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Volatility in Sectors and National Income Growth: A Comparative Analysis of Pakistan and South Korea

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Abstract

The study empirically investigated the impact of sectoral volatility on fluctuations in economic growth of Pakistan and South Korea (Korea). ADF unit root test is used to check the stationery of the data. Autoregressive Conditional Heteroscadasticity (ARCH) and Generalized Autoregressive Conditional Heteroscadasticity (GARCH) have been used for estimating the volatility in variables under analysis. The results revealed that there exists almost equal level of volatility in GDP growth rate of both countries. However, volatility in agriculture, industry, services, export and import sector varies for two nations. Greater volatility shocks exist in agriculture sector of Pakistan as compared to Korea. Volatility in industrial sector persists in Korean economy only but not to the greater extent. Almost equal level of volatility shocks have been observed in services and import sector of both economies. However, export sector has shown greater volatility shocks in Korea as compared to Pakistan. The results of regression analysis have shown that volatility in agriculture sector contributes more towards volatility in GDP growth of Pakistan as compared to Korea. The volatility in industrial sector almost equally contributes to volatility in GDP of both countries. On the other hand the volatility in services sector contributes more volatility in GDP of Korea as compared to Pakistan. The export sector volatility contributes to volatility in GDP of only Pakistan. Finally the imports sector volatility negatively impacts the GDP volatility in Pakistan but positively in Korea.

Keywords: international trade, agriculture sector, services sector, industrial sector, economic fluctuations, fluctuations in GDP.

JEL Classification: E32, O14, O40.

Introduction

The growth of the economies depends on characteristics of different economic sectors such as export, import, agriculture, industry and services etc. The structural changes in these sectors

contribute volatility in growth rate of the economies (Koren and Tenreyro 2005). The share of agriculture sector in GDP has traditionally been dominated in pre-industrialized economies while the industrial and service sectors' shares remain comparatively modest. In the industrialized countries like Japan, U.S.A and certain number of the European countries, the share of agriculture sector in GDP remain as little as 2 percent. The remaining share of production originates from the industrial and service sectors (Dutta 2009). For the industrializing economies like Taiwan, China and South Korea (Korea in the coming pages), etc. the share of industrial sector is increasing. On the other hand there is variety of the developing economies where agriculture sector is having a greater share in national output. However, Singapore is the economy having largest share of exports. Fluctuations in growth of these sectors may oscillate the GDP growth. For instance a major chunk in agriculture sector of Pakistan due to virus attack on cotton decreased the agricultural production in Pakistan. Consequently GDP growth rate of the economy remained lower for the early years of 1990s. Similarly the floods devastated the agricultural land in Southern Punjab and Sind in 2010 which affected the GDP growth rate of Pakistan economy.

An important ingredient of development is growth stability. Instability in the national income becomes costly for developing countries as it deters growth rate in the long-run (Mobarak 2005). It is attributed to volatility in major sectors of the economy[*]. The analysis of volatility in growth of economies and the factors behind this phenomenon can be useful for formulation of the policies for mitigating the volatility in national income growth.

However, in the empirical literature there are contradicting evidences of relationship between fluctuations in sectoral growth and fluctuations in GDP growth rate. Some of the researchers have found positive association between sectoral growth and economic growth volatility (Imbs 2007) while others (Aizenman and Marion 1993; Ramey and Ramey 1995) have found that sectoral volatility decrease the economic growth. These contradictions may be due to varying estimation techniques, nature and structure of the economies and sectors as well as proxies and variables used in the models. It makes the notion of contribution of sectoral volatility in economic growth volatility ambiguous.

Pakistan is a developing economy with average growth rate of 4.62, 3.66 and 6.28 percent in the last three decades respectively. On the other hand Korea is one of the Asian economic tigers having growth rate of 4.17, 6.18 and 8.74 percent in the last three decades. The largest sector of the Pakistan and Korean economies is services (See Ahmed and Ahsan 2011 for contribution of services sector in Pakistan). Pakistan is taking Korea as role model and trying to follow the initiatives that were taken by Korean economy during its past track record in the last sixty years. Actually Pakistan and Korea have started their economic progress since 1961 from per-capita GDP of $86.87 and $91.62 respectively. Currently the GDP per-capita of these economies is $1256.65 and $2259.15 respectively. That is why the current study concerned with these two economies[†]. For the relationship between fluctuations in sectoral growth and GDP growth fluctuations, the agriculture, industry, services, export and import sectors have been included in the analysis[‡].

We will attempt to see the effect of volatility in growth of sectors on volatility in economic growth of two countries, i.e. Pakistan and Korea. The core objective of the study is to see the role of volatility in sectoral growth in volatility in GDP growth and making a comparison of implications of sectors as well as economies.

Review of Literature

In the literature, there are evidences that the sectors in which economies specialize have a significantly large effect on production and trade of these economies (Koren and Tenreyro 2005; Krishna and Levchenko 2009). Plethora of the studies have estimated the sectoral volatility and its effect on economic performance of the countries by using various econometric techniques and models (Hnatkovska and Loayza 2003; Mobarak 2005; Imbs 2007).

[*] Political instability, socio-cultural fluctuations in the form of ethnic disruptions, terrorism and strategic disturbances along with natural and environmental changes also make fluctuations in growth rate of the economies (Iyigun and Owen 2004; Aisen and Veiga 2011).

[†] See also, Khan, et. al. (2013a) for adaptation of Korean growth model for Pakistan.

[‡] Although other sectors like financial sector also contribute towards volatility in GDP (Azid, et. al. 2006).

The cross country association among volatility and economic growth rate was empirically investigated by Ramey and Ramey (1995).Two samples of countries were chosen for analysis. The first sample was consisted of 92 countries while the second was consisted of 24 OECD countries. The study used the data for the period 1960-1985 for the first sample and 1950-1988 for the second sample. They calculated the mean and standard deviation of per-capita annual growth rate over time period for each country and see its effect on GDP growth. They found that economies with higher volatility in per-capita growth rate had lower economic growth rate. The results also revealed that the investment as a share of GDP played a little part in association between volatility of per-capita annual growth rate to economic growth. However, the government spending volatility has shown negative impact on economic growth.

Azid, et al. (2006) investigated the impact of sectoral volatility on economic growth of Pakistan. The quarterly dataset for the time period 1971-72 to 2002-2003 was used. Volatility was estimated by using rolling variance of the series and GARCH. The output (GDP) as dependent variable and value added of agriculture, finance and insurance, services, industry and whole sale and retail as independent variables have been taken in the analysis. They found that every sector has a significant impact on the volatility of output growth except financial sector. However, association exists only for the short-run. There exists no long-run relationship between volatility of growth rate of different sectors of the economy and fluctuations in growth rate of output.

Imbs (2007) has analyzed the relationship between sectoral fluctuations and economic growth across countries. The study used the data for the time period 1963-19996 for 47 countries to demonstrate that velocity at the sectoral level and economic growth correlate in the same direction. Data includes yearly value added of different sectors, employment and factor of production in manufacturing activities published by United Nations Industrial Development Organization (UNIDO). It was found that across countries the relationship between economic growth and volatility was positive.

