Webology (ISSN: 1735-188X)
Volume 19, Number 3, 2022

Key Sectors And GDP: Cointegration And Causality Analysis For Pakistan Economy

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Abstract

The agricultural, Industrial and Services sectors have crucial role in the economic development of Pakistan economy. The goal of this study was to investigate the interrelationships among the key sectors and between the key sectors and GDP. To accomplish the study time series data ranging 1950 to 2014 were obtained from different sources. Stationarity analysis of time series was made by applying Augmented Dickey- Fuller and Philips - Perron unit root tests, stationarity analysis indicated that all the variables were not level I (0) stationary but differenced I (1) stationary which satisfied the condition of same order of integration and study variables to be cointegrated. Correlation analysis depicted positive and negative correlations among study variables. To attain the objective of the study Engel Granger two step method was applied. The co-efficient indicated long run relationship among the variables. The Error Correction Model' short run coefficient was found significant and depicted convergence to long run equilibrium. The Granger causality analysis explored the existence of bidirectional causality between agriculture and GDP, bidirectional causality between industry and GDP, bidirectional causality between GDP and services sector, unidirectional causality between industry and agriculture and industry was found granger cause agriculture, bidirectional causality between agriculture and services sector and indicated unidirectional causality between industry and services sector and industry was found granger cause services.

Keywords: Agriculture, Industry, Services, Gross Domestic Product, Time series, Stationarity analysis, Long run and short run, Granger causality unidirectional, Bi-directional.

1.Introduction

The study aimed to investigate the Cointegration and causality among the GDP, agriculture, industry and services sector. The study has significance that only few studies have been evaluated the relationship between the sectors and GDP. The results of this study would require important implication by keeping in view the situation of Pakistan economy. The positive economic growth is the foremost objective of economic policies in both developing and developed nations. agriculture, industry and services are key sectors of an economy and being fundamental component of GDP, the agriculture encompasses a big part of labor force and through forward and backward linkages it supports industry and services sectors. Technological advancements in industrial and services sectors have been spillover to agriculture sector. The scarce resources are an issue in developing economies like Pakistan so an aggravate growth process is possible through wisely allocated resources among key sectors. Over the study period the relative significance of agriculture sector narrowed due to industrialization in Pakistan. Being backbone of the economy agriculture contributes 19.2 percent to Gross Domestic Product (GDP) by employing 38.5 percent of labor force (GoP 2021). Many policies have been formulated by the government to augment the efficiency of sectors. For the development of agriculture sector availability of improved quality seeds as well as hybrid and high yielding varieties, fertilizer, pesticides. The government got rid of subsidies which mostly assisted interest groups in spite of poor farmers (GoP, 2014).

The secondary sector/industry contributes 20.4 percent to Gross Domestic Product GDP) and 20 percent of total labor force has been employed by industrial sector**.** Overhauling of vocational and technical education institutions was completed with the objective to provide skilled labor to industrial sector. Policies were adopted to strengthen the small and medium industries as; facilities of targeted loans, technical and extension assistance, contacts to foreign markets by attaining the Generalized System of Preferences (GSP) plus position. The tertiary sector/services has emerged as a new growth power house in Pakistan economy by contributing 59.16 percent in Gross Domestic Product and has a tremendous role for the economic development (GoP, 2016). The services sector's growth persisted faster against the commodity producing sectors of the economy since 2008-09. From the policy perspective it was significant to investigate the structural relationships among the sectors of the economy and towards GDP. Analysis of inter-sectoral dynamics could be useful to work out a favorable and appropriate long-term development plan. Furthermore, such analysis has been considered more significant for a developing country like Pakistan and it will help to go a long way in restoring different socio-economic problems, unemployment and inequality. Accelerating the pace of development of agriculture, industry and services sectors will lead to foster integration and improvement in the welfare of communities. The study will provide the guidelines to the policy maker and investors.

2. Literature review

Katirciologlu (2004) conducted research with reference to Turkish Republic of Northern Cyprus (TRNC) to investigate the possible relationship among the economic growth and key sectors (agriculture, services, industry). The researcher declared the agriculture sector as backbone of the economy. Long run association was found between industry and agriculture sectors. No causal relationship was found from agriculture to economic growth. A long run relationship among the primary sector, secondary sector, tertiary sector, and

real GDP was found. The researcher further reconnoitered uni-directional causality running from real Gross Domestic Product to secondary and tertiary sector's output.

Rashid (2004) examined empirically the association among, primary, secondary and various subdivisions of the services sector. The research focused on to identify the most dynamic and growth stimulating sector with backward and forward linkages in the economy and industrial sector was found most significant in determining overall growth. Further it was concluded that the agricultural growth can be attributed to industrial and services growth.

Blunch and Verner (2006) analyzed and compared the growth of sectors in three African economies - Cote d'Ivoire, Ghana and Zimbabwe since 1965. They extended the typical two-fold economy the agriculture and manufacturing sectors by including services sector. The researchers empirically explored the statistically significant long-run association among sectoral GDP for three mentioned economies. The study indicated a strong dependency among agriculture, manufacturing and services sectors in the long-run economic growth process. Researchers concluded that for maximum economy-wide growth, the three sectors (agriculture, industry and services) should be considered important during policy formulation.

Mahmood and Linden (2007) by using data of fifteen Schengen countries ranging 1970-2004 tried to explore empirically the long run relationship between sectors of the economy and overall economic growth. The researchers explored that share of industrial, services, and agriculture sectors had been positively correlated to economic growth in the long run. The researchers analyzed that structural change in the economy has involve the long run dynamics of industrial, services, and agriculture sectors, further the share of industry, services, and agriculture sectors were interrelated to each other and to overall economic growth. Long run relationship between the sectoral shares was confirmed through applying Cointegration method. Estimates of EC-model based on various arrangements of sectoral contribution, Cointegration pointed out the existence of long run structural modification among all sectoral contribution pairs. The researchers concluded that linkages between GDP per capita growth and services, agricultural, industrial shares were complexed one but industrial sector was declared by the researchers as the "engine" of economic development.

Eddin Chebbi (2010) applied Cointegration and Granger causality technique to look at the linkages among the growth of agriculture sector and growth of other sectors of the economy of Tunisia. The investigator empirically explored and mentioned the existence of long-term interrelationship amongst agriculture and other sector's growth.

Tiwari (2011) by using data ranging 1950-51 to 2008-09, for Indian economy, analyzed the static and dynamic causality among agriculture, industry and services incomes and total GDP by employing Engle-Granger, Impulse-Response and Variance Decomposition analysis. Results of static causality indicated that services were Granger cause to industry and total GDP and agriculture were Granger cause to service sector. The results of dynamic causality depicted that impact of industry on GDP forecast error was highest, followed by agriculture and service sectors, on the other hand the impact of GDP on the forecast error of Industry was highest followed by service and agriculture sectors.

