0.54706							0.000329			
t-Prob		0.6170							0.9954			
AR(4)		-0.50629							-0.030118			
t-Prob		0.0217							0.6668			
AR(5)												
t-Prob												
MA(1)	0.815979	-0.74056	0.007409	0.03705		-0.688714		-0.650871		-0.717567	-0.37069	-0.51674
t-Prob	0.0000	0.5918	0.9237	0.8683		0		0		0.0248	0.0259	0
MA(2)		-1	-0.042982	-0.74448				0.125581		0.111458	-0.43726	0.155591
t-Prob		0.7283	0.4208	0				0.1117		0.3017	0.0020	0.0289
MA(3)		1		0.203699				0.124394			-0.02020	
t-Prob		0.5890		0.0334				0.0384			0.6808	
MA(4)		0.278827		-0.03674				-0.23243				
t-Prob		0.2511		0.5629				0.0001				
MA(5)		-0.32889		-0.15709				0.071743				
t-Prob		0.0865		0.0064				0.0212				

Variance Equation												
C	0.085156	0.000099	0.030924	8.139792		9.068819		3.401756	0	19.78981	0.027073	1.750957
t-Prob	0.0006	0	0.0574	0		0.0514		0.0003	1	0	0.1528	0.0008
α(1)	0.078365	0.032209	0.117441	0.400056		0.302019		0	0.031059	0.366388	0.058591	0.080309
t-Prob	0.0141	0.4394	0.0297	0.0661		0.0236		1	0.3721	0.6057	0.0473	0.1209
β(1)	0.852465	0.918638	0.908686	0.551504		0.546548		0.444342	0.959120	0	0.837298	0.447557
t-Prob	0	0	0	0.0001		0.0005		0.0007	0	1	0	0.0004
Υ(1)	-0.16137	0.064612	-0.124917	-0.51088		-0.24604		0.662452	0.013025	0.999995	-0.00937	0.174381
t-Prob	0.0042	0.2446	0.0042	0.0132		0.1286		0.0001	0.6668	0.4709	0.8985	0.1466
α(1)+β(1)+Υ(1)	0.850144	0.983152	0.963669	0.440677		0.725543		0.775568	947.210	0.866386	0.8912	0.615057
Log Likelihood	1381.212	507.422	1695.807	811.808	1231.187	555.100	1353.085	733.416	0.996692	536.700	1431.078	901.202
Akaike Criteria	-6.752886	-2.424678	-6.710963	-3.18015		-2.984237		-3.931611	-5.098968	-2.878805	-7.723252	-4.85979
Schwarz Criteria	-6.683938	-2.286783	-6.643837	-3.07946		-2.920518		-3.825413	-5.003390	-2.804466	-7.617054	-4.78545
Shibata Criteria	-6.753464	-2.426941	-6.711459	-3.18125		-2.984757		-3.933036	-5.100127	-2.879511	-7.724677	-4.86049
Hannan-Quinn	-6.725600	-2.370107	-6.684630	-3.14065		-2.958922		-3.889419	-5.060996	-2.849271	-7.681061	-4.83025

Table-A 5.5(b) GJR (1, 1) Modeling with Normal distribution

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Model Specifications	ARMA (1,0)	ARMA (1,0)	ARMA (4,2)	ARMA (0,1)	ARMA (2,0)	ARMA (0,3)	ARMA (0,1)	ARMA (0,1)	ARMA (0,1)	ARMA (5,1)	ARMA (0,1)	ARMA (0,2)
	GJR(1,1)	GJR (1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)
Mean equation												
C	0.027643	-0.000892	0.006509	0.002459	0.00517	0.002968	0.0133	-0.00098	0.015722	-0.00023	0.01489	0.001130
t-Prob	0	0.6804	0	0.2697	0	0.0025	0	0	0	0.8603	0	0.5378
AR(1)	0.260192	-0.434173	1		1					0.600327	0.484115	
t-Prob	0	0	0		0					0	0	
AR(2)			-0.153794		-0.29733					0.072685		
t-Prob			0.3865		0					0.4123		
AR(3)			-0.273626							-0.06925		
t-Prob			0.0070							0.29		
AR(4)			0.298127							-0.09601		
t-Prob			0							0.122		
AR(5)										-0.33348		
t-Prob										0.0479		
MA(1)			-0.741831	-0.339218		-0.13558	0.381516	-0.60909	0.164668	-0.83486		-0.43829
t-Prob			0.0020	0		0.0597	0	0	0.0006	0		0
MA(2)			0.189724			0.026933						-0.09555
t-Prob			0.3637			0.6536						0.2228
MA(3)						0.018854						
t-Prob						0.7833						
MA(4)												
t-Prob												
MA(5)												

t-Prob												
Variance Equation												
C	0.332290	17.79528	0.033698	6.913259	0.011338	2.400134	0.096195	37.68059	2.620086	0.007504	0.57223	0.000457
t-Prob	0.0001	0	0.0627	0.3469	0	0	0.4726	0.0576	0.0026	0.0003	0.0062	0.0011
$\alpha(1)$	0.007539	0.148391	0.519705	0	0	0.006785	0.320919	0	0.13769	0	0.201969	0.148056
t-Prob	0.5673	0.0954	0.0007	1	1	0.8351	0.1789	1	0.0753	1	0.0345	0.0095
$\beta(1)$	0.917866	0.108220	0.765773	0.751558	0.878908	0.077757	0.759814	0.212315	0.48694	0	0.786742	0.751738
t-Prob	0	0.0057	0	0.0072	0	0.3717	0.0004	0.1536	0	1	0	0
$\Upsilon(1)$	0.098792	0.804572	-0.572560	0.096510	0.039651	0.938613	-0.29502	0.068811	0.287639	0.428235	-0.24685	0.060148
t-Prob	0.0007	0.0001	0.0003	0.3956	0	0.1550	0.1603	0.189	0.1658	0.1883	0.0142	0.6092
$\alpha(1)+\beta(1)+\Upsilon(1)$	0.974802	0.658896	0.999198	0.799813	0.918559	0.553848	0.785716	0.281126	0.912269	0.214118	0.741858	0.929868
Log Likelihood	721.176	548.226	1136.157	472.200	793.874	666.803	873.015	350.329	642.398	294.123	770.572	345.691
Akaike Criteria	-3.886828	-2.946881	-6.717356	-2.783286	-5.98383	-5.00990	-6.10574	-2.42485	-4.13246	-1.83846	-4.9011	-2.17109
Schwarz Criteria	-3.823109	-2.883162	-6.592116	-2.714973	-5.88875	-4.90124	-6.02865	-2.34776	-4.05979	-1.70525	-4.82912	-2.08712
Shibata Criteria	-3.887348	-2.947401	-6.719422	-2.783912	-5.9852	-5.01168	-6.10661	-2.42572	-4.1332	-1.8409	-4.90183	-2.17207
Hannan-Quinn	-3.861513	-2.921566	-6.667426	-2.756051	-5.94562	-4.96623	-6.07483	-2.39395	-4.1034	-1.7852	-4.87234	-2.13753

Table-A 5.6(a) Diagnostic Test n-GJR (1, 1)

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Normality Test												
Skewness	1.4094	0.17686	-0.23588	0.5925		-1.5933		0.20328	0.18461	-1.4604	1.0060	-0.16297
p-value	2.2746e-031	0.14375	0.030300	5.30E-08		5.2246e-036		0.10994	0.146591	1.5893e-030	2.5705e-015	0.20001
Excess Kurtosis	8.6687	0.31013	1.7435	0.6101		6.3521		-0.013763	0.81585	8.2337	3.1299	0.54139
p-value	1.7513e-282	0.19882	1.0488e-015	0.005003		2.1882e-138		0.95673	0.0012991	4.1344e-231	5.6234e-035	0.032823
Jarque-Bera	1409.1	3.7528	68.370	37.231		774.38		2.5374	12.296	1170.3	212.27	6.1233
p-value	1.0457e-306	0.15314	1.4243e-015	8.23E-09		6.9925e-169		0.28119	0.0021375	7.4121e-255	8.0438e-047	0.046810
Q-Statistics on Standard Residuals												
Q(5)	7.90083		16.2893	52.1177		5.19774			3.18344	8.29086		11.0063
p-value	[0.0481063]*		[0.0002903]**	[0.0000000]**		[0.2676029]			[0.0743880]	[0.0403678]*		[0.0116920]*
Q(10)	16.1108	30.4029	41.2825	385.481		19.4669		31.0394	12.9852	19.9945	23.0469	24.2406
p-value	[0.0408221]*	[0.0000000]**	[0.0000007]**	[0.0000000]**		[0.021503]*		[0.0000092]**	[0.043715]*	[0.0103570]*	[0.0003307]**	[0.0020883]**
Q(15)	72.7071	116.844	145.328			98.2025		190.115	132.579	111.727	54.9457	46.5756
p-value	[0.0000000]**	[0.0000000]**	[0.0000000]**			[0.000000]**		[0.000000]**	[0.000000]**	[0.0000000]**	[0.0000018]**	[0.0002444]**
Q(20)	238.020	196.816	372.751			359.966		538.315	314.338	384.007	150.221	122.777
p-value	[0.0000000]	[0.0000000]**	[0.0000000]**			[0.000000]**		[0.000000]**	[0.000000]**	[0.0000000]**	[0.000000]**	[0.0000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.219250	2.33863	8.47408	24.0707		0.050246		10.5167	2.47216	10.4800	2.41901	0.945973
p-value	[0.9744234]	[0.5051611]	[0.0371656]*	[0.0000241]**		[0.9970492]		[0.0146481]**	[0.4803425]	[0.0148975]*	[0.4901062]	[0.8143216]
Q(10)	0.431908	7.29397	11.6242	47.7628		4.24078		30.2161	3.68960	11.8091	4.73124	5.31188
p-value	[0.9999237]	[0.5052728]	[0.1687761]	[0.0000001]**		[[0.8347718]		[0.0001936]**	[0.8839871]	[0.1599285]	[0.7858769]	[0.7237807]

Q(15)	14.8873	22.7090	24.5603			7.13716			23.0768	21.3447	15.0181	13.8733
p-value	[0.6696938]	[0.2020201]	[0.1375161]			[0.9889178]			[0.1876549]	[0.2623782]	[0.6607226]	[0.7372801]
Q(20)	25.8997	58.0671	56.8755			28.2795			66.9615	57.7840	28.3251	52.6212
p-value	[0.9962078]	[0.1514315]	[0.1781381]			[0.9895930]			[0.0365017]*	[0.1574888]	[0.9894077]	[0.2998312]
ARCH Test												
ARCH(1-2)	0.10049	0.77179	3.1585	3.7522		0.010211		3.0021	0.50883	0.30968	0.65335	0.088294
p-value	[0.9044]	[0.4629]	[0.0433]*	[0.0241]*		[0.9898]		[0.0509]	[0.6016]	[0.7339]	[0.5209]	[0.9155]
ARCH(1-5)	0.042996	0.45827	1.5708	4.3295		0.009543		1.9102	0.47275	2.1246	0.45800	0.18111
p-value	[0.9989]	[0.8072]	[0.1667]	[0.0007]**		[1.0000]		[0.0919]	[0.7966]	[0.0620]	[0.8074]	[0.9696]
ARCH(1-10)	0.14490	0.78383	1.0626	5.2205		0.51207		2.8821	1.0584	1.1712	0.38382	0.51486
p-value	[0.9991]	[0.6445]	[0.3897]	[0.0000]**		[0.8815]		[0.0018]*	[0.3943]	[0.3092]	[0.9534]	[0.8796]
Residual based diagnostic												
RBD(2)	0.055126	0.424259	-2.48337	6.63609		0.021928		-25.0239	0.769795	0.496512	2.13339	0.373782
p-value	[0.9728134]	[0.8088600]	[1.0000000]	[0.0362236]		[0.9890957]		[1.0000000]	[0.6805203]	[0.7801601]	[0.3441434]	[0.8295342]
RBD(5)	0.093774	3.55295	1.46997	-44.0691		0.049042		-9.98455	4.00372	6.92358	3.32818	1.10443
p-value	[0.9998615]	[0.6153912]	[0.9165090]	[1.0000000]		[0.9999722]		[1.0000000]	[0.5488803]	[0.2263862]	[0.6495309]	[0.9537106]
RBD(10)	0.487243	10.8836	4.29324	-36.0115		4.33205		-43.1287	5.64049	8.71047	4.87699	6.75798
p-value	[0.9999942]	[0.3666574]	0.9331502]	[1.0000000]		[0.9311271]		[1.0000000]	[0.8445097]	[0.5597842]	[0.8992421]	[0.7480782]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.6(b) Diagnostic Test n-GJR (1, 1)

