Tracing Information Transmission between Pakistani and Chinese Stock Markets: Pre and Post CPEC Announcement Analysis

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Registration No. PIDE2016FMPHILEAF33

MPhil Economics and Finance

A Dissertation Submitted to the Pakistan Institute of Development Economics, Islamabad, in partial fulfillment of the requirements of the Degree of Master of Philosophy in Economics and Finance

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May, 2018

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CERTIFICATE

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Declaration

I declare that this research work titled "*Tracing Information Transmission between Pakistani and Chinese Stock markets: Pre and Post CPEC announcement analysis"* is my own effort. The work has not been presented elsewhere for valuation. The material that has been used from other sources has been well acknowledged / referred.

Student Signature

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ACKNOWLEDGEMENTS

I simply bow my head before Almighty Allah the maker of universe, for providing me believe & trust in my skills and enabling me to finalise this thesis work and granting me with His Mercy, countless Blessings and limitless help during the phase of the Thesis.

It is not a one-man job. So, I am honoured to present this formation, which is a product of guidance by my respectful instructor, dearest friends' and loving family. For me no one can be chosen 1st on the list, as everybody's assistance is a primary component of my work. I express my heartiest thankfulness to Dr. Saud Ahmed Khan, my supervisor, for their supervision in the direction and scope of the project & his assistance with the evolving ideas in the Thesis process.

I sincerely recognise hard work of all my professors specifically, Dr. Ahsan-ul-Haq Satti, Dr. Hassan Mohsin and Dr. Abd ul Jalil because without their help, inspiration and efforts it wasn't easy to achieve my goal. Moreover, I humbly recognise the backing provided by all the staff members of Department of Economics & Finance, PIDE. Without their hard work and support we all are nil.

In the end I want to thanks all my class fellows and my colleagues for helping me out and for giving assistance throughout the degree tenure especially Jamshed Ahmad, Wajahat Mehmood, Zubair Hafeez and Usman Masood for their help and support they provide me in execution of this thesis.

I present this thesis in the foremost Barghah of Hazrat Muhammad Mustafa (S.A.W.W) who by his Profound knowledge & Sublime Ethics carried glory to this world at time when it was sinked in blackness…….

& to my adorable parents, my dearest brother and guiding tutors for their belief in me throughout my academic career

Abstract

This study traces impact of China Pakistan Economic Corridor project announcement on information transmission between Pakistan's stock market PSX (formally KSE-100 index) and Chinese stock markets i.e. Shanghai Stock market and Shenzhen Stock market. Daily data from 1st January 2010 to 30th of November 2017 is utilised for tracing information transmission between both countries' stock markets. To analyse the pre and Post-impact of CPEC on financial markets the data is subdivided into two parts. First subpart contains data from 1st January 2010 to 20th of April 2015 for pre-CPEC analysis, as CPEC project was officially announced on 20th of April 2015 when honourable Chinese president 'Mr. Xi Jingping' visited Pakistan. 2nd subpart contains data from 21st April 2015 to 30th of November 2017 for post CPEC analysis. For tracing information transmission and volatility modelling appropriate univariate GARCH family models are used i.e. GARCH (p, q) and GJR-GARCH (p, q). The data from 23rd December 2016 to 30th of November 2017 is also analysed as a special case to check out the impact of Chinese investment in purchasing Pakistan stock market shares on mean spillover effect between both countries' financial markets. As on 23rd December 2016 Chinese consortium bids the highest price per share to purchase 40% shares of PSX. Returns series has utilised rather than series at level. The descriptive statistics of stock markets indices return series depicts that all returns series have stylised properties of financial return series. Return series are non-normal, not symmetric and skewed. All return series are stationary and have ARCH effect.