Koren and Tenreyro (2010) investigated volatility, diversification and development in the Gulf Cooperation Council (GCC) countries. The volatility was estimated as the deviation of output growth rate of a specified sector in a specified country from average growth rate of that sector over the time period. A positive covariance among sectoral shocks and volatility in GDP of specific country was found. The study concluded that GCC countries were more fluctuated as compared to other countries at the same level of economic development and it was due to their strong dependence on oil. The high levels of country specific fluctuations suggested that macroeconomic policies should be enhanced to alleviate volatility.

Babatunde (2013) investigated the relative contributions of stock market volatility on economic growth in Nigeria. The study used quarterly time series data for the years 1980:1 to 2010:4 for stock price index, real GDP, consumer price index as measure of economic activities, inflation and short-term interest rate. Volatility was estimated by Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH). The study revealed that the volatility shock was quite persistent in Nigeria and it might distort growth of the economy. The study recommended to make the stock market less volatile.

The reviewed studies have applied various analytical techniques to find the association between sectoral volatility and economic growth (as well as fluctuations in economic growth). We are focusing on the comparative analysis of volatility effect of some sectors of Pakistan and Korea on fluctuation of their GDP growth rates using the same time period data for both countries and employing ARCH and GARCH technique for volatility. To check structural breakpoint Chow test is applied.

Methodology

Annual time series data for the years 1971-2010 taken from World Development Indicators (World Bank 2012) is used for estimation of volatility and OLS regression. Time-series data often contains a unit root or non-stationarity. Ordinary least square estimates are impractical if in a model all the variables are non-stationary on level or if integration orders of all the variables are not zero. To check stationary properties of time-series data Augmented Dickey Fuller (ADF) unit root test is applied. Volatility of the variables under discussion, i.e. growth rates of national income, value added of agriculture, value added of industry, value added of services, exports, and imports is examined by applying Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized

Autoregressive Conditional Heteroscedasticity (GARCH). After estimating volatility of all the variables Ordinary Least Square method is used to check the relationship between volatility in growth of different sectors and volatility in growth of output in both countries. To diagnose multicollinearity Variance Inflation Factor (VIF) is used. To check structural breakpoint or parameter stability of regression models Chow test is employed, furthermore Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests are also employed to check stability of model. After observing structural breakpoint we apply OLS by using Gregory and Hansen methodology (Gregory and Hansen 1996a and 1996b). Finally, to check the effect of the shock in the volatility of one sector on the volatility in growth rate of output as a whole Impulse Response Function (IRF) is employed.

Theoretical Framework for Chow Test and Gregory and Hansen Methodology

To check structural breakpoint we employ the Chow test. When regression model is used that is involving time series data, it may happen that there is a structural change in the relationship between the regressand and the regressors. By structural change, it means that the values of the parameters of the model do not remain the same through the entire time period. After analyzing the structural break point we apply OLS using Greogry and Henson methodology.

The four models of Gregory and Hansen (1996a and 1996b) with assumptions about structural breaks and their specifications with two variables, for simplicity, are as follows:

Model 1: Level Shift

$$Y_t = \mu_1 + \mu_2 d_{tk} + \alpha_1 X_t + e_t \quad \text{.....} \quad (1)$$

Model 2: Level Shift with Trend

$$Y_t = \mu_1 + \mu_2 d_{tk} + \beta_1 t + \alpha_1 X_t + e_t \quad \text{.....} \quad (2)$$

Model 3: Regime Shift where Intercept and Slope coefficients change

$$Y_t = \mu_1 + \mu_2 d_{tk} + \beta_1 t + \alpha_1 X_t + \alpha_2 X_t d_{tk} + e_t \quad \text{.....} \quad (3)$$

Model 4: Regime Shift where Intercept, Slope coefficients and Trend change

$$Y_t = \mu_1 + \mu_2 d_{tk} + \beta_1 t + \beta_2 d_{tk} + \alpha_1 X_t + \alpha_2 X_t d_{tk} + e_t \quad \text{.....} \quad (4)$$

Where t = time subscript and k = break date.

Model Specifications

Stationarity of the variables are checked under the step of unit root. If mean, variance and auto covariance of a variable remains same no matter at what point we compute them, then variable is called stationary. In literature many tests are offered to detect that whether a series has a unit root or not. If stochastic terms are not correlated then Dickey Fuller test is applicable. But Dickey Fuller test is ineffective if the stochastic term is correlated. To solve this problem Augmented Dickey Fuller (ADF) test is being presented. ADF test solve this issue by augmenting the equations of DF test by adding the lagged values of the endogenous variable. We apply Augmented Dickey Fuller (ADF) test on growth rate of the variables to check the stationary property of the variables. The primary objective of this analysis is to test out the impact of volatility of various sectors on the growth rate of output. In this regard we also apply unit root test on the volatility variables obtained from ARCH and GARCH process as well. We can write ADF test in equation form as:

None (i.e. without intercept and Trend)

$$\Delta Y_t = \delta Y_{t-1} + \alpha \sum Y_{t-1} + \mu_t \quad \text{.....} \quad (5)$$

With Intercept and no Trend

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \alpha \sum Y_{t-1} + \mu_t \quad \text{.....} \quad (6)$$

With Intercept and Trend

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \alpha \sum Y_{t-1} + \mu_t \quad \text{.....} \quad (7)$$

H_o: $\delta = 1$ for non-stationary process (null hypothesis).

H_1: $\delta < 1$ for stationary process (alternative hypothesis).

To check volatility in the variables GARCH (1, 1) model (Bollerslev 1986) is used. General form of GARCH (p, q) model is:

$$Y_t = \alpha + \beta X_t + u_t$$

$$u_t \mid \Omega_t \sim N(0, h_t)$$

$$h_t = \gamma_0 + \sum_{i=1}^{p} \delta_i h_{t-i} + \sum_{j=1}^{q} \gamma_j u^2_{t-j}$$

which explains that the value of h_t (i.e. variance parameter) depends on past values of the shocks (expressed by the lagged squared residuals terms) and on past values of variance (expressed by lagged h_t terms). GARCH (1, 1) is the simplest form of GARCH (p, q) model. Variance equation for GARCH (1,1) model is:

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u^2_{t-1}$$

Where p shows the order of GARCH term and q shows the order of ARCH term. Model for growth rate of national output of Pakistan and Korea are:

$$GR\_Y_{Pak} = \beta_0 + \beta_1 GR\_Y_{t-1} + u_t \quad \text{..... (8)}$$

$$GR\_Y_{Kor} = \pi_0 + \pi_1 GR\_Y_{t-1} + u_t \quad \text{..... (9)}$$

In the same way to check volatility of different sectors of both countries GARCH (1, 1) model is applied on all independent variables.

The operational definitions of the variables have been given in table-1.