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
						Normality Test						
Skewness	-1.6741	-2.1409	0.85058	-0.91706	-4.9137	-0.35828	0.12729	-7.8346	0.14903	-0.05213	0.60681	-0.55821
p-value	1.4115e-039	1.3556e-063	1.7250e-010	5.8603e-012	9.05E-235	0.017507	0.37868	0	0.2833	0.70742	1.10E-05	5.2419e-005
Excess Kurtosis	20.048	16.114	2.9330	3.4746	59.509	3.2294	0.85146	99.006	1.3433	0.72189	1.4013	2.3900
p-value	0	0	2.4758e-028	4.4348e-039	0	3.8118e-027	0.003132	0	1.23E-06	0.009138	3.54E-07	3.7680e-018
Jarque-Bera	6334.9	4262.7	160.47	215.47	39865	119.91	9.3458	1.19E+05	24.298	6.8273	44.673	90.460
p-value	0	0	1.4237e-035	1.6234e-047	0	9.1670e-027	0.009345	0	5.29E-06	0.032921	1.99E-10	2.2741e-020
						Q-Statistics on Standard Residuals						
Q(5)	15.1655	6.74319		10.3954	20.2301	12.2651	16.1607	1.64048	35.0231		8.83162	6.78206
p-value	[0.0043701]**	[0.1500980]		[0.0342681]*	[0.0001521]**	[0.0021710]**	[0.0028109]	[0.8014982]	[0.0000005]**		[0.0654487]	[0.0791783]
Q(10)	22.5026	17.8089	25.8582	37.0869	21.2128	19.1449	27.7517	8.3193	73.0012	23.935	12.9369	14.4557
p-value	[0.0074156]**	[0.0374569]*	[0.0000338]**	[0.0000254]**	[0.0066030]**	[0.0077455]**	[0.0010493]**	[0.5023159]	[0.0000000]**	[0.0000823]**	[0.1654809]	[0.0706348]
Q(15)	37.1291	59.8534	41.6527	117.242	23.7306	39.4993	80.6563	20.1269	245.502	45.5378	36.9979	48.0238
p-value	[0.0076451]**	[0.0000041]**	[0.0001403]**	[0.0000000]**	[0.1640521]	[0.0015220]**	[0.0000000]**	[0.3869805]	[0.0000000]**	[0.0000334]**	[0.0079397]**	[0.0001493]**
Q(20)	83.8076	130.910	89.5095	249.611	55.1824	92.4533	188.095	45.041	556.788	80.5432	88.3087	145.522
p-value	[0.0014358]**	[0.0000000]**	[0.0000608]**	[0.0000000]**	[0.2216352]	[0.0000850]**	[0.0000000]**	[0.6343331]	[0.0000000]**	[0.0006408]**	[0.0004905]**	[0.000000]**
						Q-Statistics on Squared Standard Residuals						
Q(5)	0.264018	0.215273	5.32167	2.41547	2.75852		3.49302	0.058953	0.928021	4.88725	2.27286	2.50754
p-value	[0.9666473]	[0.9750868]	[0.1497025]	[0.4907169]	[0.4303734]		[0.3216688]	[0.9962597]	[0.8186609]	[0.1802416]	[0.5177397]	[0.473924]
Q(10)	0.776654	0.596480	7.57573	6.40003	2.89143	16.6893	8.79942	0.111851	7.51871	7.31614	8.33647	9.96430
p-value	[0.999304	[0.999740	[0.4759703	[0.6025167	[0.9409847]	[0.033511	[0.3594981	[0.9999996	[0.481836	[0.502939	[0.401311	[0.267540

	1]	0]	]	]		7]*	]	]	0]	4]	3]	3]
Q(15)	1.61739	1.05405	11.3496	10.1782	2.92772	22.9323	25.0078	0.159301	31.489	28.2217	15.6016	15.6455
p-value	[0.999999 8]	[1.000000 0]	[0.8789354]	[0.9259359]	[0.9999770]	[0.193204 0]	[0.1247022]	[1.0000000]	[0.025253 4]*	[0.058760 7]	[0.620329 6]	[0.617270 5]
Q(20)	29.9631	2.72666	37.3879	51.7795	4.28767	56.3229	46.0722	0.286731	84.9982	46.6638	41.3154	34.4232
p-value	[0.980779 1]	[1.000000 0]	[0.8655623]	[0.3286158]	[1.0000000]	[0.191611 1]	[0.5521558]	[1.0000000]	[0.000794 2]**	[0.527663 1]	[0.741453 7]	[0.929683 6]
ARCH Test												
ARCH(1-2)	0.004225	0.072959	1.5100	0.065513	1.2996	0.046273	1.108	0.012761	0.27105	0.06385	0.45462	0.80491
p-value	[0.9958]	[0.9297]	[0.2224]	[0.9366]	[0.2744]	[0.9548]	[0.3317]	[0.9873]	[0.7628]	[0.9382]	[0.6351]	[0.4481]
ARCH(1-5)	0.050474	0.041201	1.3138	0.47928	0.51891	2.7364	0.34345	0.011084	0.18668	0.90178	0.46121	0.34707
p-value	[0.9984]	[0.9990]	[0.2577]	[0.7917]	[0.7619]	[0.0199]*	[0.8862]	[1.00000]	[0.9675]	[0.4802]	[0.8050]	[0.8840]
ARCH(1-10)	0.070994	0.13902	0.56143	0.63241	2.7481	1.5156	1.1733	0.009971	0.70003	0.78571	0.75246	0.68591
p-value	[1.0000]	[0.9992]	[0.8449]	[0.7859]	[0.0032]**	[0.1343]	[0.3091]	[1.00000]	[0.7243]	[0.6426]	[0.6746]	[0.7374]
Residual based diagnostic												
RBD(2)	0.009049	0.142288	-71.8227	0.134582	-0.43446	0.135451	2.85826	0.026237	0.87341	0.187598	0.951524	1.20732
p-value	[0.995485 7]	[0.931327 9]	[1.000000]	[0.9349232]	[1.0000000]	[0.934516 9]	[0.2395177]	[0.9869671]	[0.646162 0]	[0.910465 9]	[0.621411 3]	[0.546806 4]
RBD(5)	0.265374	0.198064	-7.86829	2.26132	-0.4079	-2.78628	1.39866	0.058152	1.30332	9.91409	2.18917	1.10600
p-value	[0.998244 1]	[0.999134 6]	[1.0000000]	[0.8119307]	[1.0000000]	[1.000000]	[0.9244599]	[0.9999575]	[0.934590 0]	[0.077706 5]	[0.822398 3]	[0.953571 1]
RBD(10)	0.751498	1.43922	8.15631	8.43464	-0.55214	2.50163	6.38364	0.111555	-4.11269	15.7718	0.815348	5.40693
p-value	[0.999954 3]	[0.999112 4]	[0.6135723]	[0.5864609]	[1.0000000]	[0.990851 9]	[0.7820676]	[1.0000000]	[1.000000 0]	[0.106354 5]	[0.999933 1]	[0.862392 0]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.7(a) GARCH (1, 1) Modeling with Student's t- distribution

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Model Specifications	ARMA (1,1)	ARMA (4,5)	ARMA (1,2)	ARMA (2,5)	ARMA (1,1)	ARMA (0,1)	ARMA (1,0)	ARMA (0,5)	ARMA (4,0)	ARMA (0,2)	ARMA (2,3)	ARMA (0,2)
	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)
Mean equation												
C	0.006118		0.006528	0.004063	0.004733	-0.00066	0.006103	0.000931	0.005234	0.004669	0.005047	0.001311
t-Prob	0.0000		0	0	0	0.3869	0	0.8138	0	0	0.0397	0.0526
AR(1)	-0.63675		0.494871	0.044572	-0.202985		0.809923		0.016815		0.554720	
t-Prob	0.0023		0	0.7651	0.1323		0		0.7521		0.0288	
AR(2)				-0.44735					0.070292		0.421660	
t-Prob				0.0003					0.1891		0.0816	
AR(3)									0.003310			
t-Prob									0.9518			
AR(4)									-0.060064			
t-Prob									0.3736			
AR(5)												
t-Prob												
MA(1)	0.794515		-0.034433	-0.67902	0.525923	-0.66665		-0.435481		-0.681713	-0.38165	-0.50175
t-Prob	0.0000		0.6162	0	0	0		0		0	0.1469	0
MA(2)			-0.039283	0.636728				0.303396		0.167949	-0.42974	0.133807
t-Prob			0.4493	0.0002				0.0001		0	0.0541	0.0607
MA(3)				-0.32595				0.166495			-0.01586	
t-Prob				0.0063				0.1133			0.7074	
MA(4)				-0.16503				0.103860				
t-Prob				0.0122				0.3887				
MA(5)				-0.17646				0.336964				

t-Prob				0.0001				0.0004				
Variance Equation												
C	0.032774		0.046672	12.85714	0.349946	9.92489	0.059809	0.628291	0	13.25844	0.026973	1.902324
t-Prob	0.1856		0.1895	0.0041	0.1849	0.0101	0.4293	0.0587	1	0.4974	0.2701	0.0778
α(1)	0.049663		0.058897	0.250019	0.558865	0.290653	0.681275	0.012276	0.029510	0.276951	0.072215	0.174478
t-Prob	0.1062		0.0378	0.1067	0.2122	0.0053	0.5656	0.6027	0.0453	0.4666	0.0524	0.0155
β(1)	0.897529		0.878988	0.301149	0.308271	0.436301	0.533527	0.937538	0.966569	0.693286	0.817105	0.408492
t-Prob	0.0000		0	0.0219	0.1315	0.0018	0.2412	0	0	0	0	0.1280
Student (DF)	5.749865		6.954514	6.166037	2.635890	3.756243	2.712829	17.951356	11.59261	2.265635	7.375355	11.57648
t-Prob	0.0005		0.0007	0.0768	0	0	0	0.5117	0.1157	0	0.0062	0.0459
α(1)+β(1)	0.94719		0.93788	0.55117	0.86714	0.72695	1.21480	0.94981	0.99608	0.97024	0.88932	0.58297
Log Likelihood	1403.946	512.166	1696.90	797.946	1317.196	590.503	1369.735	713.625	949.904	609.683	1442.910	902.253
Akaike Criteria	-6.864597		-6.714472	-3.12503	-7.120633	-3.176646	-7.411601	-3.824050	-5.113607	-3.275449	-7.787553	-4.86551
Schwarz Criteria	-6.795650		-6.647345	-3.02434	-7.046295	-3.112927	-7.347882	-3.717852	-5.018029	-3.201110	-7.681355	-4.79116
Shibata Criteria	-6.865176		-6.714967	-3.12614	-7.121339	-3.177166	-7.412121	-3.825476	-5.114765	-3.276155	-7.788979	-4.86621
Hannan-Quinn	-6.837312		-6.688138	-3.08553	-7.091099	-3.151331	-7.386286	-3.781859	-5.075634	-3.245915	-7.745362	-4.83597

Table-A 5.7(b) GARCH (1, 1) Modeling with Student's t- distribution

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Model Specifications	ARMA (1,0)	ARMA (1,0)	ARMA (4,2)	ARMA (0,1)	ARMA (2,0)	ARMA (0,3)	ARMA (0,1)	ARMA (0,1)	ARMA (0,1)	ARMA (5,1)	ARMA (0,1)	ARMA (0,2)
	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)
Mean equation												
C	0.023354	0.002837	0.004140	0.004351		0.002976	0.013115	0.001743	0.014288	-0.00041	0.012193	0.002850
t-Prob	0	0	0	0.0236		0.0010	0	0.0332	0	0.7062	0	0.0673
AR(1)	0.353247	-0.38072	1							0.598446	0.477276	
t-Prob	0	0	0.0022							0	0	
AR(2)			-0.21921							0.076234		
t-Prob			0.5235							0.2227		
AR(3)			-0.00100							-0.066		
t-Prob			0.9916							0.2638		
AR(4)			0.032492							-0.09448		
t-Prob			0.4624							0.1529		
AR(5)										-0.32418		
t-Prob										0		
MA(1)			-0.66628	-0.348455		-0.15100	0.368685	-0.67425	0.18885	-0.83496		-0.49329
t-Prob			0.0432	0		0.0348	0	0	0	0		0
MA(2)			0.047945			0.022116						-0.07459
t-Prob			0.8433			0.7699						0.3070
MA(3)						0.011046						
t-Prob						0.8644						
MA(4)												
t-Prob												

MA(5)												
t-Prob												
Variance Equation												
C	0.009401	0.065887	0.346323	1.026089		2.215528	0.369185	0.660293	3.208898	0.000759	0.72394	0.000296
t-Prob	0.7770	0.1171	0.1456	0.3929		0.1109	0.0016	0.1329	0.013	0.0947	0.0702	0.0112
α(1)	0.070807	1	1	0.023583		0.224581	0.379882	0.018039	0.151405	0.050348	0.178807	0.159216
t-Prob	0.0059	0.0002	0	0.2340		0.1109	0.0016	0.0534	0.2304	0.0823	0.0962	0.0252
β(1)	0.938241	0.528689	0.520180	0.946726		0.280284	0.421781	0.953124	0.519755	0.908992	0.707266	0.807567
t-Prob	0	0	0	0		0.1861	0.0001	0	0.0076	0	0	0
Student (DF)	3.528391	2.794476	2.224162	5.482574		3.544985	6.005183	3.4892	5.766731	5.688664	4.262204	4.552499
t-Prob	0	0	0	0.0006		0	0.0011	0	0.0064	0.0023	0.004	0.0001
α(1)+β(1)	1.00905	1.52869	1.52018	0.97031	1.47135	0.50487	0.80166	0.97116	0.67116	0.95934	0.88607	0.96678
Log Likelihood	795.719	750.416	1176.465	484.603	964.243	683.269	870.801	477.376	647.378	294.774	774.125	359.759
Akaike Criteria	-4.29196	-4.04574	-6.958000	-2.857332		-5.13512	-6.09015	-3.31955	-4.1648	-1.84269	-4.92388	-2.26127
Schwarz Criteria	-4.22824	-3.98202	-6.832760	-2.789019		-5.02646	-6.01306	-3.24246	-4.09213	-1.70947	-4.8519	-2.17729
Shibata Criteria	-4.29248	-4.04626	-6.960066	-2.857959		-5.13690	-6.09102	-3.32042	-4.16554	-1.84512	-4.9246	-2.26225
Hannan-Quinn	-4.26664	-4.02043	-6.908071	-2.830098		-5.09145	-6.05924	-3.28864	-4.13574	-1.78942	-4.89511	-2.22771

Table-A 5.8(a) Diagnostic Test t-GARCH (1, 1)