By analysing the whole data set we conclude that there is unidirectional mean spillover effect exist from Shanghai SE to PSX and Shenzhen SE to PSX. While there is no volatility spillover effect among these financial markets neither unidirectional nor bidirectional. While by analysing the pre-CPEC dataset we found that there exist no mean spillover affect neither

unidirectional nor bidirectional between Pakistan, Shanghai and Shenzhen stock markets. In case of volatility spillover effect we found unidirectional volatility spillover effect from Shenzhen SE to PSX, while there is no volatility spillover effect observed between PSX and Shanghai in a pre-CPEC period. While Post-CPEC period analysis leads us to conclude that there is unidirectional mean spillover effect exist from Shanghai SE to PSX and Shenzhen SE to PSX. While there is no volatility spillover effect among these financial markets neither unidirectional nor bidirectional. By analysing the post period of Chinese investment in PSX shares the results shows there exist no mean spillover effect neither from PSX to Chinese stock markets nor from Chinese to Pakistan stock market in a said period. All this means that CPEC project announcement has influenced the spillover effect between both countries financial markets. There exist a unidirectional mean spillover effect in post-CPEC period in contrast to Pre-CPEC period. So there is a linkage developed between the two countries financial markets after CPEC announcement.

Contents

Chapter 1

Introduction

CPEC project becomes the hot topic for past few years, and both Chinese and Pakistani governments emphasize a lot on this project. Both countries claim that this particular project will have a considerable economic impact on both economies and called it a game changer for the region. However, the CPEC impact on economic indicators required to be investigated. Under CPEC project highways and railways network are to be built and also includes special economic zones and energy production projects. Huge investment in Pakistan economy expected which will uplift the growth and reduce unemployment in the country. The impact on the economy of these projects can be analysed through Pakistan and Chinese stock markets.

For a developing country like Pakistan CPEC is termed as great opportunity by policy makers to increase its economic growth. It is particularly the part of BRI (Belt & Road initiative) project which was initiated by Chinese government few years ago. The Project Aim is to link Chinese North-western region of Xinjiang to Pakistani port of Gawadar in Baluchistan. Approximately 2700 kilometres road has to be built from Gwadar to Kashgar under CPEC. Motorway from Lahore to Karachi of 1100 kilometres, railway track between Karachi and Peshawar, the extension of already existing Karakorum highway is also included under this project (Riaz et al.2017). For China it will deliver them the shortest land way to the Middle East, Africa and European region that will further enhanced its economy, particularly to western province.

CPEC agreement based on 51 Memoranda of understandings (MOU's). $46 billion agreement (MOU's) was signed publicly on 20th of April 2015 when the

honourable Chinese president ‘Mr.Xi Jinping’ visited Pakistan. The investment over CPEC is approximately 20% of Pakistan yearly GDP. Project Investment which has increased from $46 billion to $55 billion and later further increased to $62 billion will likely lead to the speedy transformation of Pakistani infrastructure, its transportation and specifically the quick retrieval of energy crises issue in Pakistan which had been the serious matter for more than 2 decades for Pakistani economy. The encouraging sentiments for Pakistani economy directed it towards stability. Projects under CPEC have been divided in to three phases. First phase includes short term projects which are expected to be completed till 2017. Midterm and long term projects by 2025 & 2030 respectively. (Jawad, 2013). Moreover, Chinese consortium on December 23, 2016 bids the highest price of 28rs per share to buy 40 percent strategic shares of Pakistan Stock Exchange. The value of transaction is approximately $85 million. The huge investment may impact the linkages between both neighbouring countries’ financial markets and hence required to be investigated.

Economic progress and regional integration enhanced more through partnership and connectivity (Cheema, 2015). The markets globalisation is because of capital flow easiness and financial associations among the economies. Economies of China and Pakistan are on the edge of financial integration, the Chinese Banks opening in Pakistan is one step further in the direction of financial integration. The examination is useful to identify about the level of connection between Pakistan and China stock markets Post and pre-CPEC agreement which will be useful for portfolio managers, market players, and financial institutes.

In mid-1980s first time the co-movements of risk & return between financial markets were observed and now for past three decades the global financial integration has got a major significance. The extensive development of technology also played a

vital role in globalisation of markets. In 90's Engle et al. (1990) came up with Heat wave and Meteor shower hypothesises i.e. analysis of intra-firm co-movements & analysis of intra-market co-movements.