Table 1: Operational Definitions of the Variables

Variables	**Operational Definitions**
GR_Y (Growth rate of GDP)	Annual percentage growth rate of Gross Domestic Product (GDP) at market prices based on constant local currency
GR_AGR (Growth rate of agriculture)	Annual growth rate of agricultural value added based on constant local currency
GR_IND (Growth rate of industry)	Annual growth rate of industrial value added based on constant local currency
GR_SER (Growth rate of services)	Annual growth rate of services value added based on constant local currency
GR_EXP (Growth rate of exports)	Annual growth rate of exports of goods and services based on constant local currency
GR_IMP (Growth rate of imports)	Annual growth rate of imports of goods and services based on constant local currency

Ordinary Least Square (OLS) methods for Pakistan and Korea are as:

$$VOL\_Y_{Pak} = \beta_0 + \beta_1 VOL\_AGR + \beta_2 VOL\_IND + \beta_3 VOL\_SER + \beta_4 VOL\_EXP + \beta_5 VOL\_IMP \quad \text{..... (10)}$$

$$VOL\_Y_{Kor} = \pi_0 + \pi_1 VOL\_AGR + \pi_2 VOL\_IND + \pi_3 VOL\_SER + \pi_4 VOL\_EXP + \pi_5 VOL\_IMP \quad \text{..... (11)}$$

Where
VOL_Y = Volatility in growth rate of GDP (for Pakistan and Korea)
VOL_AGR = Volatility in growth rate of agriculture
VOL_IND = Volatility in growth rate of industry
VOL_SER = Volatility in growth rate of services
VOL_EXP = Volatility in growth rate of exports
VOL_IMP = Volatility in growth rate of imports

In our analysis for remedy of structural break we incorporate a dummy variable such that:

$$D_{tk} = 0 \text{ if } t \leq k, \qquad D_{tk} = 1 \text{ if } t > k$$

The model specification after incorporating dummy variable for Pakistan is as:

Model 1: Level Shift

$$VOL\_Y_t = \mu_1 + \mu_2 D_{tk} + \alpha_1 VOL\_AGR + \alpha_2 VOL\_IND + \alpha_3 VOL\_SER + \alpha_4 VOL\_EXP + \alpha_5 VOL\_IMP + e_t \ldots..(12)$$

Model 2: Regime Shift where Intercept and Slope Coefficient Change

$$VOL\_Y_t = \mu_1 + \mu_2 D_{tk} + \alpha_1 VOL\_AGR + \alpha_{11} VOL\_AGR\ D_{tk} + \alpha_2 VOL\_IND + \alpha_{22} VOL\_IND\ D_{tk} + \alpha_3 VOL\_SER + \alpha_{33} VOL\_SER\ D_{tk} + \alpha_4 VOL\_EXP + \alpha_{44} VOL\_EXP\ D_{tk} + \alpha_5 VOL\_IMP + \alpha_{55} VOL\_IMP\ D_{tk} + e_t \ldots\ldots\ldots\ldots (13)$$

In the same way model specification after incorporating dummy variable for Korea is as:

Model 1: Level Shift

$$VOL\_Y_t = \sigma_1 + \sigma_2 D_{tk} + \beta_1 VOL\_AGR + \beta_2 VOL\_IND + \beta_3 VOL\_SER + \beta_4 VOL\_EXP + \beta_5 VOL\_IMP + e_t \ldots (14)$$

Model 2: Regime Shift where Intercept and Slope Coefficient Change

$$VOL\_Y_t = \sigma_1 + \sigma_2 D_{tk} + \beta_1 VOL\_AGR + \beta_{11} VOL\_AGR\ D_{tk} + \beta_2 VOL\_IND + \beta_{22} VOL\_IND\ D_{tk} + \beta_3 VOL\_SER + \beta_{33} VOL\_SER\ D_{tk} + \beta_4 VOL\_EXP + \beta_{44} VOL\_EXP\ D_{tk} + \beta_5 VOL\_IMP + \beta_{55} VOL\_IMP\ D_{tk} + e_t \ldots\ldots\ldots\ldots (15)$$

Empirical Results

ARCH and GARCH Estimates for Volatility

Before doing the ARCH and GARCH process to check the stationarity of the time series ADF unit root test has been applied on all the variables. The results of ADF unit root test of all the variables about Pakistan and Korea are reported in table 2 and 3 respectively. The results express that all the variables for both countries are stationary at level 1 percent at Mackinon Critical values, with intercept, and with trend and intercept. It means that all of the variables are integrated of order zero or I (0) for both countries.

Table 2: Unit Root Test of Variables for Pakistan

ADF Statistics				
Variables	Intercept	Trend and Intercept	None	
	Level	Level	Level	First Difference
GR_Y	-4.846	-4.964	-1.436	-10.172
GR_AGR	-8.098	-7.966	-0.926	-7.429
GR_IND	-5.127	-3.679	-0.635	-3.119
GR_SER	-4.230	-4.769	-1.343	-7.230
GR_EXP	-6.355	-6.300	-5.202	-8.398
GR_IMP	-5.799	-5.636	-5.368	-8.265
Critical values (1%)	-3.610	-3.211	-2.625	-2.628
Critical values (5%)	-2.938	-3.529	-1.949	-1.950
Critical values (10%)	-2.607	-3.196	-1.611	-1.611

When unit root is applied on without trend and intercept data is stationary at first difference. This means that without trend and intercept data of the variables is integrated of order one or I (1).

Table 3: Unit Root Test of Variables for Korea

ADF Statistics				
Variables	Intercept	Trend and Intercept	None	
	Level	Level	Level	First Difference
GR_Y	-4.979	-5.672	-0.859	-6.128
GR_AGR	-9.618	-5.537	-8.376	-6.432
GR_IND	-4.471	-5.580	-1.741	-5.708
GR_SER	-4.029	-4.506	-1.062	-9.590
GR_EXP	-4.994	-5.472	-2.737	-8.732
GR_IMP	-6.273	-6.467	-1.826	-6.597
Critical values (1%)	-3.610	-4.211	-2.632	-2.632
Critical values (5%)	-2.938	-3.529	-1.950	-1.950
Critical values (10%)	-2.607	-3.196	-1.611	-1.611

The variables under analysis are stationary at level with intercept, and with trend and intercept. The ADF statistics are found significant at 1 percent. Without trend and intercept data is stationary at first difference and all variables are found significant at 1 percent.

The results of ARCH and GARCH process for Pakistan and Korea are reported in Table 4 and 5 respectively (see Annexure I and II for conditional variance graph).