Rahman et al., (2011) conducted a study for the economy of Bangladesh to explore the associations amongst the different sectors of the economy. The major intention of the researchers was to examine the

causal relationship among GDP, agriculture, industry and service sector. The analysis revealed a bi-directional causality between GDP and agriculture sector, GDP and industrial sector, industry and services sector and uni-directional causality running from industrial to agricultural sector and GDP to services sector. The researchers explored that growth in agriculture and industry remained significant towards GDP growth and it was concluded that services sector's growth was not significant towards GDP growth.

Sepehrdoust and Hye (2012) explored the sectoral growth significance towards economic growth. The linkages among sectors and GDP were observed by researchers with reference to Iranian economy. The study depicted those changes in sectoral contributions are interrelated and also related to overall economic growth. Long run relationship was explored among sectoral growth and overall economic growth when GDP was taken as dependent variable and industrial agricultural, services, oil & gas value added were taken as independent variables. After analysis results of long run elasticity demonstrated that one percent change in value added of secondary, primary, tertiary and oil & gas sectors caused and will cause a change in the GDP by 0.219, 0.091, 0.431 and 0.156 percent respectively.

Farooq et al. (2013) investigated the effect of significant factors like primary, secondary, tertiary sector, exchange rate and the trade openness on the overall economic growth with reference to Pakistan. The sensitivity of real economic growth in response of changes in the independent variables in the long-run was investigated by applying Johansen VAR-based Cointegration approach. The study concluded that positively and significantly the real GDP was affected by the estimated coefficients 0.05, 0.42, 0.35, 0.025, and 0.062 percent all the way through agriculture, services, industrial production, trade openness and the foreign exchange rate respectively. The industrial output was the most significant factor identified having impact upon the real GDP. Its contribution towards the real GDP was 0.42 percent.

Adenomon and Oyejola (2013) employed VAR and SVAR model to investigate the contribution of key sectors i-e agriculture and industry on GDP for Nigerian economy by using data ranging 1960-2011. The results of VAR model revealed that agriculture sector's contribution about 58% was followed by industry about 32%. SVAR model depicted more contributions from agriculture sectors to the structural innovations of GDP in Nigeria. They concluded that sound policies should be formulated for the development of agriculture sector.

Enu, Osei-Gyimah, Attah-Obeng and Opok (2013) was made with reference to Ghanian economy aiming at to investigating the contributions made by the agriculture, industry and services sectors towards the overall economic growth. The results illustrated that one percent change of agricultural output caused and will cause GDP growth to change by 0.452849 percent and one percent change in the services sector growth caused and will cause 0.376308 percent change in GDP growth. Finally, one percent change in the industrial sector growth caused and will cause 0.1827 percent change in GDP growth. It was demonstrated by the researchers that towards overall economic growth agriculture sector was found most significant. The researchers recommended that agriculture sector should lead the Ghanian economy for achieving higher GDP growth.

Siboleka et al., (2014) also analyzed the causal and long-term relationship between agriculture and industrial sector of Namibia for the period of 1981-2012 and found no relationship.

Gaspar, Pina and Simões (2014) examined the long- run relationship and causality among agriculture, industry and service sectors for the economy of Portugal (1970-2006) and found a weak

influence of agriculture sector on other two and agriculture was not affected by them. For developed countries same was expected.

Uddin (2015) conducted an analysis regarding the contribution of key sectors (agriculture, industry and services) to GDP growth in Bangladesh by using data ranging 1980 to 2013. Data were found not stationary and Cointegration analysis explored a strong, positive and significant linear relationship among GDP and key sectors. Bi-directional causality was found between agriculture and GDP and industry and GDP and uni-directional causality from services to agriculture and from industry sector to services sector. Through VECM short and long run relationship was examined.

Alhowaish and Al-Shihri (2015) by using time series data ranging 1970-2012, explored the causality between the economic growth and sectors (agriculture, oil, industry, services) for the economy of Saudi Arabia. The researcher used multivariate econometric analysis. The GDP was used as economic growth. The result depicted bi-directional causality among the variables.

Yetiz and Ozden (2017) for Turkish economy explored the causal relationship among GDP, agriculture, industry and services sectors ranging data 1968-2015. The researchers employed Engle-Granger causality/block erogeneity Wald test, Impulse Response and Variance Decomposition analysis and found unidirectional causality from agriculture to GDP and the other three sectors. The result of the study was also an expected result for all developing countries like Pakistan but not true for developed nations.

3. Data and Methodology

To accomplish the study time series secondary data ranging 1950 to 2014 were obtained from State Bank of Pakistan, Finance Division, Government of Pakistan, World Bank and World Development Indicators. Data was in nominal terms which was converted into real terms by using deflator

Table 1. An overview of the econometric techniques applied.

Data /Variables	The variables are real GDP (Rs. million), real agricultural/traditional output (Rs. million), real industrial/ secondary output (Rs. million) and real services/tertiary output (Rs. million). Real services output was approximated summing up, transport storage & communication, wholesale &retail finance and insurance, ownership of dwelling, public administration & defense, and community services (output is in terms of Rs. million).
Data properties	• Data description • Correlation (Pearson) matrix
Technique applied	• Engle-Granger two-step modeling method (EGM) • Long run model • Error Correction Model (ECM)- short run relationship
Stationarity analysis	• Augmented Dickey Fuller test(ADF) • Philip perron test
Long run model	$GDP_t=\beta_0+\beta_1 Agri_t+\beta_2 Ind_t+\beta_3 Serv_t+\mu_t$

Shor-run adjustment	$D(GDP_t)=\beta_0+\beta_1 D(Agri_t)+\beta_2 D(Ind_t)+ \beta_3 D(serv_t)+ \beta_4 ECT(-1)$
Technique applied	Granger causality test
Causality model	$GDP_t = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i} GDP_{t-i} + \sum_{t=1}^{n} \alpha_{2i}\, agriculture_{t-i} + u_{1t}$ $agriculture_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i} agriculture_{t-i} + \sum_{t=1}^{n} \beta_{2i}\, GDP_{t-i} + u_{2t}$ $GDP_t = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i} GDP_{t-1} + \sum_{t=1}^{n} \alpha_{2i} industry_{t-i} + u_{1t}$ $industry_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i} industry_{t-i} + \sum_{t=1}^{n} \beta_{2i}\, GDP_{t-i} + u_{2t}$ $GDP_t = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i} GDP_{t-i} + \sum_{t=1}^{n} \alpha_{2i}\, services_{2i} + u_{1t}$ $services_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i} services_{t-i} + \sum_{t=1}^{n} \beta_{2i}\, GDP_{t-i} + u_{2t}$

3.1. Unit root tests and order of integration

Prior to estimation it is obligatory to ensure stationarity of time series data. Nelson and Plosser (1982) and Hall (1978) concluded that time series variables have random pace. Granger and Newbold (1974); Granger (1986); Phillips (1986) and Ohanian (1988) analyzed that regression results will be spurious in case of non-stationary data. Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) were applied to investigate the level of possible Cointegration among the study variables (Dickey & Fuller, 1981; Phillips Perron, 1990). Phillips Perron test has the justification in current study as the Pakistan economy experienced military regimes, political instability and this test took into account the structural breaks. The test was conducted for each variable and lag length was selected by using Akaike Information Criterion (AIC). Following three regression equations have been used by Dicky and Fuller to investigate unit root issue.