The information of one market transmits to other market by two means; through return and through volatility. Information transmission can also called as spill over effect. For studying spillover effect between both countries' financial markets, modern Econometric tools are used. In mean spillover, we analyse how PSX (formally KSE-100 index) returns affect Shanghai stock market & Shenzhen stock market returns and how the return of these two' affects the returns of Pakistan stock market. In volatility spillover effect, we examine how the change in volatility in Pakistan stock market affect Shanghai stock market and Shenzhen stock markets volatility & vice versa. In other words, we examine the existence of unidirectional or bi-directional spillover in these financial markets.

Our primary research focus is on finding spillover effect between Pakistan stock exchange, Shanghai stock exchange and Shenzhen stock exchange by CPEC announcement. We are interested to know the spillover (mean spill over or volatility spillover, unidirectional or bidirectional) effect after the announcement of $46 billion investment which later on increased to $55 billion and later further increased to $62 billion. Furthermore, to explore impact of 40% of PSX shares purchasing by Chinese consortium on financial linkages as a special case.

1.1 Research Gap:

Tracing Information Transmission has been studied for a long time. It is evident from the presence of the lengthy literature. It includes studies analysing the spillover effect pre and post financial crises 2008 impact among the different stock exchanges of

different regions, literature has been found on spillover effect among Asian emerging countries including Karachi and Shanghai stock exchanges the pre and post financial crises analysis. To the best of my knowledge none of the studies explore CPEC impact on information transmission between Pakistani and Chinese markets.

1.2 Study Objective:

The study objective is to investigate the linkages between Pakistan stock exchange & China stock exchanges including Shanghai and Shenzhen Stock markets in general and particularly after the China Pakistan economic corridor announcement in April 2015. To find the mean spillover effect and volatility spillover effect the pre & post-CPEC announcement analysis. The objective of this research leads us to conclude the following research questions.

1.3 Research Questions:

- Are there any significant linkages observed between Pakistani and Chinese stock markets before the CPEC announcement?
- Are there any significant linkages observed between Pakistani and Chinese stock markets after the CPEC announcement?

1.4 Study Significance:

The study will help the investors who are very keen on investing in stock markets of Pakistan and China, the market players who are always there in the market and portfolio managers. If the level of linkage among markets is significant and positive then the portfolio managers should revisit their portfolio basket as diversification advantage will not be there and vice versa.

The empirical analysis of CPEC impact on stock markets is important as well as helpful for investors, portfolio managers and financial institutes who have their eyes

on CPEC project. Massive literature has been found on pre and posts financial crises analysis on different stock markets including Pakistan and China stock market, but very few studies managed to capture the CPEC analysis.

Chapter 2

Literature Review

Previous studies are briefly discussed under this chapter. It is evident from the presence of the lengthy literature that tracing information transmission has been studied for long time. In financial econometrics literature researchers came with enormous theoretical and empirical efforts to prove their selected models. This review emphasizes on CPEC impact on information transmission between two neighbouring countries stock markets.

2.1 CPEC & Pakistani Economy:

Concerning economy in Pakistan, Mehmood and Ahmad (2017) analysed the pre and post impacts of CPEC in its economy. For this purpose, they study the change in volatility in returns of financial markets of Karachi Stock Exchange and Shanghai. The extensive study found a significant impact of the project's announcement on the volatility of returns of markets. The study further found a decreasing impact of the project on the volatility of Pakistan Stock Exchange market return in post-announcement period. Thus, the market becomes more suitable and more stable for the investors to invest in it in post CPEC period.

Zafar and Ahmad found that the CPEC announcement effect on different sectors Beta (used as a systematic risk measure as in association to market as whole) is significant and shows downfall in different sectors, i.e., automobile, banking and insurance (2017). It is because of increased local demand due to CPEC and to meet the rise in demand more industries should be built. They concluded that investors are in the win-win situation as CPEC projects cause higher demand for goods and the local manufacturing rate is low.