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Normality Test												
Skewness	1.3676		-0.16502	0.75398	4.3571	-1.5884	2.3360	0.53476	0.22690	-2.6829	1.0480	-0.19337
p-value	1.2357e-029		0.12966	4.39E-12	2.9751e-257	8.4569e-036	2.3325e-075	2.6104e-005	0.074390	8.4804e-099	1.7116e-016	0.12838
Excess Kurtosis	8.0971		1.6363	0.72669	36.240	6.5548	10.986	0.26917	1.1370	19.847	3.3501	0.70613
p-value	9.8307e-247		5.1431e-014	0.000828	0	3.1529e-147	0	0.28864	7.3879e-006	0	8.0326e-040	0.005374 8
Jarque-Bera	1238.7		58.402	58.726	21302.	813.55	2185.4	18.651	22.980	6481.2	239.45	9.9388
p-value	1.0405e-269		2.0808e-013	1.77E-13	0	2.1914e-177	0	8.9140e-005	1.0232e-005	0	1.0086e-052	0.006947 3
Q-Statistics on Standard Residuals												
Q(5)	8.41564		15.2831	37.5629	2.30305	5.77257	5.21964		3.33860	10.3158		11.5209
p-value	[0.038159 1]*		[0.0004801]**	[0.0000000]**	[0.5119372]	[0.216788 8]	[0.2654947]		[0.067672 3]	[0.016064 3]*		[0.009128]**
Q(10)	15.6154		44.1633	339.805	8.56010	20.6042	9.78155	39.4942	11.9403	20.5186	21.8738	25.1274
p-value	[0.048227 1]*		[0.0000002]**	[0.0000000]**	[0.3807514]	[0.014528 5]*	[0.3684582]	[0.0000000 2]**	[0.063314 7]	[0.008542 4]**	[0.000553 3]**	[0.001479 1]**
Q(15)	61.8893		156.039		53.7399	104.190	75.8089	192.043	129.170	102.435	53.9611	47.6685
p-value	[0.000001 0]**		[0.0000000]**		[0.0000201] **	[0.000000]**	[0.0000000]**	[0.0000000]**	[0.000000 0]**	[0.000000 0]**	[0.000002 7]**	[0.000168 6]**
Q(20)	208.107		383.836		109.133	373.832	209.955	549.586	302.005	363.881	148.466	124.243
p-value	[0.000000]**		[0.0000000]**		[0.0000012] **	[0.000000]**	[0.0000000]**	[0.0000000]**	[0.000000 0]**	[0.000000 0]**	[0.000000]**	[0.000000 0]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.199767		3.30302	26.7758	0.304738	0.832651	1.71509	4.37759	1.93869	7.45649	1.70997	1.22128
p-value	[0.977627 0]		[0.3472223]	[0.0000066]**	[0.9591350]	[0.841642 5]	[0.6335850]	[0.2234726]	[0.585227 9]	[0.058687 1]	[0.634719 1]	[0.747904 8]
Q(10)	0.501112		6.51983	54.3922	0.474553	5.26848	3.26457	11.3601	2.69394	8.33454	3.81884	4.32390
p-value	[0.999865 5]		[0.5892090]	[0.0000000]**	[0.9998907]	[0.728532 6]	[0.9166744]	[0.1821203]	[0.952073 7]	[0.401492 0]	[0.873087 4]	[0.826782 4]

Q(15)	8.60807		27.2991		1.22941	10.2257	6.10655		18.3426	11.4166	13.1896	13.5687
p-value	[0.9681426]		[0.1735533]		[1.0000000]	[0.9242909]	[0.9957459]		[0.4333052]	[0.8758478]	[0.780199]	[0.7567403]
Q(20)	16.8592		61.2257		2.71821	30.7413	33.5612		57.8778	29.5177	26.4764	49.3508
p-value	[0.9999913]		[0.1952167]		[1.00000000]	[0.9751062]	[0.9434498]		[0.1554633]	[0.9835377]	[0.9950752]	[0.4189631]
ARCH Test												
ARCH(1-2)	0.045814		0.81937	1.1985	0.068044	0.33040	0.67320	0.45523	0.47880	0.042881	0.22851	0.054533
p-value	[0.9552]		[0.4413]	[0.3025]	[0.9342]	[0.7189]	[0.5107]	[0.6347]	[0.6199]	[0.9580]	[0.7958]	[0.9469]
ARCH(1-5)	0.037336		0.59640	4.8893	0.060422	0.147466	0.35297	0.85234	0.38976	1.4472	0.30762	0.23483
p-value	[0.9992]		[0.7028]	[0.0002]**	[0.9976]	[0.9719]	[0.8802]	[0.5134]	[0.8558]	[0.2066]	[0.9083]	[0.9470]
ARCH(1-10)	0.22649		0.61515	6.6417	0.042773	0.60059	0.38567	1.0533	0.85361	0.78134	0.30061	0.43338
p-value	[0.9937]		[0.8014]	[0.0000]**	[1.0000]	[0.8133]	[0.9526]	[0.3982]	[0.5773]	[0.6469]	[0.9808]	[09298]
Residual based diagnostic												
RBD(2)	0.017025		12.1789	0.46911	0.140959	0.522403	0.855605	1.76483	0.737125	-11.7669	1.08716	0.485646
p-value	[0.9915232]		[0.1022666]	[0.7909226]	[0.9319466]	[0.7701258]	[0.6519403]	[0.4137817]	[0.6917280]	[1.0000000]	[0.5806644]	[0.7844105]
RBD(5)	0.223573		-4.22259	8.67709	0.311596	0.628415	1.72069	4.59105	2.00157	4.75685	2.00344	1.04525
p-value	[0.9988390]		[1.000000]	[0.1226583]	[0.9974193]	[0.9866653]	[0.8862831]	[0.4677949]	[0.8489278]	[0.4462692]	[0.8486689]	[0.9588345]
RBD(10)	0.608213		2.04436	-35.5395	0.53504	4.74778	4.76493	10.1426	4.59020	10.0325	3.19968	4.56842
p-value	[0.9999832]		[0.9959887]	[1.0000000]	[0.9999912]	[0.9073773]	[0.9063177]	[0.4280765]	[0.9168209]	[0.4376470]	[0.9763265]	[0.9180846]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.8(b) Diagnostic Test t-GARCH (1, 1)

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Normality Test												
Skewness	-2.2726	-14.958	13.792	-0.96536		-1.0520	0.49797	-9.1085	0.22746	0.24177	0.59156	-0.63751
p-value	2.0048e-071	0	0	4.3089e-013		2.4841e-012	0.000573	0	0.1015	0.081751	1.82E-05	3.8535e-006
Excess Kurtosis	33.499	263.28	226.03	3.6380		6.8421	1.1739	120.92	1.6652	1.1256	1.3983	2.9544
p-value	0	0	0	1.1261e-042		1.1050e-115	4.63E-05	0	1.82E-09	4.81E-05	3.74E-07	6.8448e-027
Jarque-Bera	17523.0	1.0766e+006	7.2373e+005	236.78		561.51	28.046	1.77E+05	38.24	19.26	43.616	134.60
p-value	0	0	0	3.8450e-052		1.1739e-122	8.13E-07	0	4.97E-09	6.57E-05	3.38E-10	5.9043e-030
Q-Statistics on Standard Residuals												
Q(5)	11.2553	0.524353		10.4434		13.5060	12.7607	1.61628	35.5289		6.9207	7.38832
p-value	[0.0238394]*	[0.9710873]		[0.0335859]*		[0.0011674]**	[0.0125062]*	[0.8058639]	[0.0000004]**		[0.1401385]	[0.0604985]
Q(10)	17.4621	1.25129	2.37791	36.4786		19.0104	23.5786	6.10811	74.6373	18.4692	12.1534	14.2631
p-value	[0.0419519]*	[0.9986058]	[0.6666237]	[0.0000326]**		[0.0081547]**	[0.0050196]**	[0.7290510]	[0.0000000]**	[0.0009989]**	[0.2047980]	[0.0751609]
Q(15)	31.7931	2.88878	3.82046	114.493		37.4973	82.9447	15.6582	242.32	38.7219	40.0133	43.1367
p-value	[0.0329724]*	[0.9999921]	[0.9964528]	[0.0000000]**		[0.0028799]**	[0.0000000]**	[0.6799472]	[0.0000000]**	[0.0004026]**	[0.0032591]**	[0.0007654]**
Q(20)	90.0871	6.26103	14.3261	251.303		88.5800	198.037	37.4584	559.625	70.1758	100.495	130.980
p-value	[0.0003160]**	[1.0000000]	[0.99999936]	[0.0000000]**		[0.0002336]**	[0.0000000]**	[0.8856436]	[0.0000000]*	[0.0072995]**	[0.0000207]**	[0.000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.257644	0.021914	0.0135826	4.17638			0.653324	0.044643	1.12199	1.52009	4.08979	2.50551
p-value	[0.9677872]	[0.9991429]	[0.9995807]	[0.2430369]			[0.8841236]	[0.9975246]	[0.7717676]	[0.6776421]	[0.2519298]	[0.4742953]
Q(10)	0.505842	0.027544	0.0143169	8.54958		7.43779	3.9982	0.090634	8.15737	5.92195	11.5288	6.57878

p-value	[0.9998606]	[1.0000000]	[1.0000000]	[0.3817037]		[0.4902161]	[0.8572859]	[0.9999998]	[0.4182509]	[0.6559748]	[0.1734973]	[0.5826829]
Q(15)	1.19445	0.028559	0.0165472	12.3931		12.2172	35.1728	0.152857	35.2953	33.9449	18.8482	13.0970
p-value	[1.0000000]	[1.0000000]	[1.0000000]	[0.8262903]		[0.8358241]	[0.0089900]**	[1.0000000]	[0.0086751]**	[0.0127944]*	[0.4012264]	[0.7857814]
Q(20)	30.8617	0.034101	0.107387	57.2399		31.1470	75.5372	0.339023	98.9449	54.4622	43.2974	33.7126
p-value	[0.9741245]	[1.0000000]	[1.0000000]	[0.1696332]		[0.9716786]	[0.0067935]**	[1.0000000]	[0.0000214]**	[0.2421350]	[0.6656438]	[0.9411834]
ARCH Test												
ARCH(1-2)	0.026497	0.004716	0.0035067	1.2020		0.56535	0.17315	0.003249	0.060474	0.44858	0.83734	0.56378
p-value	[0.9739]	[0.9953]	[0.9965]	[0.3019]		[0.5689]	[0.8411]	[0.9968]	[0.9413]	[0.6390]	[0.4339]	[0.5696]
ARCH(1-5)	0.048863	0.004277	0.17758	0.88309		1.3414	0.18516	0.008299	0.2165	0.27916	0.83139	0.30769
p-value	[0.9985]	[1.0000]	[0.9709]	[0.4926]		[0.2474]	[0.9681]	[1.00000]	[0.9553]	[0.9244]	[0.5282]	[0.9082]
ARCH(1-10)	0.046350	0.019827	0.64143	0.88412		0.85836	0.44931	0.008286	0.79446	0.59274	0.993	0.60173
p-value	[1.0000]	[1.0000]	[0.7779]	[0.5484]		[0.5730]	[0.9207]	[1.00000]	[0.6342]	[0.8196]	[0.4495]	[0.8121]
Residual based diagnostic												
RBD(2)	0.068928	0.000113	0.0009277	9.45547		-5.72941	0.622154	0.023169	8.18599	1.1475	-3.16912	1.06843
p-value	[0.9661234]	[0.9999436]	[0.9995362]	[1.0000000]		[1.000000]	[0.7326574]	[0.9884823]	[0.0166892]	[0.5634082]	[1.0000000]	[0.8561293]
RBD(5)	0.264325	0.000131	0.0030711	24.6205		-2.87071	1.76874	0.02665	0.798596	1.42759	3.67461	1.59259
p-value	[0.9982607]	[1.0000000]	[1.0000000]	[1.0000000]		[1.000000]	[0.8801287]	[0.9999939]	[0.9771228]	[0.9212718]	[0.5971465]	[0.9021436]
RBD(10)	0.399644	0.162421	0.0827445	-34.9893		-0.34925	4.46317	0.058716	5.75311		10.7802	5.14861
p-value	[0.9999978]	[1.0000000]	[1.0000000]	[0.9839384]		[1.000000]	[0.9240439]	[1.0000000]	[0.8355620]		[0.3748970]	[0.8810322]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.9(a) EGARCH (1, 1) Modeling with Student's t- distribution

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Model Specifications	ARMA (1,1)	ARMA (4,5)	ARMA (1,2)	ARMA (2,5)	ARMA (1,1)	ARMA (0,1)	ARMA (1,0)	ARMA (0,5)	ARMA (4,0)	ARMA (0,2)	ARMA (2,3)	ARMA (0,2)
	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)
Mean equation												
C			0.007060	0.00661	0.004902		0.006766	0.001832		0.004927		0.001073
t-Prob			0	0	0		0	0.0731		0		0.1373
AR(1)			0.468320	0.577154	-0.195933		0.797490					
t-Prob			0	0.0027	0.3220		0					
AR(2)				-0.08058								
t-Prob				0.6292								
AR(3)												
t-Prob												
AR(4)												
t-Prob												
AR(5)												
t-Prob												
MA(1)			0.015898	-1	0.563523			-0.645087		-0.694951		-0.54666
t-Prob			0.8275	0	0.0002			0		0		0
MA(2)			-0.006546	0.211594				0.147813		0.177707		0.165844
t-Prob			0.9007	0.4003				0.0250		0		0.0600
MA(3)				0.073686				0.135964				
t-Prob				0.3688				0.0308				
MA(4)				0.032889				-0.23430				
t-Prob				0.5243				0.0025				
MA(5)				-0.13711				0.077210				

t-Prob				0.002				0.0187				
Variance Equation												
C			0	0	0		0	0.246611		1		0
t-Prob			1	1	1		1	0.9924		0		1
α(1)			0.750422	0.147563	-0.005056		-0.146636	0.340572		-0.131452		0.965631
t-Prob			0.2900	0.5564	0.9895		0.13330	0.1103		0.9183		0.4513
β(1)			0.587416	0.668637	0.885838		0.911543	0.589284		0.963758		0.082472
t-Prob			0.1303	0	0		0	0		0		0.7678
θ(1)			0.105742	0.497122	-0.106520		0.228927	-0.38865		0.025933		-0.10562
t-Prob			0.0267	0	0.2856		0.0003	0		0.9558		0.0476
θ(2)			0.246857	0.091662	0.494051		0.495255	0.110699		1		0.254041
t-Prob			0.0145	0.0019	0.0090		0	0		0.3824		0.4605
Student (DF)			26.446703	100	3.846315		3.909974	99.999995		2.016722		58.26572
t-Prob			0.4850	0	0.0001		0	0		0		0.3273
α(1)+β(1)			1.337838	0.8162	0.880782		0.746907	0.929856		0.832306		1.048103
Log Likelihood	1399.194	496.743	1679.842	812.417	1287.211	586.130	1365.137	732.831	932.144	613.854	1422.180	895.139
Akaike Criteria			-6.639531	-3.17462	-6.946797		-7.375745	-3.917560		-3.287249		-4.81597
Schwarz Criteria			-6.555623	-3.05715	-6.851219		-7.290787	-3.790122		-3.191671		-4.72039
Shibata Criteria			-6.640301	-3.17612	-6.947956		-7.376664	-3.919598		-3.288408		-4.81713
Hannan-Quinn			-6.606614	-3.12854	-6.908825		-7.341992	-3.866930		-3.249277		-4.77799