Table 4: Results (Variance) of GARCH (1, 1) Model for Pakistan

Variable	Coefficient	z- statistic	Prob.
Dependent variable: GR_Y_{Pak}			
Variance Equation			
Constant	0.41832	4.197325	0.0000*
RESID(-1)^2	-0.20277	-318554	0.0014*
GARCH(-1)	1.1576	16.6187	0.0000*
Dependent variable: GR_AGR_{Pak}			
Variance Equation			
Constant	1.51948	1.7756	0.0758**
RESID(-1)^2	-0.23768	-2.5206	0.0117*
GARCH(-1)	1.10551	29.4014	0.0000*
Dependent variable: GR_IND_{Pak}			
Variance Equation			
Constant	3.75196	0.32315	0.7466
RESID(-1)^2	0.02583	0.08488	0.9324
GARCH(-1)	0.64601	0.56433	0.5725
Dependent variable: GR_SER_{Pak}			
Variance Equation			
Constant	0.11619	1.10872	0.2675*
RESID(-1)^2	-0.16663	-1.93261	0.0533*
GARCH(-1)	1.13293	9.53239	0.0000
Dependent variable: GR_EXP_{Pak}			
Variance Equation			
Constant	91.4484	1.79961	0.0719**
RESID(-1)^2	-0.25416	-2.64880	0.0081*
GARCH(-1)	0.62807	1.74888	0.0803**

Dependent variable: GR_IMP_{Pak}			
Variance Equation			
Constant	23.1593	0.89456	0.3710*
RESID(-1)^2	-0.25387	-2.75603	0.0059*
GARCH(-1)	1.08164	4.81253	0.0000*

* represents 5 percent level and ** represents 10 percent level of significance
No. of observations = 39

Table 5: Results (Variance) of GARCH (1, 1) Model for Korea

Variable	Coefficient	z- statistic	Prob.
Dependent variable: GR_Y_{Kor}			
Variance Equation			
Constant	0.26624	0.08485	0.9324
RESID(-1)^2	-0.19411	-2.05200	0.0402*
GARCH(-1)	1.16574	4.13717	0.0000*
Dependent variable: GR_AGR_{Kor}			
Variance Equation			
Constant	9.22264	0.39134	0.6955
RESID(-1)^2	0.21266	0.49421	0.6212
GARCH(-1)	0.53168	0.57478	0.5654
Dependent variable: GR_IND_{Kor}			
Variance Equation			
Constant	18.9485	2.51031	0.0121*
RESID(-1)^2	-0.15600	-3.23364	0.0012*
GARCH(-1)	0.66090	3.11169	0.0019*
Dependent variable: GR_SER_{Kor}			
Variance Equation			
Constant	-0.32524	-0.29942	0.7646
RESID(-1)^2	-0.22158	-1.34765	0.1778
GARCH(-1)	1.20465	4.11883	0.0000*
Dependent variable: GR_EXP_{Kor}			
Variance Equation			
Constant	6.92433	11.7476	0.0000*
RESID(-1)^2	-0.20154	-3.32910	0.0009*
GARCH(-1)	1.07427	11.0645	0.0000*
Dependent variable: GR_IMP_{Kor}			
Variance Equation			
Constant	8.39981	2.89218	0.0038*
RESID(-1)^2	-0.18308	-3.96707	0.0001*
GARCH(-1)	1.08991	21.4668	0.0000*

* represents 5 percent and ** represents 10 percent level of significance.
No. of observations = 39

Empirical results reported above are obtained from GARCH (1, 1) model. For convenience we denote ARCH parameter by α and GARCH parameter by β. To check volatility we add the ARCH and GARCH coefficients ($\alpha + \beta$). If the sum is very close to 1, it indicates that volatility shocks are persistent to the greatest extent and if the sum is very close to 0 it indicates that there is no persistent of volatility shocks. From tables 4 and 5 variance equation for GR_Y_{Pak} and GR_Y_{Kor} shows that the sum of the lag squared error term and lagged value of variance i.e. ($\alpha + \beta$) is equal to 0.95483 and 0.97163 respectively for Pakistan and Korea, which indicated that volatility shocks in GDP growth rate of Pakistan and Korea are persistent to a greater extent. The estimates of ARCH and GARCH coefficients are also highly significant.

Similarly the variance equation for GR_AGR, GR_IND, GR_SER, GR_EXP and GR_IMP show that the sum of the lagged square error term and lagged value of variance is equal to 0.86783 and 0.97163, 0.67184 and 0.5049, 0.9663 and 0.98307, 0.37391 and 0.87266, and 0.8277 and 0.9816 respectively for Pakistan and Korea which indicates that the volatility in growth rate of agriculture, services and imports for Pakistan and Korea are persistent to a greater extent while volatility in growth rate of exports are not much more persistent for Pakistan, and the estimates of ARCH and GARCH coefficients are also highly significant except coefficient of industry for Pakistan.

4.2 OLS Estimates

We have applied the unit root test on volatility variables. The results of the ADF unit root tests of all the variables about Pakistan and Korea are presented in table 6 and 7 respectively.

Table 6: Unit Root Test of the Volatility in Variables for Pakistan

ADF Statistics			
Variables	Intercept	Trend and Intercept	None
VOL_Y	-8.426	-8.895	-8.522
VOL_AGR	-6.045	-5.953	-6.069
VOL_IND	-5.105	-5.114	-6.589
VOL_SER	-6.322	-6.743	-6.335
VOL_EXP	-6.150	-6.055	-6.160
VOL_IMP	-6.684	-6.556	-6.741
Critical values (1%)	-3.615	-4.219	-2.627
Critical values (5%)	-2.941	-3.533	-1.949
Critical values (10%)	-2.609	-3.198	-1.611

Table 7: Unit Root Test of the Volatility in Variables for Korea

ADF Statistics			
Variables	Intercept	Trend and Intercept	None
VOL_Y	-5.762	-6.619	-5.795
VOL_AGR	-4.757	-4.803	-4.793
VOL_IND	-5.489	-6.196	-5.567
VOL_SER	-5.970	-6.656	-6.053
VOL_EXP	-5.667	-5.881	-5.737
VOL_IMP	-5.463	-5.850	-5.539
Critical values (1%)	-3.615	-4.219	-2.627
Critical values (5%)	-2.941	-3.533	-1.949
Critical values (10%)	-2.609	-3.198	-1.611

The results of table 6 and 7 show that with intercept or with trend and intercept or without trend and intercept all the variables are stationary at level one or I (0) i.e. integrated of order zero.

Before employing the OLS we listed results of multicollinearity for both countries. To diagnose multicollinearity we have employed Variance Inflation Factor (VIF) test, and the results are presented in table 8 and 9 for Pakistan and Korea respectively.

Table 8: Test of Multicollinearity for Pakistan

Variables	Coefficient Variance	Uncentered VIF	Centered VIF
Constant	0.04123	1.08190	NA
VOL_AGR	0.00359	1.11153	1.10368
VOL_IND	0.00363	1.24991	1.24908
VOL_SER	0.00929	1.20871	1.19634
VOL_EXP	0.00026	1.11606	1.08341
VOL_IMP	0.00023	1.13029	1.10552

The larger is the value of VIF the higher collinear in the variable Xj. In the limit VIF can be finite in case of perfect colinearity. A rule of thumb, if the VIF of a variable is greater than 10, which will happen if R^2j is higher than 0.90, that variable is said be highly collinear. Our results show that the value of VIF of variables VOL_AGR, VOL_IND, VOL_SER, VOL_EXP and VOL_IMP are 1.106, 4.491, 2.438, 1.755 and 3.077 respectively. It shows that as explanatory variables are not collinear with each other. Multicollinearity doesn't exist in the model.