$y_t = \gamma\, y_{t-1} + \mu_t$, No intercept and trend (none) (1)

$y_t = \alpha + \gamma\, y_{t-1} + \mu_t$ With intercept (2)

$y_t = \alpha + \beta t + \gamma\, y_{t-1} + \mu_t$ With intercept and trend (3)

Yt is variable of interest , α is the intercept and βt is the trend and μ_t is error term. In above regression equations the Yt is time series. The parameter of interest is γ (where, $\gamma = \rho-1$, if $\gamma = 0$, then $\rho = 1$). If $\gamma=0$ it indicates that it contains a unit root-the time series is non-stationary and contrary if the $\gamma < 0$ the series is stationary.

H0. $\gamma = 0$ the series has unit root; series is not stationary or integrated of order one and it indicates a long run relationship.

H1. $\gamma \neq 1$ or $\gamma < 0$. The series has no unit root; series is stationary, and it indicates no long run relationship.

If the data are not stationary at levels than stationarity is checked by applying following equations.

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{q} \theta_i \Delta y_{t-1} \quad \text{(Without intercept and trend)} \quad (4)$$

$$\Delta y_t = a + \gamma y_{t-1} + \sum_{i=1}^{q} \theta_i \Delta y_{t-1} \quad \text{(With intercept)} \quad (5)$$

$$\Delta y_t = a + \beta t + \gamma y_{t-1} + \sum_{i=1}^{q} \theta_i \Delta y_{t-1} \quad \text{(With intercept and trend)} \quad (6)$$

If the variables are differenced stationary than series are integrated of order one or I (1). So if H0 is rejected than first differenced stationary is confirmed I (1)

PP test based upon the long run variance of residuals. The equations are same as were used by the DF. While for hypothesis testing the critical values of MacKinnon (1991) were used.

3.2. Test for Cointegration

Stationarity analysis depicted the non-stationarity of data so application of OLS was not possible although researchers have solution to difference the series successively until it became stationary. But the differencing of series can generate misleading results. So, a real breakthrough came with the introduction of the concept of Cointegration in early 1980s.To avoid the unfavorable situation, long run relationship was checked through applying co integration technique introduced by Engle and Granger (1987) and afterward was developed and modified by Marcellino et al., (2003), Johansen (1988) and Johansen and Juselius (1990). Majority of the economic theories were about the long run behavior of time series (Maddala, 2001). Co integration between two series indicates the existence of long run relationship or in other way it indicates that both the series move in the same direction over time so the occurrence of short-term disturbances can be corrected so that short-term disturbances from the long-term trend will be corrected Manning and Andrianacos (1993). The absence of co integration indicate no long run relationship among time series and they can drift away from each other (Dickey, Jansen & Thornton, 1994). To analyze the long run and short run association Cointegration and Error Correction Models (ECM) have been applied as were applied by Tiffn and Irz, 2006; Khan, 2008; Udah, 2010; Jatuporn et al., 2011; Akram et al., 2008; Wilber, 2002; Alhowaish, 2014; Blunch and Verner, 2006; Mahmood and Linden, 2007; Rahman et al., 2011; Ugwuanyi and Abula, 2015; Lashkarizadeh et al., 2012; Usman et al., (2021); for the same because the estimates of the Engle-Granger (1991) long-run ordinary-least-squares (OLS) have been considered consistent and highly efficient(Stock, 1987). Many researchers recommended the addition of dynamic (differenced or lags) components (Charemza & Deadman, 1997; Cuthbertson, Hall, & Taylor, 1992; Inder, 1993; Phillips & Loretan, 1991; Saikkonen, 1991; Wickens & Breusch, 1988). Some were with the opinion of having appropriate corrections and modifications to the static parameter estimates as were presented by the EG Engle and Yoo (1991), Park and Phillips (1988), Phillips and Hansen (1990), West (1988). Banerjee, Dolado, Hendry and Smith (1986) were with the opinion for estimating long-run parameters in an unrestricted error-correction model (ECM) along with all the dynamic components; on the otherhand some favored Phillips and Hansen (1990) for eliminating the bias by making some corrections to the OLS estimator (Phillips and Hansen call this “the modified OLS

estimator"). Inder (1993) recommended after comparing different estimators of long run parameters the model which included dynamics was more reliable. In the present study to explore the long run relationship and short run adjustment among study variables the Engle-Granger two-step modeling (EGM) technique has been applied.

3.3. The Engle-Granger two-step modeling method (EGM)

According to this method long run equilibrium relationship can be modeled by applying regression straightaway by ignoring all the dynamics.

- **Long run model**

The EG residual based tests are simply the unit root test application to the residuals which have been obtained from OLS technique.

- At first step by ignoring all the dynamics the co integrating regression was estimated by applying Ordinary Least Square (OLS.)
- The stationarity level of the residuals was tested by employing unit root test.
- The residuals were found stationary than it indicated long run relationship among variables.

Model (7) has been specified to estimate long run relationship.

$$GDP_t=\beta_0 +\beta_1 agri_t +\beta_2 ind_t+\beta_3 serv_t+\mu_t \quad (7)$$

Where

GDP_t = real Gross Domestic Product (Rs. million)
$agri_t$ = real agricultural output (Rs. million)
ind_t = real industrial output (Rs. million)
$serv_t$ = real services output (Rs. million)

Model further has;

β_0 = the intercept (the GDP_t in case $\beta_1 = \beta_2 = \beta_3 = 0$)
β_s = parameters which have to be estimated
μ_t = error term (assumed to be distributed normally having zero mean and constant variance).
t = time series

Following were the hypothesis of the model

H_0= Long run relationship does not exist between GDP and agricultural output
H_1= Long run relationship exists between GDP and agricultural output
H_0= Long run relationship does not exist between GDP and industrial output
H_1= Long run relationship exists between GDP and industrial output
H_0= Long run relationship does not exist between GDP and services output
H_1= Long run relationship exists between GDP and services output

The spurious results generated by using the non-stationary data were ignored even with the high R^2 unless the correction procedure was employed to eliminate the bias. Engle and Yoo (1991), Park and Phillips (1988), Phillips and Hansen (1990) and West (1988) have presented different types of corrections.