Table-A 5.9(b) EGARCH (1, 1) Modeling with Student's t- distribution

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Model Specifications	ARMA (1,0)	ARMA (1,0)	ARMA (4,2)	ARMA (0,1)	ARMA (2,0)	ARMA (0,3)	ARMA (0,1)	ARMA (0,1)	ARMA (0,1)	ARMA (5,1)	ARMA (0,1)	ARMA (0,2)
	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)	EGARCH (1,1)
Mean equation												
C	0.022592	0.003622		0.004267	-0.00394		0.013851	0.00175		-0.0009		0.002905
t-Prob	0	0		0.0429	0.8104		0	0.3143		0.4679		0.1848
AR(1)	0.363020	-0.41902			0.917494		0.393489			0.653499		
t-Prob	0	0			0		0			0		
AR(2)					0.095172					0.042145		
t-Prob					0.1606					0.5146		
AR(3)										-0.06942		
t-Prob										0.2418		
AR(4)										-0.10367		
t-Prob										0.0535		
AR(5)										-0.29702		
t-Prob										0		
MA(1)				-0.315601				-0.66441		-0.82327		-0.49362
t-Prob				0				0		0		0.2216
MA(2)										0		-0.05833
t-Prob										1		0.8332
MA(3)												
t-Prob												
MA(4)												
t-Prob												

MA(5)												
t-Prob												
Variance Equation												
C	100	100		0	-0.54214		0.758097	0		0.947177		0
t-Prob	0.9958	0.9897		1	0		0.9731	1		0.0006		1
α(1)	-0.16048	-0.92091		0.164509	0.961875		0.163726	-0.00827		0.947177		-0.11036
t-Prob	0.7581	0		0.6713	0		0.5596	0.969		0.0006		0.9545
β(1)	0.975035	1.006849		0.773285	0.961875		0.740029	0.91526		-0.80586		0.968329
t-Prob	0	0		0	0		0	0		0.0131		0.0041
θ(1)	-0.59419	0.353836		-0.144967	0.433123		0.375546	0.128475		-0.19746		-0.12758
t-Prob	0.2119	0.4330		0.0338	0.003		0	0.7518		0.0313		0.9068
θ(2)	1	1		0.290956	0.923757		0.108428	0.337703		0.619151		0.077938
t-Prob	0.1820	0.0513		0.0004	0		0.001	0.6253		0.0149		0.9879
Student (DF)	2.010794	2.006612		6.128561	2.651609		100	3.071549		17.74889		4.211711
t-Prob	0	0		0.0002	0		0	0.6287		0.7125		0.6965
α(1)+β(1)	0.814559	0.085947		0.937794	0.419732		0.903755	0.906992		0.141313		0.857965
Log Likelihood	785.679	738.849	1173.837	478.132	970.399	675.064	882.013	463.748	640.751	298.611	766.302	362.584
Akaike Criteria	-4.22652	-3.97201		-2.806758	-7.31102		-6.15502	-3.20949		-1.85462		-2.26656
Schwarz Criteria	-4.14156	-3.88705		-2.715674	-7.18878		-6.05223	-3.1067		-1.69718		-2.15859
Shibata Criteria	-4.22744	-3.97293		-2.807864	-7.31326		-6.15655	-3.21102		-1.85799		-2.26816
Hannan-Quinn	-4.19277	-3.93826		-2.770446	-7.26189		-6.11381	-3.16828		-1.79167		-2.22341

Table-A 5.10(a) Diagnostic Test t-EGARCH (1, 1)

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Normality Test												
Skewness			-0.27700	0.45855	4.6682		1.9217	0.15052		-3.3559		-0.14514
p-value			0.010967	2.54E-05	0		1.3697e-051	0.23657		1.8650e-153		0.25376
Excess Kurtosis			1.4132	0.41383	40.594		10.835	-0.15542		27.684		0.50105
p-value			7.9410e-011	0.056927	0		0	0.54009		0		0.048245
Jarque-Bera			48.290	21.217	26604.		2026.5	1.7600		12443.		5.1413
p-value			3.2653e-011	2.47E-05	0		0	0.41478		0		0.076484
Q-Statistics on Standard Residuals												
Q(5)			13.4743	73.1654	2.76812		6.34296			13.5145		10.5089
p-value			[0.0011860]**	[0.0000000]**	[0.4287750]		[0.1749581]			[0.0036463]**		[0.0147009]*
Q(10)			37.6144	400.545	11.0369		16.4990	39.6926		21.3281		23.2133
p-value			[0.0000036]**	[0.0000000]**	[0.1996172]		[0.0571644]	[0.0000043]**		[0.0063251]**		[0.0031009]**
Q(15)			138.969		48.9460		96.1850	185.858		106.642		43.8311
p-value			[0.0000000]**		[0.0001088]**		[0.0000000]**	[0.0000000]**		[0.0000000]**		[0.0006089]**
Q(20)			361.288		105.447		248.974	518.457		381.325		117.607
p-value			[0.0000000]**		[0.0000034]**		[0.0000000]**	[0.0000000]**		[0.0000000]**		[0.0000001]**
Q-Statistics on Squared Standard Residuals												
Q(5)			2.29032	17.2874	0.282412		1.10735	5.95616		11.0422		3.01761
p-value			[0.5143770]	[0.0006168]**	[0.9633017]		[0.7752991]	[0.1137626]		[0.0115000]*		[0.3889175]
Q(10)			5.46702	37.2575	0.403592		3.01358	18.1926		11.6828		8.85160
p-value			[0.7066907]	[0.0000103]**	[0.9999412]		[0.9335023]	[0.0198277]*		[0.1659280]		[0.3549694]

Q(15)			25.9250		0.865407		6.00353			13.7029		17.7177
p-value			[0.1014853]		[1.0000000]		[0.9961827]			[0.7482453]		[0.4743871]
Q(20)			0.49356		2.64197		31.2427			24.5041		56.7337
p-value			[0.0014498]**		[1.0000000]		[0.9708207]			[0.9980814]		[0.1815295]
ARCH Test												
ARCH(1-2)			0.17157	1.9375	0.056485		0.13391	0.68970		0.015184		0.79027
p-value			[0.8424]	[0.1452]	[0.9451]		[0.8747]	[0.5024]		[0.9849]		[0.4545]
ARCH(1-5)			0.45993	3.2216	0.054014		0.22514	1.0500		2.1527		0.59300
p-value			[0.8061]	[0.0071]**	[0.9982]		[0.9515]	[0.3880]		[0.0588]		[0.7054]
ARCH(1-10)			0.49356	4.1893	0.038109		0.34107	1.7815		1.2020		0.95110
p-value			[0.8944]	[0.0000]**	[1.0000]		[0.9693]	[0.0627]		[0.2883]		[0.4863]
Residual based diagnostic												
RBD(2)			0.432794	3.70214	0.153892		0.214640	1.48613		21.9393		0.392057
p-value			[0.8054155]	[0.1570692]	[0.9259400]		[0.8982383]	[0.4756541]		[0.0000172]		[0.8219887]
RBD(5)			0.649011	19.6067	0.175342		0.464519	6.96763		58.5796		2.17696
p-value			[0.9856495]	[0.0014809]	[0.9993567]		[0.9933649]	[0.2230585]		[0.0000000]		[0.8241565]
RBD(10)			4.70893	40.7361	0.315663		1.06149	-15.3440		86.9592		14.1890
p-value			[0.9097547]	[0.0000126]	[0.99999993]		[0.9997738]	[1.0000000]		[0.0000000]		[0.1645440]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.10(b) Diagnostic Test t-EGARCH (1, 1)

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Normality Test												
Skewness	-1.5512	-18.103		-0.89662	-5.2945		-10.057	-5.2945		-0.02692		-0.97400
p-value	3.2048e-034	0		1.7020e-011	3.17E-272		0	3.17E-272		0.8463		6.8084e-012
Excess Kurtosis	21.217	337.85		3.5020	51.598		137.83	51.598		0.67251		1.9757
p-value	0	0		1.1364e-039	0		0	0		0.01516		6.9763e-013
Jarque-Bera	7050.4	1.7703e+006		216.07	30404		2.30E+05	30404		5.8414		97.377
p-value	0	0		1.2042e-047	0		0	0		0.053896		7.1574e-022
Q-Statistics on Standard Residuals												
Q(5)	13.4439	1.47371		9.90841	4.70768		0.449123	4.70768				4.33843
p-value	[0.0092986]**	[0.8312884]		[0.0419991]*	[0.1944970]		[0.9782611]	[0.1944970]				[0.2271623]
Q(10)	21.5679	1.53763		36.6080	10.3637		5.00519	10.3637		25.0679		8.76513
p-value	[0.0103541]*	[0.9968579]		[0.0000309]**	[0.2404190]		[0.8338559]	[0.2404190]		[0.0000488]**		[0.3624954]
Q(15)	41.2836	1.71008		114.701	13.8903		12.9884	13.8903		43.1823		45.6928
p-value	[0.0022121]**	[0.9999999]		[0.000000]**	[0.7362146]		[0.8391624]	[0.7362146]		[0.0000801]**		[0.0003289]**
Q(20)	95.9717	2.16862		259.757	79.3839		32.2296	79.3839		79.3483		141.205
p-value	[0.0000697]**	[1.0000000]		[0.000000]**	[0.0029359]**		[0.9691775]	[0.0029359]**		[0.0008629]**		[0.000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.783220	0.011533		3.36986	0.212694		0.049669	0.212694		3.64143		0.638250
p-value	[0.8534761]	[0.9996717]		[0.3380370]	[0.9755145]		[0.9970994]	[0.9755145]		[0.3028765]		[[0.8876227]
Q(10)	1.45396	0.014839		8.35902	0.674134		0.092917	0.674134		6.70732		10.3858

p-value	[0.9934463]	[1.0000000]		[0.3992080]	[0.9995886]		[0.9999998]	[0.9995886]		[0.5685150]		[0.2389840]
Q(15)	2.37136	0.014982		11.1412	0.861034		0.145534	0.861034		22.9356		21.2008
p-value	[0.9999956]	[1.0000000]		[0.8882693]	[1.0000000]		[1.0000000]	[1.0000000]		[0.1930764]		[0.2694013]
Q(20)	40.0911	0.016477		43.2611	48.7082		0.340587	48.7082		36.8935		57.3829
p-value	[0.7844346]	[1.0000000]		[0.6670842]	[0.4443476]		[1.0000000]	[0.4443476]		[0.8781063]		[0.1663770]
ARCH Test												
ARCH(1-2)	0.041271	0.001429		0.49800	0.029275		0.00794	0.029275		0.19009		0.091662
p-value	[0.9596]	[0.9986]		[0.6082]	[0.9712]		[0.9921]	[0.9712]		[0.8270]		[0.9124]
ARCH(1-5)	0.15006	0.002237		0.70468	0.04149		0.009675	0.04149		0.74493		0.11771
p-value	[0.9800]	[1.0000]		[0.6203]	[0.9990]		[1.00000]	[0.9990]		[0.5904]		[0.9884]
ARCH(1-10)	0.13024	0.011043		0.82786	0.058691		0.008859	0.058691		0.61087		0.93346
p-value	[0.9994]	[1.0000]		[0.6020]	[1.0000]		[1.00000]	[1.0000]		[0.8044]		[0.5026]
Residual based diagnostic												
RBD(2)	28.7516	0.011455		0.858771	0.037072		0.001187	0.037072		3.66601		0.128119
p-value	[0.0000006]	[0.9942889]		[0.6509090]	[0.9816347]		[0.9994069]	[0.9816347]		[0.1599323]		[0.9379494]
RBD(5)	65.7143	0.036647		2.58774	0.115998		0.005125	0.115998		-129.159		3.45161
p-value	[0.0000000]	[0.9999865]		[0.7632273]	[0.9997661]		[0.9999999]	[0.9997661]		[1.0000000]		[0.6307222]
RBD(10)	110.628	0.253692		9.30486	0.556974		0.067845	0.556974		8.91472		5.95227
p-value	[0.0000000]	[0.9999998]		[0.5034364]	[0.9999889]		[1.0000000]	[0.9999889]		[0.5402158]		[0.8192574]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.11(a) GJR (1, 1) Modeling with Student's t- distribution