Table 9: Test of Multicollinearity for South Korea

Variables	Coefficient Variance	Uncentered VIF	Centered VIF
Constant	0.02504	1.02946	NA
VOL_AGR	0.00075	1.10613	1.09659
VOL_IND	0.00277	4.49174	4.49085
VOL_SER	0.00957	2.43806	2.43417
VOL_EXP	0.00032	1.75586	1.73359
VOL_IMP	0.00062	3.07731	3.07714

The results of multicollinearity for Korea are presented in Table 9. The results show that the value of VIF of variables VOL_AGR, VOL_IND, VOL_SER, VOL_EXP and VOL_IMP are 1.106, 4.491, 2.438, 1.755 and 3.077 respectively. It shows that explanatory variables are not collinear with each other and multicollinearity doesn't exist in our results.

To check the relationship between volatility in growth of different sectors and volatility in GDP growth for Pakistan and Korea, OLS models have been applied. The results of multivariate regression analysis are presented in Table 10. Dependent variable is volatility in GDP growth rate and independent variables are volatility in growth rate of different sectors.

Table 10: Regression Analyses of Volatility for Pakistan and Korea

	Pakistan		South Korea	
Model	Coefficient (Prob.)	t-values	Coefficient (Prob.)	t-values
Constant	-0.047 (0.848)	-0.192	-0.336 (0.006)*	-2.885
VOL_AGR	0.201 (0.009)*	2.778	0.095 (0.000)*	4.719
VOL_IND	0.249 (0.001)*	2.456	0.207 (0.000)*	10.439
VOL_SER	0.285 (0.019)*	3.434	0.751 (0.000)*	5.343
VOL_EXP	0.035 (0.080)*	1.801	-0.017 (0.199)	-1.308
VOL_IMP	-0.033 (0.080)**	-1.800	0.059 (0.002)*	-2.886

	R^2 = 0.582 Adj. R^2 = 0.519 F-stat = 9.194	R^2 = 0.966 Adj. R^2 = 0.961 F-stat = 189.71
Dependent Variable: VOL_Y		

* represents 5 percent and ** represents 10 percent level of significance.
No. of observations = 39

Results obtained from multivariate regression analyses of both countries show that volatility in each sector has a significant impact on volatility in GDP except volatility in export sector in Korea.

Structural or Parameter Stability: The Chow Test

In order to investigate the structural breakpoint we have employed the Chow test. The results of Chow test are presented in table 11 and 12 for Pakistan and Korea respectively.

Table 11: Estimates of Chow Test for Pakistan

F-statistic	2.085676	Prob. F(12,21)	0.0883
Log likelihood ratio	14.85196	Prob. Chi-Square(12)	0.0214
Wald Statistic	12.51406	Prob. Chi-Square(12)	0.0514
Chow Breakpoint Test: 1986			

Table 12: Estimates of Chow Test for South Korea

F-statistic	3.762077	Prob. F(12,21)	0.0075
Log likelihood ratio	23.69635	Prob. Chi-Square(12)	0.0006
Wald Statistic	22.57246	Prob. Chi-Square(12)	0.0010
Chow Breakpoint Test: 1998			

Results in tables 11 and 12 show that there exists structural breaks in both economies of Pakistan and Korea. The F-statistics is significant at 5 percent level so we reject the null hypothesis (i.e. there is no structural breakpoint). Breakpoint for Pakistan is 1986 while for Korea it is 1998. For remedy we run OLS by using Gregory and Henson methodology. The results of both models (i.e. level shift as well as intercept and slope coefficient change) for Pakistan are presented in table 13 and 14.

Table 13: Multi Regression Estimates of Pakistan after Incorporating Dummy

Model 1 (DUM 1986)			
Variables	Coefficient	t-Statistic	Prob.
Constant	5.701549 *	17.71394	0.0000
VOL_AGR	0.235593 *	4.232902	0.0002
VOL_IND	0.293027 *	5.279901	0.0000
VOL_SER	0.193430 *	2.111782	0.0426
VOL_EXP	0.047494 *	3.160354	0.0034
VOL_IMP	-0.003513	-0.249951	0.8042
DUM	-1.056151 *	-2.651447	0.0124
R^2 = 0.775 Adj. R^2 = 0.732 F-stat. = 18.38			

* indicates 5 percent level of significance. The year relevant to dummy variable is indicated in the first row in the parentheses. DUM 1986 means that the dummy is unity after that year and so on.

Table 14: Multi Regression Estimates of Pakistan after Multiplying Dummy with all Regressors

Model 2 (DUM 1986)			
Variables	Coefficient	t-Statistic	Prob.
Constant	5.819540 *	17.36752	0.0000
VOL_AGR	0.195641 **	1.942740	0.0625
VOL_IND	0.335071 *	3.266962	0.0030
VOL_SER	0.124453	1.087456	0.2864
VOL_EXP	0.076193 *	3.303988	0.0027
VOL_IMP	-0.021035	-0.964484	0.3434
DUM	-1.174015 *	-2.872100	0.0078
DUM × VOL_AGR	0.047814	0.394128	0.6966
DUM × VOL_IND	-0.078683	-0.628946	0.5347
DUM × VOL_SER	0.207101	0.914496	0.3686
DUM × VOL_EXP	-0.055612 **	-1.820512	0.0798
DUM × VOL_IMP	0.024377	0.801886	0.4296
R^2 = 0.812 Adj. R^2 = 0.736 F-stat. = 10.64			

* and ** indicate 5 percent and 10 percent level of significance respectively. The year relevant to dummy variable is indicated in the first row in the parentheses. DUM 1986 means that the dummy is unity after that year and so on.

The results of both models (i.e. level shift as well as intercept and slope coefficient change) for Korea are presented in table 15 and 16.

Table 15: Multi Regression Estimates of Korea after Incorporating Dummy

Model 1 (DUM 1998)			
Variables	Coefficient	t-Statistic	Prob.
Constant	6.982710 *	39.34048	0.0000
VOL_AGR	0.090700 *	3.725465	0.0008
VOL_IND	0.181400 *	3.887832	0.0005
VOL_SER	0.647208 *	7.051567	0.0000
VOL_EXP	-0.030888 **	-1.915704	0.0644
VOL_IMP	0.089770 *	4.058623	0.0003
DUM	-1.037664 *	-3.175781	0.0033
R^2 = 0.954 Adj. R^2 = 0.946 F-stat. = 112.30			

* and ** indicate 5 percent and 10 percent level of significance respectively. The year relevant to dummy variable is indicated in the first row in the parentheses. DUM 1998 means that the dummy is unity after that year and so on.

Table 16: Multi Regression Estimates of Korea after Multiplying Dummy with all Regressors

Model 2 (DUM 1998)			
Variables	Coefficient	t-Statistic	Prob.
Constant	6.880006 *	39.93948	0.0000

VOL_AGR	0.109409 *	4.442454	0.0001
VOL_IND	0.174628 *	3.734498	0.0009
VOL_SER	0.851075 *	6.639564	0.0000
VOL_EXP	-0.035645 *	-2.232308	0.0341
VOL_IMP	0.076586 *	3.271359	0.0029
DUM	-1.178206 *	-3.713899	0.0009
DUM × VOL_AGR	-0.132187 *	-1.976347	0.0584
DUM × VOL_IND	-0.090618	-0.635177	0.5307
DUM × VOL_SER	-0.366302 **	-1.708792	0.0990
DUM × VOL_EXP	-0.050455	-0.934637	0.3583
DUM × VOL_IMP	0.116796 **	1.826955	0.0788
R^2 = 0.967 Adj. R^2 = 0.954 F-stat. = 73.12			

* and ** indicates 5 percent and 10 percent level of significance respectively. The year relevant to dummy variable is indicated in the first row in the parentheses. DUM 1998 means that the dummy is unity after that year and so on.