3.4. Error correction model- short run relationship

If long run relationship disturbs due to short run deviations from equilibrium thus an Error Correction Model (ECM) would be a helpful framework. If the time series were co integrated than there exist ECM which combines the long run relationship with short run dynamics Engle and Granger (1987). Whenever regression models have been analyzed the long run relationship may take place among the variables but short run relationship may not take place. In such situation to correct or eliminate the inconsistency which occurs in short run the ECM has been applied. ECM depicts the speed of adjustments towards the long run equilibrium after a short run shock. For short run adjustment and convergence long run equilibrium, error correction model (8) has been estimated and results have been presented in chapter four.

$$D(GDP_t)=\beta_0+\beta_1 D(GDP_t)+\beta_2 D(Agri_t)+\beta_3 D(Ind_t)+ \beta_3 D(serv_t)+ \beta_4 ECT(-1) \quad (8)$$

Where

$D(GDP_t)$, $D(Agri_t)$, $D(Ind_t)$, $D(Serv_t)$ = first differenced variables

β_0 = Intercept

$\beta_1, \beta 2, \beta 3, \beta 4$ = short run coefficient

ECT (-1) = error correction term

In model 8 "D" indicated differenced stationary and ECT (-1) was the error correction term. For short term relationship the coefficient of ECT (-1) should take a value between -1 and 0. As a rule of thumb in Granger representative with a negative sign otherwise reflected weak relationship.

3.5. Model for Granger causality

The study aimed to analyze the existence of causal relationship among the study variables. The regression analysis did not imply causation among variables although it indicated the dependency of a variable upon the other, but it did not demonstrate the causality/direction of influence among variables. The direction of causation between the two variables has always been identified by using standard Granger framework. In empirical literature Granger causality test has a significant position. In case of two variables X_t, Y_t , Y_t is said to be Granger- causing X_t if X_t can be predicted by using past values of Y_t as compare to the case when these values were not used Granger (1969). If two variables such as X_t and Y_t are integrated than there can be four ways of causation.

- X_t may Granger causing Y_t (unidirectional)
- Y_t may Granger causing X_t (unidirectional)
- X_t may Granger causing Y_t and Y_t may Granger causing X_t (bi directional)
- X_t Granger causing Y_t nor Y_t Granger causing X_t (no causal relationship)

In empirical growth literature the Granger causality test has been widely used. The GCT was used by Ghali (1997), Chong and Calderon (2000), Bader and Aamer (2003), Hsieh and Lai (1994) and Vanhoudt (1998).

Briefly, any event of past can cause the event of present, but the event of future cannot cause the event of present. The main concept was at the back of the so-called Granger causality test.

- Is it GDP that "causes" agriculture (GDP → agriculture)
- Is it GDP that "causes" industries (GDP →industries)
- Is it GDP that "causes" services (GDP → services)

OR

- Is it agriculture that "causes" GDP (agriculture→GDP)
- Is it industries that "causes" GDP (industries→GDP)
- Is it services that "causes" GDP (services→GDP)

Where the arrow points to the direction of causality.

- **Model specification for Granger causality test**

Granger (1988) concluded that when series are co-integrating there must be one direction (unidirectional) or two direction (bidirectional) causality. Mayer (2001), Narayan and Smyth (2004), Meulemeester and Rochit (1995) used GCT for analyzing the causal relationship among economic factors and economic growth. Katircgulu (2006) investigated the causality among GDP, agriculture, industry and services sector. The following pair of regressions for estimation have been constructed following Granger causality phenomena, fitted with data to investigate that whether the agriculture, industry and services stimulates the GDP growth or GDP growth leads the key sectors. The results have been presented in table 4.45(chapter 4).

$$\mathrm{GDP}_t = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i}\mathrm{GDP}_{t-i} + \sum_{t=1}^{n} \alpha_{2i}\,\mathrm{agriculture}_{t-i} + u_{1t} \quad (9)$$

$$\mathrm{agriculture}_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i}\mathrm{agriculture}_{t-i} + \sum_{t=1}^{n} \beta_{2i}\,\mathrm{GDP}_{t-i} + u_{2t} \quad (10)$$

$$\mathrm{GDP}_t = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i}\mathrm{GDP}_{t-1} + \sum_{t=1}^{n} \alpha_{2i}\mathrm{industry}_{t-i} + u_{1t} \quad (11)$$

$$\mathrm{industry}_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i}\mathrm{industry}_{t-i} + \sum_{t=1}^{n} \beta_{2i}\,\mathrm{GDP}_{t-i} + u_{2t} \quad (12)$$

$$\mathrm{GDP}_t = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i}\mathrm{GDP}_{t-i} + \sum_{t=1}^{n} \alpha_{2i}\,\mathrm{services}_{2i} + u_{1t} \quad (13)$$

$$\mathrm{services}_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i}\mathrm{services}_{t-i} + \sum_{t=1}^{n} \beta_{2i}\,\mathrm{GDP}_{t-i} + u_{2t} \quad (14)$$

In above system $u_{1t}u_{2t}$ are uncorrelated and white noise error term series indicates the equation (9) hypothesizes that GDP in time period t was linked with its past values as well as that of agriculture and similar behavior can be observed in case of equation (10) which depicted that agriculture in time period t depended upon its past value as well as of GDP. Equation (11) hypothesizes that GDP in time period t was linked to its past values as well as of industry. Equation (12) hypothesizes that industry in time period t depended upon its past value as well as of GDP. Equation (13) hypothesizes that GDP in time period t was linked to its past value and as well as of services and equation (14) hypothesizes that services in time period t depended upon its past value as well as of GDP.