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Model Specifications	ARMA (1,1)	ARMA (4,5)	ARMA (1,2)	ARMA (2,5)	ARMA (1,1)	ARMA (0,1)	ARMA (1,0)	ARMA (0,5)	ARMA (4,0)	ARMA (0,2)	ARMA (2,3)	ARMA (0.2)
	GJR(1,1)	GJR (1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)
Mean equation												
C			0.006881		0.004788	-0.00049	0.007048	0.002281	0.005187	0.004682	0.005005	0.001140
t-Prob			0		0	0.4816	0	0.0115	0	0	0.0360	0.1099
AR(1)			0.476819		-0.188310		0.818709		0.017056		0.552213	
t-Prob			0		0.1798		0		0.7472		0.0074	
AR(2)									0.070167		0.423502	
t-Prob									0.2006		0.0309	
AR(3)									0.004508			
t-Prob									0.9354			
AR(4)									-0.05601			
t-Prob									0.4021			
AR(5)												
t-Prob												
MA(1)			-0.022020		0.520292	-0.69893		-0.650771		-0.689435	-0.38099	-0.51148
t-Prob			0.7316		0	0		0		0	0.0732	0
MA(2)			-0.051472					0.129065		0.166967	-0.42948	0.144937
t-Prob			0.2975					0.1010		0	0.0189	0.0455
MA(3)								0.124118			-0.01256	
t-Prob								0.0415			0.7913	
MA(4)								-0.235455				
t-Prob								0.0006				
MA(5)								0.072374				
t-Prob								0.0216				

Variance Equation												
C			0.026648		0.387552	6.492394	0.064228	3.4229994	0	13.19538	0.029603	1.755124
t-Prob			0.0318		0.1903	0.0162	0.1305	0.0008	1	0.5097	0.3932	0.0042
α(1)			0.102266		0.692436	0.531366	0.785361	0	0.027360	0.579049	0.070089	0.103579
t-Prob			0.0117		0.2398	0.0022	0.4187	1	0.5247	0.4985	0.0449	0.0815
β(1)			0.924224		0.250973	0.576040	0.534791	0.442602	0.965818	0.694509	0.798076	0.442927
t-Prob			0		0.3356	0	0.0888	0.0008	0	0	0	0.0034
ϒ(1)			-0.113996		-0.417044	-0.43475	-0.672648	0.666603	0.006792	-0.378507	0.028424	0.131560
t-Prob			0.0021		0.4811	0.0098	0.3081	0.0001	0.8729	0.5435	0.7924	0.2312
Student (DF)			7.982690		2.660303	3.681007	2.923873	99.999995	11.73767	2.251862	7.344945	13.21926
t-Prob			0.0058		0	0	0	0	0.1131	0	0.0064	0.0775
α(1)+β(1)+ϒ(1)			0.969492		0.734886	0.89003	0.983828	0.775904	0.996574	1.0843	0.882377	0.612286
Log Likelihood	1408.512	507.8	1704.784	821.652	1317.655	594.241	1373.510	733.371	949.993	610.427	1442.964	902.879
Akaike Criteria			-6.742680		-7.117689	-3.191525	-7.426684	-3.925928	-5.108658	-3.274062	-7.782411	-4.86347
Schwarz Criteria			-6.667163		-7.032731	-3.117186	-7.352346	-3.809110	-5.002460	-3.189104	-7.665594	-4.77851
Shibata Criteria			-6.743306		-7.118608	-3.192231	-7.427390	-3.927647	-5.110083	-3.274981	-7.784130	-4.86439
Hannan-Quinn			-6.713055		-7.083936	-3.161991	-7.397150	-3.879517	-5.066466	-3.240309	-7.736001	-4.82972

Table-A 5.11(b) GJR (1, 1) Modeling with Student's t- distribution

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Model Specifications	ARMA (1,0)	ARMA (1,0)	ARMA (4,2)	ARMA (0,1)	ARMA (2,0)	ARMA (0,3)	ARMA (0,1)	ARMA (0,1)	ARMA (0,1)	ARMA (5,1)	ARMA (0,1)	ARMA (0,2)
	GJR(1,1)	GJR (1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)	GJR(1,1)
Mean equation												
C	0.023217	0.002825		0.004198	0.004975	0.002779	0.013508	0.001735	0.014319	-0.00033	0.012652	0.002848
t-Prob	0	0		0.0343	0	0.0031	0	0.0344	0	0.7675	0	0.0691
AR(1)	0.356573	-0.377460			0.747738				0.189634	0.618126	0.46329	
t-Prob	0	0			0				0	0	0	
AR(2)					0.043146					0.070158		
t-Prob					0.6143					0.2304		
AR(3)										-0.07204		
t-Prob										0.311		
AR(4)										-0.10035		
t-Prob										0.103		
AR(5)										-0.30325		
t-Prob										0		
MA(1)				-0.335350		-0.14112	0.403781	-0.67251		-0.83155		-0.49326
t-Prob				0		0.0417	0	0		0		0
MA(2)						0.038322						-0.07455
t-Prob						0.6012						0.3072
MA(3)						0.024439						
t-Prob						0.7226						
MA(4)												
t-Prob												
MA(5)												

t-Prob												
					Variance Equation							
C	0.023144	0.084882		5.578343	0.044999	2.404516	0.326511	0.432858	2.662419	0.007599	0.620528	0.000296
t-Prob	0.5039	0.1255		0.4060	0.6086	0.0001	0.033	0.48	0.0017	0.0011	0.0142	0.0103
α(1)	0.032489	0.418345		0	1	0.077523	0.708879	0	0.12168	0	0.285992	0.158865
t-Prob	0.0511	0.0221		1	0.6029	0.2700	0.0169	1	0.1102	1	0.0411	0.0648
β(1)	0.948490	0.518543		0.774667	0.56382	0.195961	0.44733	0.967578	0.521447	0	0.747813	0.807570
t-Prob	0	0		0.0097	0.0035	0.0930	0.008	0	0	1	0	0
Υ(1)	0.044436	0.479686		0.111949	-0.89237	0.325918	-0.6654	0.018621	0.227059	0.458308	-0.32709	0.000612
t-Prob	0.1262	0.3393		0.3004	0.6133	0.2461	0.0348	0.6632	0.2817	0.1002	0.0313	0.9951
Student (DF)	3.711574	2.613606		5.547727	2.529976	3.823848	6.679094	3.510653	6.398316	7.305139	4.721593	4.552542
t-Prob	0	0		0.0035	0.0692	0	0.0009	0	0.0074	0.0098	0.0083	0.0001
α(1)+β(1)+Υ(1)	1.0032	1.75839		0.830641	0.671454	0.436443	0.490808	0.986199	0.870186	0.229154	0.706714	0.966741
Log Likelihood	796.865	751.049	1181.303	486.636	968.141	684.322	878.195	477.585	648.472	297.419	777.84	359.759
Akaike Criteria	-4.292744	-4.043747		-2.863498	-7.30145	-5.13552	-6.13518	-3.31398	-4.1654	-1.85337	-4.94128	-2.25486
Schwarz Criteria	-4.218405	-3.969408		-2.783800	-7.19279	-5.01328	-6.04524	-3.22404	-4.08063	-1.70804	-4.8573	-2.15889
Shibata Criteria	-4.293449	-4.044453		-2.864348	-7.30323	-5.13777	-6.13635	-3.31516	-4.1664	-1.85625	-4.94226	-2.25613
Hannan-Quinn	-4.263210	-4.014213		-2.831725	-7.25778	-5.08640	-6.09912	-3.27792	-4.1315	-1.79526	-4.90772	-2.21650

Table-A 5.12(a) Diagnostic Test t-GJR (1, 1)

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Normality Test												
Skewness			-0.23593		4.1971	-1.7905	2.0520	0.20561	0.22935	-3.0227	1.0601	-0.17199
p-value			0.030266		7.3484e-239	5.0819e-045	1.4320e-058	0.10593	0.071314	7.0538e-125	7.6883e-017	0.17624
Excess Kurtosis			1.8782		34.459	7.1391	9.2694	-0.002086	1.05920	22.964	3.4142	0.57732
p-value			5.5732e-018		0	2.8742e-174	0	0.99344	2.9851E-005	0	2.7108e-041	0.022854
Jarque-Bera			78.601		19288.	978.13	1575.7	2.5930	20.421	8646.5	247.67	6.9249
p-value			8.5512e-018		0	3.9974e-213	0	0.27349	3.6778E-005	0	1.6583e-054	0.031353
Q-Statistics on Standard Residuals												
Q(5)			16.5404		2.41709	7.43183	4.65021		3.44509	10.9026		11.2496
p-value			[0.0002560]**		[0.4904621]	[0.1147529]	[0.3251066]		[0.0634401]	[0.0122644]*		[0.0104500]**
Q(10)			42.6804		8.89028	23.3379	9.36069	30.6565	12.6082	20.5138	21.9324	24.6947
p-value			[0.0000004]**		[0.3516359]	[0.0054804]**	[0.4046670]	[0.0000109]**	[0.0496968]*	[0.0085574]**	[0.0005393]**	[0.0017818]**
Q(15)			150.680		55.4002	107.743	81.3308	188.830	131.545	102.108	53.6919	47.1630
p-value			[0.0000000]*		[0.0000111]**	[0.000000]**	[0.0000000]**	[0.0000000]**	[0.000000]**	[0.0000000]**	[0.0000030]**	[0.0002003]**
Q(20)			387.179		110.947	375.481	214.655	535.743	306.904	362.021	147.381	123.772
p-value			[0.0000000]**		[0.0000007]**	[0.000000]**	[0.0000000]**	[0.0000000]**	[0.000000]**	[0.0000000]**	[0.000000]**	[0.000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)			9.89259		0.328279	0.717626	1.85093	10.5187	2.19142	7.05433	1.68722	1.02680
p-value			[0.0195016]*		[0.9546251]	[0.8690505]	[0.6039159]	[0.0146347]**	[0.5336413]	[0.0701862]	[0.6397789]	[0.7947680]
Q(10)			12.6687		0.543642	6.61297	5.43847	30.1578	3.15528	7.80913	3.83052	4.92270
p-value			[0.1237680]		[0.9998168]	[0.5789059]	[0.7098469]	[0.0001982]**	[0.9242379]	[0.4523337]	[0.8720819]	[0.7658056]

Q(15)			25.2398		1.31093	11.8542	8.95239		20.0787	10.3410	14.5930	13.5812
p-value			[0.1184512]		[1.0000000]	[0.8546744]	[0.9608353]		[0.3284068]	[0.9202071]	[0.6896992]	[0.7559564]
Q(20)			55.7046		2.86466	32.7875	34.8996		60.5419	25.3568	27.5833	51.7508
p-value			[0.2075172]		[1.0000000]	[0.9540738]	[0.9211594]		[0.1057021]	[0.9970661]	[0.9921114]	[0.329643]
ARCH Test												
ARCH(1-2)			4.0506		0.081869	0.23341	0.54753	3.0269	0.49481	0.016416	0.20821	0.054047
p-value			[[0.0180]*		[0.9214]	[0.7919]	[0.5789]	[0.0497]*	[0.6101]	[0.9837]	[0.8121]	[0.9474]
ARCH(1-5)			1.8720		0.065567	0.15156	0.44108	1.9129	0.43576	1.3647	0.30317	0.19575
p-value			[0.0977]		[0.9971]	[0.9795]	[0.8197]	[0.0915]	[0.8235]	[0.2369]	[0.9109]	[0.9640]
ARCH(1-10)			1.1708		0.049810	0.70227	0.49608	2.8742	0.94403	0.75125	0.30251	0.47749
p-value			[0.3082]		[1.0000]	[0.7224]	[0.8924]	[0.0019]**	[0.4927]	[0.6758]	[0.9803]	[0.9043]
Residual based diagnostic												
RBD(2)			-4.14190		0.173761	0.323610	0.801738	-37.9340	0.796809	-18.3009	1.06711	0.23524
p-value			[1.0000000]		[0.9167866]	[0.8506071]	[0.6697379]	[1.0000000]	[0.6713903]	[1.0000000]	[0.5865156]	[0.8890316]
RBD(5)			-0.922413		0.347651	0.453884	1.00616	-18.3289	3.26593	4.07936	1.96376	1.04414
p-value			[1.0000000]		[0.9966497]	[0.9937147]	[0.9620675]	[1.0000000]	[0.6590613]	[0.5380470]	[0.8541369]	[0.9589274]
RBD(10)			1.57437		0.604407	6.77762	4.12291	-31.8460	5.12480	8.79276	3.20437	6.178181
p-value			[0.9986845]		[0.9999837]	[0.7462588]	[0.9416320]	[1.0000000]	[0.8826866]	[0.5518778]	[0.9761972]	[0.8000774]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H_0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H_0: series is not subject to ARCH effect. JB (Jarque Bera) test H_0: series is normal.