The empirical results of table 13 and 15 show that after incorporating dummy variable coefficients of (DUM × intercept) are significant and having negative sign for both countries, which show that after structural break, intercept change downwards. Results of model 2 (i.e. regime shift where intercept and slope coefficient change) for Pakistan and Korea presented in table 14 and 16 show that for Pakistan, after structural break the estimates of all slope coefficients are insignificant except exports, and for Korea, the estimates of agricultural, services and exports are significant while coefficient of industrial and imports sector insignificant.

Stability of the Models

In order to investigate the stability of models we have employed cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests. Pesaran, et al. (1999, 2001) proposed CUSUM and CUSUMSQ tests for estimating the stability of long and short-run estimates. Figures 1 indicates that plots for CUSUM and CUSUMSQ are between the critical boundaries at 5 percent level of significance for Pakistan.

Similarly, figures 2 indicates that plots for CUSUM and CUSUMSQ are between the critical boundaries at 5 percent level of significance for Korea. Both of the figures demonstrate the stability of models for both countries.

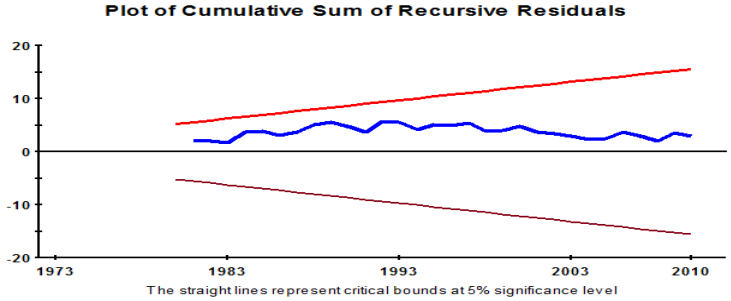

Figure 1: CUSUM Charts for Pakistan

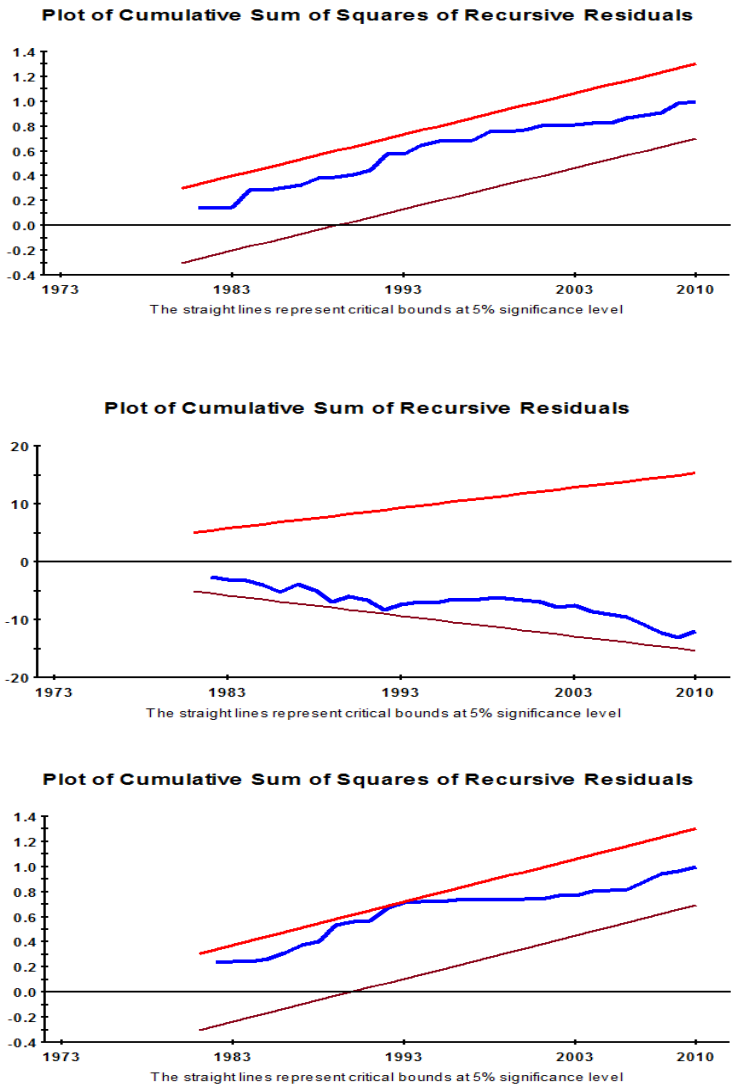

Figure 2: CUSUM Charts for Korea

Discussion

The estimates of ARCH and GARCH, and OLS are quite significant and need economic explanation. The results regarding the volatility in the sectors and GDP growth rates and the impact of volatility in sectoral growth rates on volatility in growth rate of GDP of Pakistan and Korea are discussed here.

Volatility in Agriculture Sector

The results demonstrate that agriculture sector in Pakistan and Korea contains volatilities in their growth rates. Volatility in growth rate of GDP is positively influenced by volatility in growth of agriculture in Pakistan and Korea. In Pakistan 20 percent volatility of growth rate of output is caused by one percent volatility in growth rate of agricultural sector while in Korea 9 percent volatility of growth rate of output is caused by one percent volatility in growth rate of agricultural sector. Higher volatility effect is shown in Pakistan. It may be due to the fact that the share of agriculture sector in GDP is higher in Pakistan as compared to Korea. On the other hand the share of value added of agriculture in GDP has been significantly declining (Kniivila 2007) in Korea. The agriculture is a slow-moving sector of the economy as compared to industrial and services sector.

Volatility in Industrial Sector

Industrial growth has a vital role in the economic growth of countries like Indonesia, China, Taiwan and Korea. The OLS estimates for Pakistan and Korea have shown that volatility in growth rate of industry is positively affecting the volatility in growth of GDP in Korea only. The 24 percent increase in volatility of GDP growth in Pakistan and 20 percent in Korea is caused by one percent volatility in growth of industrial sector. The results are supported by Medyawati and Yunanto (2011) for Indonesia and Azid, et. al. (2006) for Pakistan. It partially explains that industrial sector is still the "engine" of economic growth (see also Linden and Mahmood 2007 for Schengen countries).