Further it can be elaborated as following

$$\mathrm{GDP_t} = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i}\mathrm{GDP_{t-i}} + \sum_{t=1}^{n} \alpha_{2i}\,\mathrm{agriculture_{t-i}} + u_{1t} \quad (9a)$$

$$\mathrm{agriculture_t} = \beta_0 + \sum_{t=1}^{n} \beta_{1i}\mathrm{agriculture_{t-i}} + \sum_{t=1}^{n} \beta_{2i}\,\mathrm{GDP_{t-i}} + u_{2t} \quad (10a)$$

1. Granger causality can be determined by estimating the equation 9a and 10a by testing the null hypothesis that $\sum_{t=1}^{n} \alpha_{2i} = 0$ and $\sum_{t=1}^{n} \beta_{2i} = 0$ against the alternate hypothesis that $\sum_{t=1}^{n} \alpha_{2i} \neq 0$ and $\sum_{t=1}^{n} \beta_{2i} \neq 0$. Unidirectional Granger causality from agriculture to GDP was pointed out if the estimated coefficients on the lagged agriculture in equation (9a) were statistically different from zero as a group (i.e.$\sum_{t=1}^{n} \alpha_{2i} \neq 0$) and the set of estimated coefficients on the lagged GDP in (10a) was not statistically different from zero (i.e. $\sum_{t=1}^{n} \beta_{2i} = 0$). Conversely, unidirectional Granger causality from GDP to agriculture existed if the set of lagged agriculture coefficients in (9a) was not statistically different from zero (i.e.$\sum_{t=1}^{n} \alpha_{2i} = 0$) and the set of the lagged GDP coefficients in (10a) was statistically different from zero (i.e.$\sum_{t=1}^{n} \beta_{2i} \neq 0$). If both $\sum_{t=1}^{n} \alpha_{2i} \neq 0$ and $\sum_{t=1}^{n} \beta_{2i} \neq 0$ were statistically different from zero then there existed bi-directional causality. Independence/no Granger causality was suggested when the sets of agriculture and GDP coefficients were not statistically significant ($\sum_{t=1}^{n} \alpha_{2i} = 0$ and $\sum_{t=1}^{n} \beta_{2i} = 0$) in the regressions.

$$\mathrm{GDP_t} = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i}\mathrm{GDP_{t-1}} + \sum_{t=1}^{n} \alpha_{2i}\mathrm{industry_{t-i}} + u_{1t} \quad (11a)$$

$$\mathrm{industry_t} = \beta_0 + \sum_{t=1}^{n} \beta_{1i}\mathrm{industry_{t-i}} + \sum_{t=1}^{n} \beta_{2i}\,\mathrm{GDP_{t-i}} + u_{2t} \quad (12a)$$

2. Granger causality can be determined by estimating the equation 11a and 12a by testing the null hypothesis that $\sum_{t=1}^{n} \alpha_{2i} = 0$ and $\sum_{t=1}^{n} \beta_{2i}$ against the alternate hypothesis that $\sum_{t=1}^{n} \alpha_{2i} \neq 0$ and $\sum_{t=1}^{n} \beta_{2i} \neq 0$. Unidirectional Granger causality from industry to GDP was pointed out if the estimated coefficients on the lagged industry in equation (11a) were statistically different from zero as a group (i.e.$\sum_{t=1}^{n} \alpha_{2i} \neq 0$) and the set of estimated coefficients on the lagged GDP in (12a) was not statistically different from zero (i.e. $\sum_{t=1}^{n} \beta_{2i} = 0$). Conversely, unidirectional Granger causality from GDP to industry existed if the set of lagged industry coefficients in (11a) was not statistically different from zero (i.e.$\sum_{t=1}^{n} \alpha_{2i} = 0$) and the set of the lagged GDP coefficients in (12a) was statistically different from zero (i.e.$\sum_{t=1}^{n} \beta_{2i} \neq 0$). If both $\sum_{t=1}^{n} \alpha_{2i} \neq 0$ and $\sum_{t=1}^{n} \beta_{2i} \neq 0$ respectively in equations (11a) and (12a) respectively were statistically different from zero, then there existed bi-directional causality. Independence/no Granger causality was suggested when the sets of industry and GDP coefficients were not statistically significant ($\sum_{t=1}^{n} \alpha_{2i} = 0$ and $\sum_{t=1}^{n} \beta_{2i} = 0$) in the regressions.

$$\mathrm{GDPt} = \alpha_0 + \sum_{t=1}^{n} \alpha_{1i}\mathrm{GDP_{t-i}} + \sum_{t=1}^{n} \alpha_{2i}\,\mathrm{services_{2i}} + u_{1t} \quad (13a)$$

$$\text{services}_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i}\text{services}_{t-i} + \sum_{t=1}^{n} \beta_{2i}\,\text{GDP}_{t-i} + u_{2t} \qquad (14a)$$

3. Granger causality can be determined by estimating the equation 13a and 14a by testing the null hypothesis that $\sum_{t=1}^{n} \alpha_{2i} = 0$ and $\sum_{t=1}^{n} \beta_{2i}$ against the alternate hypothesis that $\sum_{t=1}^{n} \alpha_{2i\neq} 0$ and $\sum_{t=1}^{n} \beta_{2i\neq} 0$. Unidirectional Granger causality from services to GDP was pointed out if the estimated coefficients on the lagged services in equation (13a) are statistically different from zero as a group (i.e.$\sum_{t=1}^{n} \alpha_{2i\neq} 0$) and the set of estimated coefficients on the lagged GDP in (14a) is not statistically different from zero (i.e. $\sum_{t=1}^{n} \beta_{2i} = 0$). Conversely, unidirectional Granger causality from GDP to industry existed if the set of lagged industry coefficients in (13a) was not statistically different from zero (i.e.$\sum_{t=1}^{n} \alpha_{2i} = 0$) and the set of the lagged GDP coefficients in (14a) was statistically different from zero (i.e.$\sum_{t=1}^{n} \beta_{2i} \neq 0$).If both $\sum_{t=1}^{n} \alpha_{2i} \neq 0$ and $\sum_{t=1}^{n} \beta_{2i} \neq 0$ respectively in equations 13a and 14a respectively **,**were statistically different from zero then there existed bi-directional causality. Independence/no Granger causality was suggested when the sets of services and GDP coefficients were not statistically significant ($\sum_{t=1}^{n} \alpha_{2i} = 0$ and $\sum_{t=1}^{n} \beta_{2i} = 0$) in the regressions.

3.6. Lag selection

For employing causality analysis different criterions of lag selection Log L, sequential modified, LR test statistic, Final prediction error, Akaike information criterion, and Schwarz information criterion were applied.

4. Results of empirical analysis

- **Data description**

Table 2. Data description.

	Ragri	Rind	Rserv	RGDP
Mean	5374.262	5049.923	10564.25	20988.48
Median	4037	2898	6012	13019
Maximum	16592	15586	36452	67522
Minimum	1360	263	1015	2730
Std. Dev.	4006.134	4969.01	10547.67	19457.81
Skewness	0.99448	0.981967	1.070662	1.009643
Kurtosis	2.952734	2.600604	2.843139	2.704776
Jarque-Bera	10.72012	10.72012	12.48507	11.27932
Probability	0.004701	0.004701	0.001945	0.003554
Sum.	349327	328245	686676	1364251
Sum Sq. Dev.	1.03E+09	1.58E+09	7.12E+09	2.42E+10

RGDP =real output of gross domestic product, Ragri =real output of agricultural/traditional sector, Rind=real output of industrial/secondary/sector, Rserv=real output of services/tertiary sector.