Table-A 5.12(b) Diagnostic Test t-GJR (1, 1)

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Normality Test												
Skewness	-2.2331	-14.847		-0.92336	-15.041	-0.78477	0.21906	-8.9318	0.007599	-0.08366	0.61184	-0.63726
p-value	5.0234e-069	0		4.2012e-012	0	1.7398e-007	0.12977	0	0.22526	0.54697	9.29E-06	3.8870e-006
Excess Kurtosis	35.410	260.60		3.5004	235.25	5.4229	1.2493	117.62	1.474	0.83627	1.4834	2.9527
p-value	0	0		1.2321e-039	0	2.2143e-073	1.46E-05	0	1.02E-07	0.002529	7.01E-08	7.3306e-027
Jarque-Bera	19532.0	1.0548e+006		218.63	6.16E+05	349.25	20.74	1.67E+05	29.338	9.3342	48.072	134.45
p-value	0	0		3.3499e-048	0	1.4482e-076	3.14E-05	0	4.26E-07	0.0094	3.64E-11	6.3651e-030
Q-Statistics on Standard Residuals												
Q(5)	11.4371	0.566037		10.5065	0.501134	13.1643	18.1821	1.63245	35.3171		7.60652	7.39054
p-value	[0.0220673]*	[0.9667620]		[0.0327072]*	[0.9186423]	[0.0013849]**	[0.0011369]**	[0.8029484]	[0.0000004]**		[0.1071028]	[0.0604386]
Q(10)	18.8735	1.31325		36.5409	0.645592	19.2239	33.4714	6.18724	73.2159		12.0253	14.2645
p-value	[0.0262903]*	[0.9983097]		[0.0000318]**	[0.9996501]	[0.0075143]**	[0.0001105]**	[0.7210423]	[0.0000000]**	21.0326	[0.2118861]	[0.0751272]
Q(15)	33.6881	3.07201		116.691	0.807125	38.0758	85.4218	16.4231	243.137	42.9248	37.7779	43.1394
p-value	[0.0199964]*	[0.9999869]		[0.0000000]**	[1.0000000]	[0.0023995]**	[0.0000000]**	[0.6288865]	[0.0000000]**	[0.0000881]**	[0.0063329]**	[0.0007647]**
Q(20)	94.2075	6.75473		248.054	2.27209	90.3996	186.044	39.6255	555.209	79.3031	91.8995	130.989
p-value	[0.0001107]**	[1.0000000]		[0.0000000]**	[1.0000000]	[0.001460]**	[0.0000000]**	[0.8280797]	[0.0000000]**	[0.0008725]**	[0.0002002]**	[0.000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	0.208699	0.021916		2.30706	0.020521		3.412	0.04592	0.758914	4.76532	3.0494	2.51016
p-value	[0.9761730]	[0.9991428]		[0.5111701]	[0.9992230]		[0.3323563]	[0.9974187]	[0.8592669]	[0.1898106]	[0.3840716]	[0.4734573]
Q(10)	0.550322	0.027659		6.52439	0.020601	10.3918	5.88931	0.092946	7.55828	6.93137	8.17907	6.59268

p-value	[0.9998081]	[1.0000000]		[0.5887031]	[1.0000000]	[0.2385992]	[0.6596296]	[0.9999998]	[0.4777614]	[0.5440553]	[0.4161763]	[0.5811472]
Q(15)	1.13680	0.028709		9.97162	0.020903	15.8190	24.6651	0.157316	32.3223	29.0647	15.9581	13.1153
p-value	[1.0000000]	[1.0000000]		[0.9328288]	[1.0000000]	[0.6051781]	[0.1344219]	[1.0000000]	[0.0201315]*	[0.0475936]*	[0.5954707]	[0.7846797]
Q(20)	34.8384	0.034361		51.5676	0.024379	38.7024	54.616	0.351992	90.4961	48.2515	43.4928	33.7283
p-value	[0.9222913]	[1.0000000]		[0.3360882]	[1.0000000]	[0.8286763]	[0.2376559]	[1.0000000]	[0.0002026]**	[0.4626731]	[0.6578520]	[0.9409440]
ARCH Test												
ARCH(1-2)	0.014180	0.004779		0.061207	0.002886	0.081433	1.5368	0.003115	0.1458	0.023262	0.65966	0.56508
p-value	[0.9859]	[0.9952]		[0.9406]	[0.9971]	[0.9218]	[0.2169]	[0.9969]	[0.8644]	[0.9770]	[0.5178]	[0.5689]
ARCH(1-5)	0.039701	0.004277		0.45382	0.003931	1.7636	0.4264	0.00853	0.1511	0.89817	0.63731	0.30811
p-value	[0.9991]	[1.0000]		[0.8104]	[1.000000]	[0.1209]	[0.8301]	[1.00000]	[0.9796]	[0.4826]	[0.6714]	[0.9079]
ARCH(1-10)	0.049730	0.020061		0.63466	0.16329	1.0542	0.86531	0.008501	0.72689	0.7631	0.78865	0.60214
p-value	[1.0000]	[1.0000]		[0.7839]	[0.9984]	[0.3988]	[0.5663]	[1.00000]	[0.6990]	[0.6644]	[0.6398]	[0.8118]
Residual based diagnostic												
RBD(2)	0.051098	0.000186		0.0785611	0.000735	0.316863	1.07315	0.023815	0.607716	0.04035	3.9664	1.08133
p-value	[0.9747742]	[0.9999070]		[0.9614809]	[0.9996326]	[0.8534813]	[0.5847474]	[0.9881632]	[0.7379656]	[0.9800270]	[0.1376284]	[0.5823614]
RBD(5)	0.249428	0.000222		1.81631	0.000861	-5.13319	3.24604	0.027617	1.0824	10.0376	-0.25504	1.64523
p-value	[0.9984876]	[1.0000000]		[0.8739328]	[1.0000000]	[1.000000]	[0.6621128]	[0.9999933]	[0.9556495]	[0.0741778]	[1.0000000]	[0.8957259]
RBD(10)	0.542625	0.158241		7.72934	0.001501	-0.72505	7.81074	0.059072	-1.20364	16.7782	7.98602	5.14931
p-value	[0.9999902]	[1.0000000]		[0.6552556]	[1.0000000]	[1.000000]	[0.6473171]	[1.0000000]	[1.0000000]	[0.0794174]	[0.6302030]	[0.8809836]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H0: no serial correlation. LM-ARCH (n) Lagrange multiplier test for ARCH effect up to order n, its H0: series is not subject to ARCH effect. JB (Jarque Bera) test H0: series is normal.

Table-A 5.13: Parameters of mean and variance equations for Pakistan

Inflation Model			Output Model		
Mean Equation			**Mean Equation**		
Constant	C	0.0000678	Constant	c	-0.019820
t-Prob		0.0397**	t-Prob		0.4226
π_{t-1}	δ_1	0.961978	Y_{t-1}	k_1	-0.579618
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-1}	φ_1	-0.824557	ε_{t-1}	$\emptyset_1$	0.611562
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-2}	φ_2	-0.185198	ε_{t-2}	$\emptyset_2$	0.176073
t-Prob		0.0286**	t-Prob		0.0085***
ε_{t-3}	φ_3	0.117053	ε_{t-3}	$\emptyset_3$	0.205595
t-Prob		0.0284**	t-Prob		0.0019***
$\sigma^2_{\pi t}$	θ_1	-3.928042	σ^2_{Yt}	∂_1	7.845047
t-Prob		0.0965*	t-Prob		0.1355
σ^2_{Yt}	θ_2	-0.047700	$\sigma^2_{\pi t}$	∂_2	77.567640
t-Prob		0.1331	t-Prob		0.4480
Y_{t-1}	τ_1	-0.008934	π_{t-1}	ρ_1	-1.632303
t-Prob		0.0002***	t-Prob		0.0007***
Variance Equation			**Variance Equation**		
Constant	ω_0	0.001019	Constant	ω_0	0.0000011
t-Prob		0.1783	t-Prob		0.5366
ε^2_{t-1}	α_1	0.000039	ε^2_{t-1}	α_1	0.302292
t-Prob		0.99998	t-Prob		0.0000***
$\sigma^2_{\pi(t-1)}$	β_1	0.883098	$\sigma^2_{Y(t-1)}$	β_1	0.952580
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-2}	δ_2	0.038447	Y_{t-2}	k_2	0.00000004
t-Prob		0.0000***	t-Prob		0.7590
Y_{t-2}	τ_2	-0.0000002	π_{t-2}	ρ_2	-0.048741
t-Prob		0.8207	t-Prob		0.1225

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.779862 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.998789 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.14: Parameters of mean and variance equations for India

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	0.001546	Constant	C	0.007711
t-Prob		0.0374**	t-Prob		0.0001***
π_{t-1}	δ_1	1.496250	Y_{t-1}	k_1	0.325823
t-Prob		0.0000***	t-Prob		0.0523*
π_{t-2}	δ_2	-0.815418	ε_{t-1}	$\emptyset_1$	-1.037879
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-1}	φ_1	-1.170868	ε_{t-2}	$\emptyset_2$	0.306248
t-Prob		0.0000***	t-Prob		0.0157**
ε_{t-2}	φ_2	0.406921	ε_{t-3}	$\emptyset_3$	-0.010888
t-Prob		0.0000***	t-Prob		0.8792
ε_{t-3}	φ_3	0.226493	ε_{t-4}	$\emptyset_4$	-0.157905
t-Prob		0.0034***	t-Prob		0.0228**
ε_{t-4}	φ_4	0.006926	σ^2_{Yt}	∂_1	-0.563871
t-Prob		0.9025	t-Prob		0.4445
$\sigma^2_{\pi t}$	θ_1	4.913059	$\sigma^2_{\pi t}$	∂_2	-40.381066
t-Prob		0.5535	t-Prob		0.0031***
σ^2_{Yt}	θ_2	0.111703	π_{t-1}	ρ_1	-0.908091
t-Prob		0.5301	t-Prob		0.0205**
Y_{t-1}	τ_1	-0.023343	π_{t-2}	ρ_2	0.941324
t-Prob		0.0467**	t-Prob		0.0289**
Variance Equation			Variance Equation		
Constant	ω_0	0.000781	Constant	ω_0	0.022022
t-Prob		0.7002	t-Prob		0.7994
ε^2_{t-1}	α_1	0.174695	ε^2_{t-1}	α_1	0.393433
t-Prob		0.4964	t-Prob		0.0018***
$\sigma^2_{\pi(t-1)}$	β_1	0.921783	$\sigma^2_{Y(t-1)}$	β_1	0.606589
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-3}	δ_3	0.027913	Y_{t-2}	k_2	-0.0000003
t-Prob		0.0009***	t-Prob		0.2349
Y_{t-2}	τ_2	-0.0000001	π_{t-3}	ρ_3	-0.055277
t-Prob		0.2854	t-Prob		0.1841

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.880202 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.522739 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.15: Parameters of mean and variance equations for South Africa

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	0.000015	Constant	C	-0.000044
t-Prob		0.9456	t-Prob		0.9915
π_{t-1}	δ_1	0.990050	Y_{t-1}	k_1	0.199211
t-Prob		0.0000***	t-Prob		0.1733
ε_{t-1}	φ_1	-0.861784	ε_{t-1}	$\emptyset_1$	-0.691308
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-2}	φ_2	-0.036264	ε_{t-2}	$\emptyset_2$	0.211571
t-Prob		0.6086	t-Prob		0.0306**
$\sigma^2_{\pi t}$	θ_1	-3.090621	σ^2_{Yt}	∂_1	8.318372
t-Prob		0.5734	t-Prob		0.3554
σ^2_{Yt}	θ_2	0.183069	$\sigma^2_{\pi t}$	∂_2	-0.035890
t-Prob		0.7389	t-Prob		0.9995
Y_{t-1}	τ_1	0.017233	π_{t-1}	ρ_1	-0.335445
t-Prob		0.0337**	t-Prob		0.0138**
Variance Equation			Variance Equation		
Constant	ω_0	0.001400	Constant	ω_0	0.011239
t-Prob		0.1489	t-Prob		0.0090***
ε^2_{t-1}	α_1	0.247399	ε^2_{t-1}	α_1	0.473813
t-Prob		0.0000***	t-Prob		0.0001***
$\sigma^2_{\pi(t-1)}$	β_1	0.916496	$\sigma^2_{Y(t-1)}$	β_1	0.549773
t-Prob		0.0000***	t-Prob		0.0825*
π_{t-2}	δ_2	-0.001992	Y_{t-2}	k_2	-0.005158
t-Prob		0.7433	t-Prob		0.74974
Y_{t-2}	τ_2	0.003679	π_{t-2}	ρ_2	-0.113503
t-Prob		0.7123	t-Prob		0.0003***

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.901171 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.526749 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.16: Parameters of mean and variance equations for Nigeria

Inflation Model			Output Model		
Mean Equation			**Mean Equation**		
Constant	C	0.003449	Constant	C	-0.002303
t-Prob		0.0465**	t-Prob		0.3470
π_{t-1}	δ_1	0.689138	Y_{t-1}	k_1	0.421748
t-Prob		0.0000***	t-Prob		0.0363**
ε_{t-1}	φ_1	-0.328163	Y_{t-2}	k_2	0.096387
t-Prob		0.0029***	t-Prob		0.5462
$\sigma^2_{\pi t}$	θ_1	1.774872	ε_{t-1}	$\emptyset_1$	-0.869263
t-Prob		0.6603	t-Prob		0.0000***
σ^2_{Yt}	θ_2	0.049524	σ^2_{Yt}	∂_1	0.123093
t-Prob		0.4143	t-Prob		0.3431
Y_{t-1}	τ_1	-0.004028	$\sigma^2_{\pi t}$	∂_2	4.687965
t-Prob		0.7237	t-Prob		0.2899
Y_{t-2}	τ_2	0.000088	π_{t-1}	ρ_1	-0.005625
t-Prob		0.9941	t-Prob		0.9424
Variance Equation			**Variance Equation**		
Constant	ω_0	0.007632	Constant	ω_0	0.020488
t-Prob		0.2615	t-Prob		0.0159**
ε^2_{t-1}	α_1	0.106962	ε^2_{t-1}	α_1	0.432475
t-Prob		0.4288	t-Prob		0.0002***
$\sigma^2_{\pi(t-1)}$	β_1	0.674025	$\sigma^2_{Y(t-1)}$	β_1	0.850621
t-Prob		0.0069***	t-Prob		0.0000***
π_{t-2}	δ_2	0.091726	Y_{t-3}	k_3	0.046683
t-Prob		0.0000***	t-Prob		0.7174
Y_{t-3}	τ_3	0.001994	π_{t-2}	ρ_2	-0.020388
t-Prob		0.7422	t-Prob		0.5039

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant

- $\alpha^2 + \beta^2 = 0.465751 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.910591 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.17 Parameters of mean and variance equations for Indonesia