Volatility in Services Sector

The role of services in economic growth has been empirically evidenced by a number of studies (Linden and Mahmood 2007) along with theoretical support from Kuznet (1957). Our results have shown that in Pakistan approximately 29 percent volatility in GDP growth rate is caused by one percent volatility in services sector while in Korea 75 percent volatility in growth of output is caused by one percent volatility in growth of services sector. It explains that volatility shocks in services sector have higher effect on volatility of growth of output in Korea as compared to Pakistan. The explanation may be that services sector contribute highest ratio to GDP in Korea. The sector has also strong correlation to other economic sectors. It provides necessary skilled labor force to agriculture as well as manufacturing sector (Ahmed and Ahsan 2011 for Pakistan). Our results have further revealed that volatility in growth of services sector contributes highest to volatility in growth of output as compared to other sectors of the economy like agriculture, industry and exports in both Korea and Pakistan (see also Azid, et. al. 2006 for Pakistan).

Volatility in Exports

The literature explains that exports play an important role in economic growth (Fosu 1990; Zang and Baimbridge 2012; Gilbert, et. al. 2013; Khan, et. al. 2013b). Our results have shown that in Pakistan 3 percent volatility in growth of output is caused by one percent volatility in growth of exports. However, volatility in exports contributes lowest to volatility of growth of output in Pakistan as compared to other sectors. This may be due to the fact that the share of exports in GDP is comparatively lower than other sectors like services and agriculture.

Volatility in Imports

Our results have shown that volatility shocks in growth of imports have significantly affected the volatility of growth of output in Korea. The estimates have shown that 5 percent volatility of growth of output is caused by one percent volatility in growth of imports. It may be explained on the fact that imports play an important role in growth of output through different channels. For Pakistan volatility in growth of output is negatively influenced by volatility of growth of imports. The explanation may be that Pakistan's imports are highly concentrated with raw material like machinery, petroleum, chemicals, edible oil, transport equipment, iron and steel and fertilizer. The most important is the import of cotton for textile sector in Pakistan that is the largest manufacturing sector of the country. All the raw material for textile industry is produced domestically but whenever it is needed due to lower production of cotton is imported. It makes the imports volume fluctuated but smoothing the GDP growth rate. The imported raw material is used in the production of final goods, the volatility in imports may decrease in volatility of growth rate of output.

Conclusion and Policy Recommendation

The empirical analysis through ARCH and GARCH technique made us to conclude that

- There exists approximately equal level of volatility in GDP growth rate of both countries, i.e. Pakistan and Korea.
- The agriculture growth has shown greater volatility shocks in Pakistan as compared to Korea.
- Volatility in growth of industrial sector also existed only in Korea but not to a greater extent.
- Volatility in services sector indicated the existence of approximately equal level of shocks in both of the economies.
- Volatility shocks in export sector have shown higher level in Korea as compared to Pakistan.

- The volatility in growth of imports indicated approximately equal level of volatility shocks in Pakistan and Korea.

The OLS results for the influence of volatility in different sectors on volatility in GDP growth rate are concluded as:

- The volatility in agriculture sector is causing relatively higher volatility in GDP growth rate of Pakistan than that of Korea.
- The results of volatility in industry show that it contributes to volatility in growth of output in Korea.
- The volatility in growth rate of services sector contributes more to volatility in growth rate of output in Korea than Pakistan.
- The volatility of services sector is causing high volatility in GDP growth in Pakistan as well as Korea as compared to other sectors under analysis. The empirical evidences have shown that the share of services sector increases as the economy passes through the stages of development. There is a need to stabilize the services sector, which contribute to stabilize economic growth of the country. It may be recommend that there is need to equip labor force with education, skill and advance technical knowhow which reduces the unemployment and increases the productivity. Information technology may be a good tool to equip the labor force and stabilize the services sector and consequently the GDP growth. Human resource development should be stressed in areas like health, nutrition, training and education.
- The multivariate analysis has shown positive effect of volatility in exports on volatility in GDP growth in Pakistan only.
- The results of multivariate regression show that volatility in growth of imports effect volatility in growth of output negatively in Pakistan while positively in Korea.

The major imports in Pakistan are raw material for industrial sector and inputs for agricultural sector. The agricultural sector again produces the raw material to industrial sector. There is a need to stabilize the agricultural sector in Pakistan. It is also needed to establish its linkage with industries and to provide advance technology to this sector. There is also needed to stabilize the industrial sector. Industrial sector in Pakistan is largely depending upon the imported raw material in the form of fertilizers, chemicals, pesticides, etc. along with occasionally imported raw cotton (for the years when domestic cotton crop is damaged). So the industrial sector production is linked with imports. The smooth functioning of the industrial sector requires the imports at the needed level. So flexibility in imports to meet the needs of the industrial sector may result into smooth production of industrial sector. The empirical estimates have shown that imports are negatively affecting volatility in GDP growth in Pakistan. Raw material requirements comprising chemicals, fertilizers and cotton are fulfilled by imports if they are not flexible for the requirements, the GDP will fluctuate. If the imports are fixed by quota or tariff the GDP will fluctuate. The notion ultimately supports the proponents of WTO and globalization where liberal imports would result into smoothing the GDP growth rate.

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УДК 33

Волатильность в секторах и рост национального дохода: сравнительный анализ Пакистана и Южной Кореи

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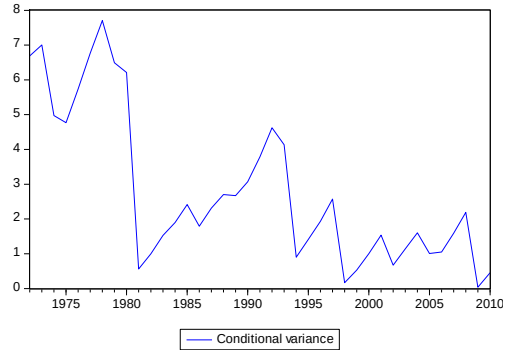
Аннотация. Авторы эмпирически исследовали влияние отраслевой волатильности на колебания экономического роста Пакистана и Южной Кореи. ADF-тест используется для проверки стационарных данных. Методы ARCH и GARCH были использованы для оценки волатильности анализируемых переменных. Результаты показали, что существует почти одинаковый уровень волатильности темпов роста ВВП в обеих странах. При этом волатильность в сельском хозяйстве, промышленности, услугах, торговле варьируется у обеих стран. Существуют большие сдвиги в волатильности сельскохозяйственного сектора Пакистана по сравнению с Кореей. Волатильность в промышленном секторе сохраняется в корейской экономики, но нельзя, что в большей степени в сравнении с Пакистаном. Почти одинаковый уровень волатильности был обнаружен в сфере услуг и секторе импорта обеих стран. Тем не менее, экспортный сектор показал больший уровень волатильности в Корее по сравнению с Пакистаном. Результаты регрессионного анализа показали, что волатильность в сельскохозяйственном секторе способствует большей волатильности роста ВВП Пакистана по сравнению с Кореей. Волатильность в промышленном секторе практически одинаково способствует нестабильности в ВВП обеих стран. С другой стороны, волатильность в секторе услуг способствует большей волатильности в ВВП Кореи по сравнению с Пакистаном. Волатильность экспортного сектора способствует нестабильности в ВВП только Пакистана. Наконец, волатильность сектора импорта негативно влияет на волатильность ВВП в Пакистане, но при этом положительно в Корее.