The table 2 indicates the basic properties of data. The mean value depicted that services sector remained a major contributor towards GDP. The greater value of standard deviation of services sector illustrated the more spread out of the observations. The skewness indicated the positive distribution of data and indicated good performance of the economy.

- **Unit root and order of integration analysis**

Table 3. Stationary analysis – ADF and PP.

	At levels				At 1st Difference			
	Ragri	Rind	Rserv	RGDP	Ragri	Rind	Rserv	RGDP
τT (ADF)	-1.582767 (1.000) (2)	1.630757 (1.000) (9)	0.592920 (0.9994) (0)	0.315339 (0.9983) (0)	-6.258348 (0.0000)* (1)	-5.103083 (0.0000)* (8)	-6.893567 (0.0000)* (0)	-7.357210 (0.0000)* (0)
τμ (ADF	4.9336 (1.0000) (2)	3.926637 (1.000) (9)	5.362340 (1.0000) (0)	5.054447 (1.0000) (0)	-8.330900 (0.0000)* (0)	-2.293346 (0.1775) (4)	-4.689159 (0.0003)* (0)	-5.143965 (0.0001)* (0)
τ (ADF)	6..140479 (1.0000) (2)	4.380675 (1.000) (2)	8.685660 (1.0000) (0)	8.559143 (1.0000) (0)	0.947779 (0.0000)* (5)	-1.859113 (0.0605)** (4)	-3.272221 (0.0000)* (0)	-0.633756 (0.4387) (0)
τT (PP)	3.087652 (1.000) (15)	-1.453757 (0.8351) (2)	0.854568 (0.9995) (6)	5.192977 (1.0000) (2)	-10.81823 (0.0000)* (8)	-7.654254 (0.0000)* (1)	-6.749848 (0.0000)* (6)	-7.308888 (0.0000)* (4)
τμ (PP)	11.01409 (1.0000) (21)	1.208337 (0.9979) (2)	5.510847 1.0000) (4)	8.337172 (1.0000) (1)	-8.334013 (0.0000)* (2)	-7.311604 (0.0000)* (3)	-4.635107 (0.0000)* (2)	-5.160488 (0.0001)* (3)
τ(PP)	12.77781 (1.000) (19)	3.039551 (0.9993) (3)	.537707 (1.0000) (3)			-6.360320 (0.0000)* (3)		-3.326367 (0.0012)* (3)

					-7.173838 (0.0000)* (4)		-2.976019 (0.0000)* (1)	

RGDP=real gross domestic product, Ragri =real output of agricultural sector, Rind=real output of industrial sector, Rserv =real output of services sector. The values in parenthesis signifies the Mackinnon critical at which the unit root hypothesis can be accepted or rejected. Small brackets indicate lag lengths. *, *** denote rejection of the null hypothesis at the 1 percent, and 10 percent levels respectively. τT=with drift and trend, τμ =with drift and witout trend, τ =without drift and trend.

The table 3 presented the unit root test results.τT represents the most general model with a drift and trend; τμ is the model with a drift and without trend; τ is the most restricted model without a drift and trend. Numbers in brackets are lag lengths used in ADF test (as determined by AIC set to maximum 3) to remove serial correlation in the residuals. When using PP test, numbers in brackets represent Newey-West Bandwith (as determined by Bartlett-Kernel). Both in ADF and PP tests, unit root tests were performed from the most general to the least specific model by eliminating trend and intercept across the models (Enders, 1995, p.254-255). The series were found stationary at first difference I (1).

- **Pearson -Correlation matrix**

Table 4. Pearson -correlation matrix.

	Ragri	Rind	Rserv	RGDP
Ragri	1.0000	0.9755	0.9901	0.9917
Rind	0.9755	1.0000	0.9930	0.9945
Rserv	0.9901	0.9930	1.0000	0.9995
RGDP	0.9917	0.9945	0.9995	1.0000

RGDP =real output of gross domestic product, Ragri =real output of agricultural/traditional sector, ind=real output of industrial/secondary/sector, Rserv=real output of services/tertiary sector.
Table 4 indicates the highest positive correlation (0.9995) between GDP and services sector followed by industrial sector (0.9945) and then agriculture sector (0.9917).The highest inter-sectoral correlation exists between services sector and industry (0.9930) followed by services sector and agriculture sector (0.9901) and then between industry and agriculture sector (0.9755).

- **Temporal profile of variables**

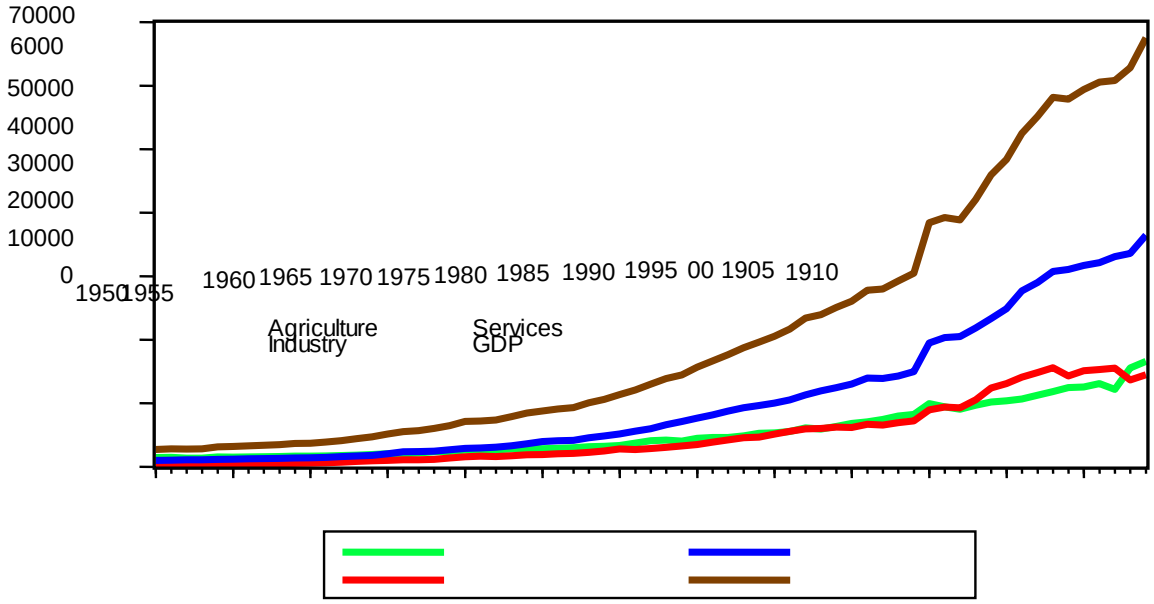

Figure 1. Trends in study variables. (Million Rs.).