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	0.001241	Constant	C	-0.001981
t-Prob		0.2722	t-Prob		0.5196
π_{t-1}	δ_1	0.712833	Y_{t-1}	k_1	-0.407040
t-Prob		0.0065***	t-Prob		0.0705*
ε_{t-1}	φ_1	-0.145593	ε_{t-1}	$\emptyset_1$	-0.337347
t-Prob		0.4974	t-Prob		0.3632
ε_{t-2}	φ_2	-0.51355	ε_{t-2}	$\emptyset_2$	-0.179562
t-Prob		0.0002***	t-Prob		0.0910*
$\sigma^2_{\pi t}$	θ_1	2.873065	σ^2_{Yt}	∂_1	1.621177
t-Prob		0.4432	t-Prob		0.0663*
σ^2_{Yt}	θ_2	0.066759	$\sigma^2_{\pi t}$	∂_2	8.769121
t-Prob		0.6047	t-Prob		0.5404
Y_{t-1}	τ_1	0.024969	π_{t-1}	ρ_1	-0.980711
t-Prob		0.0010***	t-Prob		0.0263**
Variance Equation			Variance Equation		
Constant	ω_0	0.002625	Constant	ω_0	0.0000000
t-Prob		0.0069***	t-Prob		1.0000
ε^2_{t-1}	α_1	0.540527	ε^2_{t-1}	α_1	0.480373
t-Prob		0.0000***	t-Prob		0.0000***
$\sigma^2_{\pi(t-1)}$	β_1	0.841320	$\sigma^2_{Y(t-1)}$	β_1	0.486373
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-2}	δ_2	0.011595	Y_{t-2}	k_2	0.000000
t-Prob		0.2789	t-Prob		1.0000
Y_{t-2}	τ_2	0.0000000	π_{t-2}	ρ_2	-0.424870
t-Prob		1.0000	t-Prob		0.0000***

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.999988 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.467317 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.18: Parameters of mean and variance equations for Mexico

Inflation Model			Output Model		
Mean Equation			**Mean Equation**		
Constant	C	0.002908	Constant	C	0.01007
t-Prob		0.2321	t-Prob		0.3948
π_{t-1}	δ_1	0.591059	Y_{t-1}	k_1	0.414935
t-Prob		0.0000***	t-Prob		0.0352**
π_{t-2}	δ_2	0.340963	Y_{t-2}	k_2	0.243452
t-Prob		0.0022***	t-Prob		0.0225**
ε_{t-1}	φ_1	0.112451	ε_{t-1}	$\emptyset_1$	-1.127345
t-Prob		0.3622	t-Prob		0.0000***
ε_{t-2}	φ_2	-0.334650	ε_{t-2}	$\emptyset_2$	0.376823
t-Prob		0.0004***	t-Prob		0.0137**
ε_{t-3}	φ_3	-0.228990	ε_{t-3}	$\emptyset_3$	-0.150975
t-Prob		0.0056***	t-Prob		0.0375**
$\sigma^2_{\pi t}$	θ_1	-0.504296	σ^2_{Yt}	∂_1	-7.548836
t-Prob		0.9346	t-Prob		0.3998
σ^2_{Yt}	θ_2	-1.912842	$\sigma^2_{\pi t}$	∂_2	-8.291138
t-Prob		0.2883	t-Prob		0.3110
Y_{t-1}	τ_1	0.011012	π_{t-1}	ρ_1	-0.527821
t-Prob		0.1321	t-Prob		0.0069***
Y_{t-2}	τ_2	-0.013036	π_{t-2}	ρ_2	0.578046
t-Prob		0.9346	t-Prob		0.0111**
Variance Equation			**Variance Equation**		
Constant	ω_0	0.000859	Constant	ω_0	0.0000001
t-Prob		0.1188	t-Prob		0.3033
ε^2_{t-1}	α_1	0.523809	ε^2_{t-1}	α_1	0.028782
t-Prob		0.0006***	t-Prob		0.6261
$\sigma^2_{\pi(t-1)}$	β_1	0.749794	$\sigma^2_{Y(t-1)}$	β_1	0.988347
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-3}	δ_3	0.024754	Y_{t-3}	k_3	-0.0000012
t-Prob		0.0034***	t-Prob		0.8632
Y_{t-3}	τ_3	0.0000001	π_{t-3}	ρ_3	-0.016447
t-Prob		0.8773	t-Prob		0.0096***

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.836567 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.977658 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.19: Parameters of mean and variance equations for Algeria

Inflation Model			Output Model		
Mean Equation			**Mean Equation**		
Constant	C	0.001718	Constant	C	0.012359
t-Prob		0.6535	t-Prob		0.0836*
π_{t-1}	δ_1	-0.494709	Y_{t-1}	k_1	-1.608051
t-Prob		0.0004***	t-Prob		0.0000***
π_{t-2}	δ_2	-0.617602	Y_{t-2}	k_2	-0.881613
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-1}	φ_1	0.502563	ε_{t-1}	$\emptyset_1$	1.125826
t-Prob		0.0001***	t-Prob		0.0000***
ε_{t-2}	φ_2	0.743658	ε_{t-2}	$\emptyset_2$	0.087837
t-Prob		0.0000***	t-Prob		0.5195
ε_{t-3}	φ_3	0.059480	ε_{t-3}	$\emptyset_3$	-0.520607
t-Prob		0.5635	t-Prob		0.0000***
ε_{t-4}	φ_4	0.003490	ε_{t-4}	$\emptyset_4$	-0.001295
t-Prob		0.9776	t-Prob		0.9854
ε_{t-5}	φ_5	0.123945	ε_{t-5}	$\emptyset_5$	0.071882
t-Prob		0.2160	t-Prob		0.0530**
$\sigma^2_{\pi t}$	θ_1	38.304771	σ^2_{Yt}	∂_1	-0.030860
t-Prob		0.0040***	t-Prob		0.9185
σ^2_{Yt}	θ_2	0.111539	$\sigma^2_{\pi t}$	∂_2	-5.978780
t-Prob		0.0302**	t-Prob		0.6924
Y_{t-1}	τ_1	0.014301	π_{t-1}	ρ_1	-0.010500
t-Prob		0.1844	t-Prob		0.8609
Y_{t-2}	τ_2	0.007438	π_{t-2}	ρ_2	0.08123
t-Prob		0.6187	t-Prob		0.1253
Variance Equation			**Variance Equation**		
Constant	ω_0	0.000078	Constant	ω_0	0.000485
t-Prob		0.9471	t-Prob		0.9616
ε^2_{t-1}	α_1	0.191205	ε^2_{t-1}	α_1	0.301820
t-Prob		0.0006***	t-Prob		0.0552**
$\sigma^2_{\pi(t-1)}$	β_1	0.881580	$\sigma^2_{Y(t-1)}$	β_1	0.793028
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-3}	δ_3	-0.016010	Y_{t-3}	k_3	0.000012
t-Prob		0.6859	t-Prob		0.0000***
Y_{t-3}	τ_3	0.0000002	π_{t-3}	ρ_3	-0.134403
t-Prob		0.7164	t-Prob		0.1396

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.813742 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.719988 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.20: Parameters of mean and variance equations for Eucador

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	0.000607	Constant	C	0.008343
t-Prob		0.5055	t-Prob		0.0412**
π_{t-1}	δ_1	0.974036	Y_{t-1}	k_1	-0.975027
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-1}	φ_1	-0.895739	ε_{t-1}	$\emptyset_1$	0.685846
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-2}	φ_2	0.025517	ε_{t-2}	$\emptyset_2$	-0.384618
t-Prob		0.7495	t-Prob		0.0000***
ε_{t-3}	φ_3	-0.129704	ε_{t-3}	$\emptyset_3$	0.184434
t-Prob		0.0195**	t-Prob		0.0171**
ε_{t-4}	φ_4	0.042210	ε_{t-4}	$\emptyset_4$	0.103660
t-Prob		0.7475	t-Prob		0.0132**
ε_{t-5}	φ_5	0.021000	ε_{t-5}	$\emptyset_5$	-0.227740
t-Prob		0.8061	t-Prob		0.0000***
$\sigma^2_{\pi t}$	θ_1	-0.092694	σ^2_{Yt}	∂_1	0.007267
t-Prob		0.6604	t-Prob		0.7200
σ^2_{Yt}	θ_2	0.015894	$\sigma^2_{\pi t}$	∂_2	-0.383354
t-Prob		0.0961*	t-Prob		0.7430
Y_{t-1}	τ_1	0.013095	π_{t-1}	ρ_1	-0.154040
t-Prob		0.4205	t-Prob		0.0000***
Variance Equation			Variance Equation		
Constant	ω_0	0.003190	Constant	ω_0	0.0000007
t-Prob		0.0384**	t-Prob		1.0000
ε^2_{t-1}	α_1	0.226703	ε^2_{t-1}	α_1	0.469572
t-Prob		0.0000***	t-Prob		0.0000***
$\sigma^2_{\pi(t-1)}$	β_1	0.873959	$\sigma^2_{Y(t-1)}$	β_1	0.712889
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-2}	δ_2	-0.000000	Y_{t-2}	k_2	0.152261
t-Prob		1.0000	t-Prob		0.0000***
Y_{t-2}	τ_2	0.000030	π_{t-2}	ρ_2	-0.000000
t-Prob		0.9880	t-Prob		1.0000

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.815199 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.728709 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.21: Parameters of mean and variance equations for Bolivia

Inflation Model			Output Model		
Mean Equation			**Mean Equation**		
Constant	C	0.000697	Constant	C	-0.002426
t-Prob		0.0340**	t-Prob		0.9485
π_{t-1}	δ_1	1.580216	Y_{t-1}	k_1	-1.502485
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-2}	δ_2	-0.730424	Y_{t-2}	k_2	-0.827629
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-1}	φ_1	-1.263093	ε_{t-1}	$\emptyset_1$	1.226600
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-2}	φ_2	0.409493	ε_{t-2}	$\emptyset_2$	0.550845
t-Prob		0.0010***	t-Prob		0.0000***
ε_{t-3}	φ_3	0.079344	ε_{t-3}	$\emptyset_3$	-0.099843
t-Prob		0.4227	t-Prob		0.3885
ε_{t-4}	φ_4	-0.071228	ε_{t-4}	$\emptyset_4$	0.137546
t-Prob		0.3627	t-Prob		0.2723
ε_{t-5}	φ_5	0.100889	ε_{t-5}	$\emptyset_5$	0.158068
t-Prob		0.0517**	t-Prob		0.0199**
$\sigma^2_{\pi t}$	θ_1	0.845435	σ^2_{Yt}	∂_1	2.284612
t-Prob		0.5199	t-Prob		0.8300
σ^2_{Yt}	θ_2	-0.031965	$\sigma^2_{\pi t}$	∂_2	-2.220336
t-Prob		0.7127	t-Prob		0.4482
Y_{t-1}	τ_1	0.007401	π_{t-1}	ρ_1	-0.011424
t-Prob		0.0902*	t-Prob		0.9190
Y_{t-2}	τ_2	0.001642	π_{t-2}	ρ_2	-0.037378
t-Prob		0.7285	t-Prob		0.6191
Variance Equation			**Variance Equation**		
Constant	ω_0	0.000224	Constant	ω_0	0.000000
t-Prob		0.4623	t-Prob		1.0000
ε^2_{t-1}	α_1	0.577852	ε^2_{t-1}	α_1	0.302758
t-Prob		0.0000***	t-Prob		0.0007***
$\sigma^2_{\pi(t-1)}$	β_1	0.675832	$\sigma^2_{Y(t-1)}$	β_1	0.641535
t-Prob		0.0000***	t-Prob		0.0916*
π_{t-3}	δ_3	-0.052012	Y_{t-3}	k_3	-0.000000
t-Prob		0.0000***	t-Prob		1.0000
Y_{t-3}	τ_3	0.000000	π_{t-3}	ρ_3	0.001987
t-Prob		1.0000	t-Prob		0.9365

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.790662 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.503229 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.22: Parameters of mean and variance equations for Brazil

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	-0.000088	Constant	C	0.000810
t-Prob		0.7535	t-Prob		0.3474
π_{t-1}	δ_1	0.876091	Y_{t-1}	k_1	0.547235
t-Prob		0.0002***	t-Prob		0.0000***
π_{t-2}	δ_2	0.14227	ε_{t-1}	$\emptyset_1$	-0.803169
t-Prob		0.5433	t-Prob		0.0000***
ε_{t-1}	φ_1	-0.082338	ε_{t-2}	$\emptyset_2$	0.176579
t-Prob		0.7054	t-Prob		0.0963*
ε_{t-2}	φ_2	-0.226927	ε_{t-3}	$\emptyset_3$	-0.064840
t-Prob		0.0072***	t-Prob		0.0539**
ε_{t-3}	φ_3	0.039039	σ^2_{Yt}	∂_1	0.992829
t-Prob		0.0272**	t-Prob		0.3932
$\sigma^2_{\pi t}$	θ_1	0.286714	$\sigma^2_{\pi t}$	∂_2	-0.035809
t-Prob		0.3814	t-Prob		0.0284**
σ^2_{Yt}	θ_2	-0.004645	π_{t-1}	ρ_1	-0.009050
t-Prob		0.9865	t-Prob		0.3044
Y_{t-1}	τ_1	-0.012409	π_{t-2}	ρ_2	0.019496
t-Prob		0.4674	t-Prob		0.0195**
Variance Equation			Variance Equation		
Constant	ω_0	0.001315	Constant	ω_0	0.018008
t-Prob		0.0348**	t-Prob		0.0000***
ε^2_{t-1}	α_1	0.438391	ε^2_{t-1}	α_1	0.361713
t-Prob		0.01231**	t-Prob		0.2474
$\sigma^2_{\pi(t-1)}$	β_1	0.739286	$\sigma^2_{Y(t-1)}$	β_1	0.446527
t-Prob		0.0000***	t-Prob		0.0930*
π_{t-3}	δ_3	-0.026201	Y_{t-2}	k_2	0.0000002
t-Prob		0.0020***	t-Prob		0.9585
Y_{t-2}	τ_2	0.0000005	π_{t-3}	ρ_3	-0.018571
t-Prob		0.9860	t-Prob		0.1615