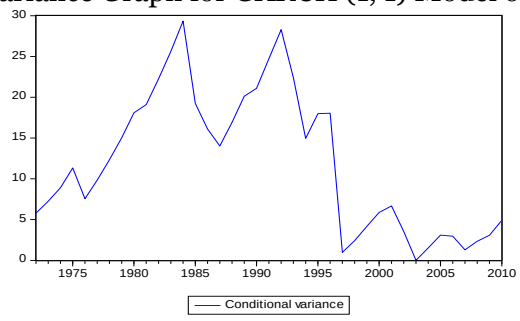
Ключевые слова: международная торговля, сектор сельского хозяйства, сектор услуг, промышленный сектор, экономические колебания, колебания ВВП.

Annexure I
(Conditional Variance Graphs for Pakistan)

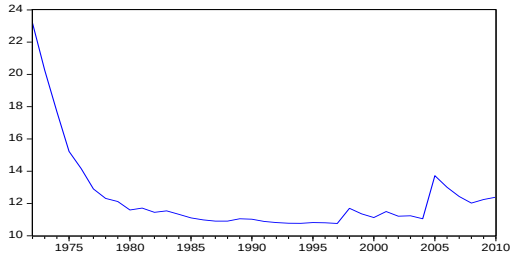
Conditional Variance Graph for GARCH (1, 1) Model of the GR_Y



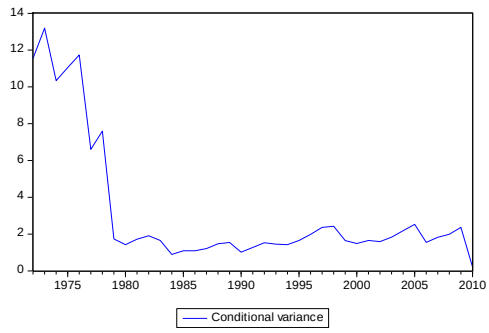
Conditional Variance Graph for GARCH (1, 1) Model of the GR_AGR



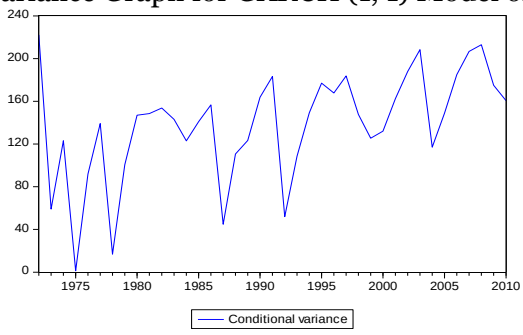
Conditional Variance Graph for GARCH (1, 1) Model of the GR_IND



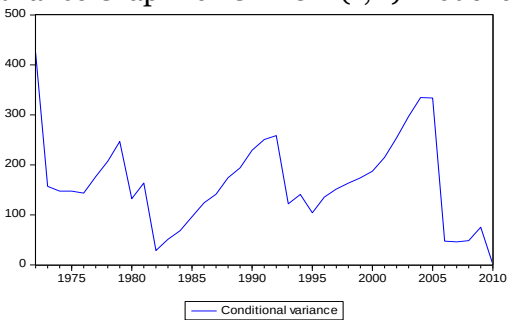
Conditional Variance Graph for GARCH (1, 1) Model of the GR_SER



Conditional Variance Graph for GARCH (1, 1) Model of the GR_EXP

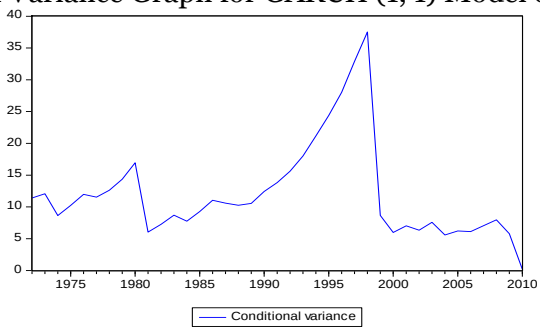


Conditional Variance Graph for GARCH (1, 1) Model of the GR_IMP

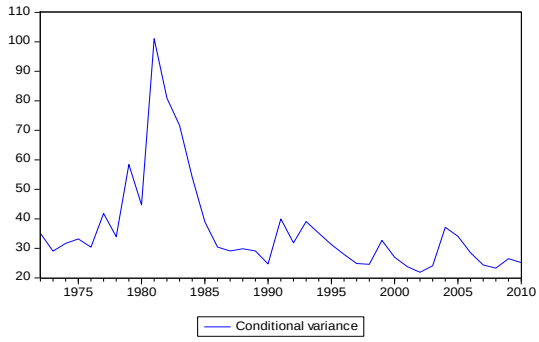


Annexure II
(Conditional Variance Graphs for Korea)

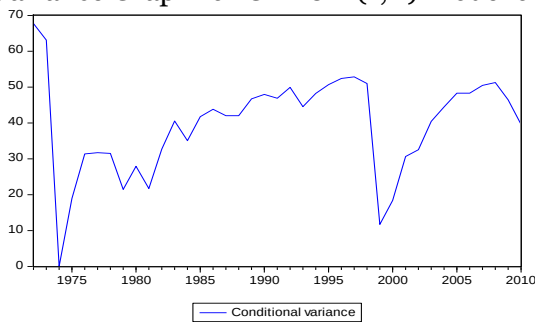
Conditional Variance Graph for GARCH (1, 1) Model of the GR_Y



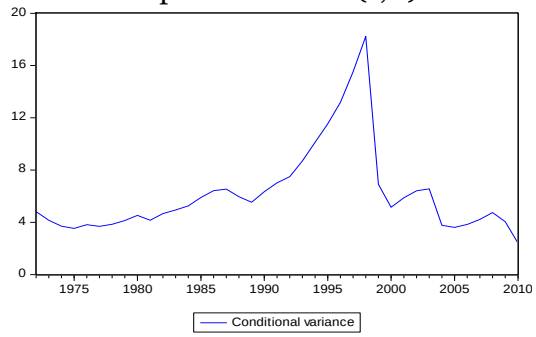
Conditional Variance Graph for GARCH (1, 1) Model of the GR_AGR



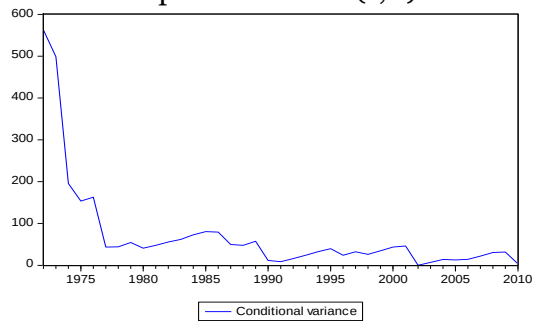
Conditional Variance Graph for GARCH (1, 1) Model of the GR_IND



Conditional Variance Graph for GARCH (1, 1) Model of the GR_SER



Conditional Variance Graph for GARCH (1, 1) Model of the GR_EXP



Conditional Variance Graph for GARCH (1, 1) Model of the GR_IMP