Figure 1 indicates that in the beginning during 1950 the output of agriculture sector was higher than industry and services sectors. But after 1965 output of services and industrial sector was higher than the agriculture sector. Although the trend in agriculture sector has been observed positive but at slow pace as compared to other sectors. A sharp rise can be observed in services sector after 1980. Economically country improved during this period. Inflow of foreign remittances increased. Due to Afghan war foreign assistance also increased and denationalization enhanced the output level by restoring the confidence level of private sector. For the enhancement in the living standard of poorest segment of the population fifth five-year plan (1978-83) was initiated. A planned investment was made, and resources were also allocated on defense spending. Sharp increase in oil prices at international level and Afghan refugees' influx into Pakistan. However, several objectives were achieved. Many restrictions on industrial sector were eliminated, the deficit in Balance of Payments (BOP) was managed, and basic food stuff supplies were increased with the exception of edible oils. The objectives: to rouse considerable private investment in industry and to move up appreciably the expenditures on rural infrastructure expansion were attained. The plan stands for a momentous move toward the private sector. During 1986-87 the decline in poverty was to 29.1 percent. Decline in unemployment was from 3.7 percent in 1980 to 2.6 percent in 1985-88 (Fasih-Uddin & Swati, 2009; World Bank, 2012; World Development Indicators, 2012). Fluctuations in the economy observed during 2000-01 have been attributed to political instability, ill governance, lack of political will and unforeseen exogenous shocks. The government adopted policies as uplift of industrial sector, interest rate was lowered, and the exports were encouraged. The farmers were facilitated through support price system on output and subsidies on input regarding seeds, fertilizers, credits and consultancy. At government level non-developmental expenditures were reduced. The taxation system was implemented efficiently. However, the social and economic prohibitions resulted in multiple deprivations for more than 50 percent of population. The year 2005-06 and 2006-07 have been considered as the

remarkable growth period and industrialists were facilitated. The construction of educational institutions and plazas, transportation and communication were enhanced. During 2005-06 poverty decreased to 22.3 percent and unemployment also decreased to 5 percent in 2008 which exhibited the success of free-enterprise economy but generally people faced continuous rising trend in food prices including sugar, wheat, vegetables fruits and edible oil.

Literacy rate was 55 percent in 2007-08 (Fasih-Uddin and Swati, 2009; World Bank, 2012; World development indicators, 2012). GDP growth rate was 6.6 percent during 2005-06 along with per capita income of $847. During 2006-07 the growth rate was 7 percent (GoP, 2011). In the year 2010, load shedding badly affected the production activities in the commodity sector. After 2010 terrorism and war on terrorism badly affected the economy. Unluckily Pakistan faced political instability but luckily the armed forces and the civil society secure the state in difficult times as the earthquakes and massive floods. The world media declared Pakistan as failed state but it was proven wrong. Pakistan turned out to be one among four fastest mounting economies in the Asian region all through 2000-07 with 7 percent growth per year. The legitimacy of Pakistan as vivacious culture and a strong nation unnoticed by the media. The real strength of the state remained pliability of its 188 million human resources struggling for developed and stronger Pakistan.

- **Co integration analysis –long run relationship**

Table 5.. Results of Engel Granger 1st step.

GDP_t=0.2647200	+0.989868 $Agri_t$	+ 0.989968Ind_t	+ 0.990057Servt
[0.247836]	[0.000152]	[0.000154]	[0.000106]
(0.2897)	(0.0000)	(0.0000)	(0.0000)
R^2=0.998, Adjusted R^2=0.998	F-statistic	=1.69E+10(0.000000)	

The values in brackets are standard error. The values in parenthesis are p value.

The table 5 indicated the estimated coefficients β_1, β_2 and $\beta 3$ (long run co-efficient) as β_1 (agriculture) = 0.98, β_2 (industry) = 0.98 and $\beta 3$ (services) =0.99 are significant. Here R^2 =0.998 indicated that the 99 % variations in dependent variables were by explanatory variables (included in the model) and remaining variations were due to other factors. Then stationary analysis of residuals of estimated model was made to explore the long run relationship.

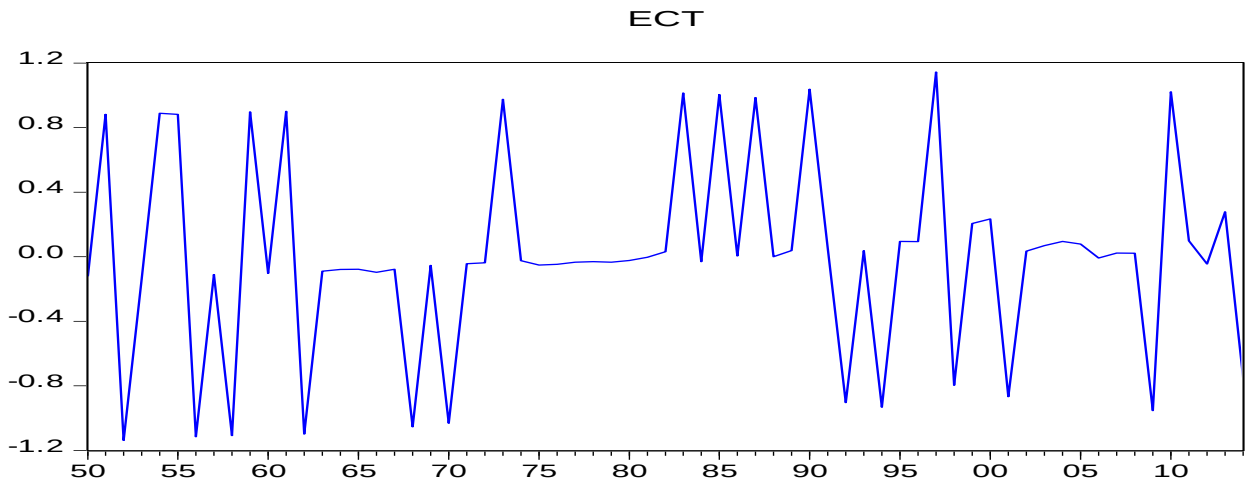

Figure 2. Graphical stationarity analysis of error terms.

Graphical stationarity analysis of error terms (obtained from regression model 4.8) was made. The figure 2 indicated that residuals were stationary at level I (0) as the curve depicted no trend in it. The analysis indicated the existence of long run association among the study variables. The stationarity status of the time series data was checked through employing augmented dickey fuller (ADF) and Phillip Perron (PP) tests.

- **Unit root tests and order of integration –Engel Granger 2nd step**

- **Table 6.** ADF and PP results for Engel Granger 2nd step.