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.738731 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.330223 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.23: Parameters of mean and variance equations for Iran

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	0.002412	Constant	C	0.001107
t-Prob		0.0003***	t-Prob		0.5039
π_{t-1}	δ_1	1.359622	Y_{t-1}	k_1	0.231589
t-Prob		0.0000***	t-Prob		0.0717*
π_{t-2}	δ_2	-0.615053	Y_{t-2}	k_2	0.081972
t-Prob		0.0342**	t-Prob		0.4133
ε_{t-1}	φ_1	-1.063751	ε_{t-1}	$\emptyset_1$	-0.882160
t-Prob		0.0025***	t-Prob		0.0000***
ε_{t-2}	φ_2	0.388574	ε_{t-2}	$\emptyset_2$	0.119182
t-Prob		0.2670	t-Prob		0.3296
$\sigma^2_{\pi t}$	θ_1	3.496578	σ^2_{Yt}	∂_1	-0.740517
t-Prob		0.0200**	t-Prob		0.0317**
σ^2_{Yt}	θ_2	0.196970	$\sigma^2_{\pi t}$	∂_2	0.261806
t-Prob		0.0583**	t-Prob		0.9601
Y_{t-1}	τ_1	-0.004801	π_{t-1}	ρ_1	-0.338659
t-Prob		0.3343	t-Prob		0.1467
Y_{t-2}	τ_2	-0.009936	π_{t-2}	ρ_2	0.369263
t-Prob		0.2628	t-Prob		0.1607
Variance Equation			Variance Equation		
Constant	ω_0	0.003087	Constant	ω_0	0.062508
t-Prob		0.2825	t-Prob		0.0066***
ε^2_{t-1}	α_1	0.505437	ε^2_{t-1}	α_1	0.219616
t-Prob		0.0007***	t-Prob		0.0000***
$\sigma^2_{\pi(t-1)}$	β_1	0.517680	$\sigma^2_{Y(t-1)}$	β_1	0.416913
t-Prob		0.0064***	t-Prob		0.0130**
π_{t-3}	δ_3	-0.057625	Y_{t-3}	k_3	0.004373
t-Prob		0.0000***	t-Prob		0.6341
Y_{t-3}	τ_3	-0.006819	π_{t-3}	ρ_3	0.000899
t-Prob		0.7193	t-Prob		0.9589

Note: t-Prob*** indicates significant at 1% , ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.523459 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.222048 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.24: Parameters of mean and variance equations for Malawi

Inflation Model			Output Model		
Mean Equation			Mean Equation		
Constant	C	0.023330	Constant	C	-0.000330
t-Prob		0.0151**	t-Prob		0.9868
π_{t-1}	δ_1	-0.506752	Y_{t-1}	k_1	0.409252
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-2}	δ_2	0.482588	ε_{t-1}	$\emptyset_1$	-0.328670
t-Prob		0.0000***	t-Prob		0.0000***
ε_{t-1}	φ_1	0.971040	σ^2_{Yt}	∂_1	-0.176909
t-Prob		0.0000***	t-Prob		0.9296
$\sigma^2_{\pi t}$	θ_1	2.834150	$\sigma^2_{\pi t}$	∂_2	0.646256
t-Prob		0.1406	t-Prob		0.9456
σ^2_{Yt}	θ_2	-1.132159	π_{t-1}	ρ_1	-0.063587
t-Prob		0.1922	t-Prob		0.7784
Y_{t-1}	τ_1	-0.000316	π_{t-2}	ρ_2	0.052013
t-Prob		0.9414	t-Prob		0.7864
Variance Equation			Variance Equation		
Constant	ω_0	0.018136	Constant	ω_0	0.000127
t-Prob		0.0000***	t-Prob		0.9522
ε^2_{t-1}	α_1	0.380396	ε^2_{t-1}	α_1	0.116877
t-Prob		0.0199**	t-Prob		0.1796
$\sigma^2_{\pi(t-1)}$	β_1	0.645361	$\sigma^2_{Y(t-1)}$	β_1	0.974758
t-Prob		0.0000***	t-Prob		0.0000***
π_{t-3}	δ_3	-0.0000001	Y_{t-2}	k_2	0.071339
t-Prob		0.0610*	t-Prob		0.0320**
Y_{t-2}	τ_2	-0.018636	π_{t-3}	ρ_3	0.0000011
t-Prob		0.2580	t-Prob		0.7251

Note: t-Prob*** indicates significant at 1%, ** significant at 5% and * significant at 10%

- $\alpha^2 + \beta^2 = 0.561193 < 1$ for inflation series and $\alpha^2 + \beta^2 = 0.963813 < 1$ for output growth series for the presence of stationary condition.

Table-A 5.25(a) Diagnostic Testing of Final Model

Countries	Pak-Inf	Pak-IP	India-Inf	India-IP	Indo-Inf	Indo-IP	Mex-Inf	Mex-IP	ALg-Inf	ALg-IP	SA-Inf	SA-IP
Normality Test												
Skewness	1.0001	0.13228	0.11698	0.69699	2.6000	-1.3869	1.8756	0.16994	-0.037202	-2.0474	1.0086	-0.17132
p-value	1.9182e-016	0.27653	0.28412	1.7516e-010	2.0567e-092	1.4987e-027	7.6257e-049	0.18323	0.77079	7.4056e-058	3.3517e-015	0.18090
Excess Kurtosis	4.7282	0.50007	2.4360	1.1270	16.251	5.1844	8.3945	0.46765	2.2927	18.599	3.2870	0.54707
p-value	1.2296e-084	0.039230	1.3427e-029	2.3482e-007	0.00000	2.3718e-092	3.1360e-238	0.066341	2.2255e-019	0.00000	6.5718e-038	0.032184
Jarque-Bera	442.58	5.3744	127.53	66.943	4439.6	527.22	1285.7	5.0828	80.023	5516.1	224.96	6.3023
p-value	7.8693e-097	0.068072	2.0327e-028	2.9081e-015	0.00000	3.2730e-115	6.5100e-280	0.078757	4.1994e-018	0.00000	1.4147e-049	0.042803
Q-Statistics on Standard Residuals												
Q(5)	4.89618	27.03837	5.24850	3.35230	9.41418	4.90161	7.42247	12.9348	4.34097	2.19602	6.82464	11.1068
p-value	[0.4286818]	[0.0000549]**	[0.3863117]	[0.6458438]	[0.0936413]	[0.4280056]	[0.1910685]	[0.0239978]	[0.5014393]	[0.8214111]	[0.2340123]	[0.0493022]
Q(10)	17.6750	70.0538	31.5211	13.3067	15.2437	20.4691	16.3545	29.0839	11.0866	4.86982	22.8308	26.0232
p-value	[0.0606990]	[0.0000000]**	[0.0004810]**	[0.2070279]	[0.1234281]	[0.0251153]*	[0.0899246]	[0.0012077]**	[0.5308083]	[0.8997024]	[0.0113885]	[0.0037092]
Q(15)	56.8076	302.160	59.4786	320.166	47.7148	80.7454	71.4426	178.483	77.3665	48.7914	56.7891	44.5071
p-value	[0.0000220]**	[0.0000000]**	[0.00000086]**	[0.0000000]**	[0.0004664]**	[0.0000000]**	[0.0000001]**	[0.0000000]**	[0.0000000]**	[0.0003291]**	[0.0000221]**	[0.0012865]**
Q(20)	215.858	723.982	113.455	1086.40	83.3121	280.369	204.595	519.138	186.047	209.236	145.054	114.841
p-value	[0.0000000]**	[0.0000000]**	[0.0000008]**	[0.0000000]**	[0.0021618]	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000000]**	[0.0000005]**
Q-Statistics on Squared Standard Residuals												
Q(5)	4.75757	1.68173	3.00531	16.5811	2.60653	1.18557	1.15279	7.93581			1.59739	1.44147
p-value	[0.4461778]	[0.8911936]	[0.6991671]	[0.1053668]	[0.7603730]	[0.9462538]	[0.9493255]	[0.1598090]			[0.9015650]	[0.9197235]

Q(10)	5.65473	13.1320	5.01594	36.6313	4.81032	2.80673	2.70011	21.5483			3.45013	4.22488
p-value	[0.8433892]	[0.2163833]	[0.8901106]	[0.2100655]	[0.9034833]	[0.9856135]	[0.9876280]	[0.1175784]			[0.9687645]	[0.9366323]
Q(15)			12.7579		5.92822	5.23758	5.26932		51.4190	23.5915	11.4723	12.7973
p-value			[0.8875287]		[0.9989910]	[0.9996030]	[0.9995842]		[0.10001383]	[0.2606926]	[0.9330430]	[0.8859087]
Q(20)			21.7358		8.28158	26.1158	30.4640		64.6780	38.2723	25.9053	45.0241
p-value			[0.9998337]		[1.0000000]	[0.9978883]	[0.9867713]		[0.2092859]	[0.8871227]	[0.9980974]	[0.6728601]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H0: no serial correlation.

Table-A 5.25(b) Diagnostic Testing of Final Model

Countries	Euc-Inf	Euc-IP	Boliv-Inf	Boliv-IP	Bra-Inf	Bra-IP	Iran-Inf	Iran-IP	Malawi-Inf	Malawi-IP	Nigeria-Inf	Nigeria-IP
Normality Test												
Skewness	-1.2020	-1.2101	0.94271	-0.94168	-8.5018	-1.2499	0.42142	-8.0900	2.21384	0.27959	0.46711	-0.66368
p-value	4.2463e-021	2.3170e-021	2.0143e-012	2.1281e-012	0.00000	1.2862e-016	0.0037402	0.00000	0.12550	0.045161	0.00077108	1.7691e-006
Excess Kurtosis	16.703	9.7492	6.5212	3.2201	93.669	8.3327	0.81067	103.93	2.3176	1.9761	1.4118	2.1923
p-value	0.00000	0.00000	1.7596e-131	1.9888e-033	0.00000	1.0105e-168	0.0051371	0.00000	8.1682e-017	1.2331e-012	3.4293e-007	2.4419e-015
Jarque-Bera	4342.8	1538.8	635.52	191.93	98182.	819.89	16.012	1.2952e+005	70.581	53.598	36.780	84.288
p-value	0.00000	0.00000	9.9447e-139	2.1083e-042	0.00000	9.1689e-179	0.00033348	0.00000	4.7144e-016	2.2975e-012	1.0313e-008	4.9781e-019
Q-Statistics on Standard Residuals												
Q(5)	8.48804	50.8389	1.20993	3.29799	0.704541	13.3893	5.38120	1.99496	7.73006	29.5962	1.41455	5.35348
p-value	[0.1313113]	[0.000000]**	[0.9439209]	[0.6541501]	[0.9827185]	[0.0199913]	[0.3711482]	[0.8498422]	[0.1717538]	[0.0000177]**	[0.9227148]	[0.3742803]
Q(10)	11.6700	54.8890	16.0791	6.82543	2.40767	29.1852	9.75827	7.48396	32.8800	71.3106	7.06516	8.68966
p-value	[0.3077510]	[0.000000]**	[0.0973899]	[0.7418159]	[0.9921540]	[0.0011628]**	[0.4619512]	[0.6791016]	[0.0002853]**	[0.000000]**	[0.719272]	[0.5617873]
Q(15)	21.1512	108.584	28.8713	34.9858	5.09671	43.9595	43.6202	19.4742	128.443	183.516	37.6819	42.7060
p-value	[0.3882793]	[0.000000]**	[0.0903243]	[0.0201803]*	[0.9996782]	[0.0015238]**	[0.0016914]**	[0.4912205]	[0.000000]**	[0.000000]**	[0.0096821]**	[0.0022353]**
Q(20)	84.8266	179.475	64.0290	92.3510	62.5788	82.9457	126.613	44.4115	277.768	389.076	110.647	145.779
p-value	[0.0015316]**	[0.000000]**	[0.0877081]	[0.0002512]**	[0.1091550]	[0.0023473]**	[0.000000]**	[0.6962961]	[0.000000]**	[0.000000]**	[0.0000018]**	[0.000000]**
Q-Statistics on Squared Standard Residuals												
Q(5)	2.86998	0.913510	2.47525	4.15565	0.0386261	6.88380	2.89827	0.133346	5.15622	9.91749	2.12116	1.14781
p-value	[0.7200224]	[0.9692358]	[0.7802173]	[0.5272314]	[0.9999846]	[0.2294268]	[0.7156664]	[0.9996706]	[0.3971143]	[0.1776072]	[0.8321383]	[0.9497856]

Q(10)	3.50155	1.45786	5.24388	5.66760	0.0524202	11.7286	12.0683	0.169056	6.67368	15.8388	6.32373	5.10057
p-value	[0.9670458]	[0.9990607]	[0.8743024]	[0.8423747]	[1.0000000]	[0.3036319]	[0.2805100]	[1.000000]	0.7558501]	[0.1043396]	[0.7873715]	[0.8843590]
Q(15)	4.59052	2.43775	7.76867	11.7848	0.0761008	16.0668		0.223537	27.3931		16.1976	13.6551
p-value	[0.9998584]	[0.9999993]	[0.9932909]	[0.923285]	[1.0000000]	[0.7124705]		[1.000000]	[0.1245623]		[0.7042923]	[0.8475418]
Q(20)	41.9019	6.63527	36.3046	52.2844	39.6985	30.2190		0.393270			45.2855	34.7167
p-value	[0.7853870]	[1.0000000]	[0.9266098]	[0.3853209]	[0.8515024]	[0.9878960]		[1.000000]			[0.6627128]	[0.9506237]

Note: * shows the 5% level of significance and ** shows significance at 1%. Q-Statistics is the Ljung-Box statistics based on standardized residual and square of standardized residual up to lag 20 with H0: there is no serial correlation