ADF		PP	
At level	ECT	At level	ECT
τT	-9.025051	τT	-9.151938
τμ	(0.0000)*	τμ	(0.0000)*
τ	-9.052846	τ	-9.166266
	(0.0000)*		(0.0000)*
	-9.126693		-9.247351
	(0.0000)*		(0.0000)*

Note. * symbolizes the level of significance (one percent) at which the null hypothesis was rejected. The values in parenthesis signifies the P-values. τT=with drift and tren, τμ =with drift and witout trend, τ =without drift and trend.

According to ADF and PP tests the regression residuals were found stationary at level table 5 depicted the results of unit root test applied on the residuals obtained from the estimated co integrating regression model (8). Engel-Granger critical values for unit root test at 5 percent and 10 percent were -3.34 and -3.04 respectively. The p-value was less than 0.05 and therefore H_0 was rejected that the residuals have a unit root. The residuals $\hat{\varepsilon}_t$ were therefore I (0) and were stationary which indicated long run

relationship among GDP, agriculture, industry and services or in other words variables were found cointegrated.

- **Error correction model- short run relationship**

Table 7. Results of estimated general ECM model.

$D(GDP_t)$= -0.028+	0.999$D(Agri_t)$+	0.996.00$D(Ind_t)$+	0.998$D(Serv_t)$	-1.271715 ECT(-1)
[0.090589]	[0.000198]	[0.000230]	[0.000170]	[0.133098]
(0.7575)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

The values in brackets are standard error. The values in parenthesis are p value.

The table 7 portrayed that after estimating error correction model short run coefficients were found significant and speed of adjustment coefficient ect(-1) has negative sign and it was significant which indicated the validity of short run equilibrium relationship among GDP, agriculture, industry and services and also convergence to long run equilibrium. In other words it explain that the whole system is convergent to the long run equilibrium at the speed of (-1.271715) and negative sign indicates its significance.

- **The Granger causality test**

Table 8. Lag Length selection criterion.

Lag	LL*	LR*	FPE*	AIC*	SC*
0	-1581.575	NA	2.59e+18	53.74832	53.88917
1	-1377.770	373.0666	4.45e+15	47.38205	48.08630*
2	-1365.041	21.57537	5.01e+15	47.49291	48.76056
3	-1325.680	61.37667	2.32e+15	46.70101	48.53206
4	-1302.812	32.55708	1.91e+15	46.46821	48.86266
5	-1267.241	45.82047	1.05e+15	45.80478	48.76263
6	-1244.242	26.50746*	9.10e+14*	45.56753*	49.08878

* Indicates lag order selected by the criterion.
Each test at 5% level LogL*. Sequential modified, LR* test statistic, FPE*. Final prediction error, AIC*. Akaike information criterion, SC*. Schwarz information criterion.
The table 8 indicates that the test results of LR, FPE and AIC suggested that six lag should be selected.

Table 9. Results of Granger causality test.

Null Hypothesis	F-statistic	P-value	Decision
AGRICULTURE does not Granger cause GDP	5.60912	0.00020	Reject H0
GDP does not Granger cause AGRICULTURE	3.85526	0.00338	Reject H0
INDUSTRY does not Granger cause GDP	5.75559	0.00016	Reject H0
GDP does not Granger cause INDUSTRY	5.38574	0.00028	Reject H0
SERVICES does not Granger cause GDP	2.70402	0.02474	Reject H0
GDP does not Granger cause SERVICES	3.48371	0.00637	Reject H0

INDUSTRY does not Granger cause AGRICULTURE	4.66625	0.00088	Reject H0
AGRICULTURE does not Granger cause INDUSTRY	8.40204	3.6E-06	Accept H0
SERVICES does not Granger cause AGRICULTURE	2.71289	0.02435	Reject H0
AGRICULTURE does not Granger cause SERVICES	5.06774	0.00046	Reject H0
SERVICES does not Granger cause INDUSTRY	6.40879	5.9E-05	Accept H0
INDUSTRY does not Granger cause SERVICES	4.83851	0.00066	Reject H0

The table 9 indicated the following causality results.

- The probability value of F-statistic is significant for both variables so null hypothesis should be rejected, and conclusion can be made that there exists bidirectional causality between agriculture and GDP.
- The probability value of F-statistic is significant for both variables so null hypothesis should be rejected, and conclusion can be made that there exists bidirectional causality between industry and GDP.
- The probability value of F-statistic is significant for both variables so null hypothesis should be rejected, and conclusion can be made that there exists bidirectional causality between GDP and services sector.
- The probability value of F-statistic for null hypothesis that industry does not granger cause to agriculture sector is significant so the null hypothesis should be rejected and the probability value of F-statistic for null hypothesis that agriculture does not granger cause industry is insignificant so accept null hypothesis. It indicates unidirectional causality between industry and agriculture.
- The probability value of F-statistic is significant for both variables so null hypothesis should be rejected, and conclusion can be made that there exists bidirectional causality between agriculture and services sector.
- The probability value of F-statistic for null hypothesis that services does not granger cause to industry is insignificant so the null hypothesis should be accepted and the probability value of F-statistic for null hypothesis that industry does not granger cause services is significant so reject null hypothesis. It indicates unidirectional causality between industry and services sector.

Conclusion

The study investigated the co integration and causal relationship among GDP, agriculture, industry and services sector in the economy of Pakistan. In other words, the analysis described a long run equilibrium relationship between study variables i-e GDP and key sectors, which was obtained by applying Engel Granger two step method. The long run long run co-efficient were significant which indicated long run relationship, error correction model short run coefficient was found significant and speed of adjustment (coefficient of ect.) (-1.271715) was found with negative sign which indicated the validity of short run

equilibrium relationship among study variables and also convergence to long run equilibrium. Correlation analysis indicated highest positive correlation between GDP and services sector. The Granger causality analysis explored the existence of bidirectional causality between agriculture and GDP, bidirectional causality between industry and GDP, bidirectional causality between GDP and services sector, unidirectional causality between industry and agriculture and industry was granger cause agriculture, bidirectional causality between agriculture and services sector and unidirectional causality between industry and services sector and industry granger cause services. The analysis indicated the importance of sectors, though agriculture sector was weak but still provider of food and raw material. The studies by Tiffn and Irz, 2005; Khan, 2008; Udah, 2010; Jatuporn et al., 2011; Khan, 2008; Wilber, 2002; Mujahid and Alam, 2014; Alhowaish, 2014; Katrigcloglu and Aryeetey, 2002; Blunch and Verner, 2006; Mahmood and Linden, 2007; Rahman et al., 2011; Ugwuanyi and Abula, 2015; Lashkarizadeh et al., 2012, confirmed the same.

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