CPEC will bring better socio-economic situation and improvement in foreign policy of Pakistan (Riaz et al. 2017), the project impact will be broader most likely on poverty line index, regional peace, unemployment issues and security. Zia & Waqar (2017) examines impact of CPEC & Road infrastructure projects on employment of Pakistan. According to them out of initial investment of US 46 billion dollars, 13.58 billion has spent on infrastructure projects. The results show that there are 40,000 direct jobs that has been created through Six CPEC projects and the average ratio of employment of Pakistani to Chinese is 18:1 so it negates the suspicion that all Chinese are getting employed. CPEC also brings concerns with it and one of them are local industries protection, and also the CPEC related outflows that can create problems for Pakistan in long run. Khan (2016)

2.2 Possible channels of information transmission:

Previous Literature traced out possible channels of transmitting information in Pakistan. Most of the studies discussed heavily about the financial crises 2008 transmission into Pakistan i.e. exploring the possible channels of crises transmission into Pakistani economy. Stock markets decay, banking system failure & reduction of direct investments are among few reasons. CPEC project have same features but in a positive way.

Stock markets, remittances, trade in commodities, capital flows are four major channels through which the financial crises transmitted into developing economies. The investment linkages between USA & Pakistan economies caused the crises transmission into Pakistan (Amjad and Din 2010). Another similar study found the direct impact on commercial banks in Pakistan during the financial crises period, it is because of spillover effect resulted in significant change in market policies, banks working strategies and financial arrangements Nazir et al. (2012)

Ghulam Ghoss et al. (2015) during his work of tracing dynamic linkages between different international stock markets with Pakistan stock market, explores the possible channels by which the global crises transmitted into Pakistan, they found some direct and indirect channels which impact the economy of Pakistan in global financial crises period. Direct channels include banking system failures, exports earning reduction (low commodity demand abroad & internationally fell of prices), financial inflows decline, remittances fall and stock market crash. While the internal loaning decline also caused the adverse effect to economy. Abdul Latif et al. (2011) confirms the reduction of exports in that particular period of time and according to him it was mainly happened because of world trade prices decline.

2.3 Some Previous empirical studies:

Hamao et al. explore the short-run price interdependence and price volatility spillover among Tokyo, London and New York using technique of ARCH models (1990), they found insignificant price volatility spill over before October 1987 and significant relationship in post October analysis. Engle, Ito, and Lin (1990) traced out intra-market co-movement using meteor shower hypothesis. In this regard, Liu (1997) analysed volatility and mean spillover effects in Japan & the United States to Pacific-Basin financial markets. The work suggested that, during the period 1984-1991, the United States' market has more influence than the Japanese market in transmitting volatility and returns spillover to four Asian markets. The study also found a significant role of market contagion in it. King and wadhwani (1990) attempted to answer the question that why despite having different economic circumstances almost all world stock markets fell together. They found out the presence of contagion effect behind it and provided evidence for rational agents' response to a price change in markets in this regard.

Wang and Firth (2004) used GJR-GARCH models to explore the linkages of three developed stock markets across the oceans with greater China stock markets. The researchers found unidirectional spillover effect to Chinese financial market from the advanced international markets. In the same year, Alexandar (2004), by using high-frequency data (five minutes to 1 day), traced information transmission speed and integration among markets. They examined how fast one market reacts to the information prevailed in another market. The results of the study suggest that all markets react to the information within the first hour. However, it placed the United States in the top position as the more important source of information for Frankfurt and London markets. Qayyum (2006) modelled volatility spillover effect by using bi-variate E-GARCH method between foreign exchange market and Pakistani stock market. The study found a significant relationship between the two variables. In 2008, Qiao et al., (2008) examined the association among Hong Kong stock market and Chinese A' shares market and B' shares market. The study utilized FIVECM-BEKK Generalized ARCH approach and indicated a significant spillover effect from A-shares market to B-shares market and Hong Kong financial market. It further observed acceleration, which is because of the relaxation policy on buying B-shares by residents from the Chinese government.

A similar investigation was carried out by Abou-Zaid (2011). He found the transmission of stock index volatility movements from the United Kingdom and the United States to selective counties in North Africa and the Middle East. Two years later, Alikhanov (2013) inspected the volatility spillover effect between oil price market and the stock markets of Europe. The study found, due to interconnected financial markets and liberalization of the economy, a strong spillover effect from the United States to European stock and oil markets. It resulted in co-movement between the two

In the same year of the study of Alikhanov, Li & Giles (2013) modelled volatility spillover effect between developed stock markets, i.e., the United States and Japan and some emerging Asian financial markets. They modelled it by using multivariate GARCH model and found significant & unidirectional volatility spillover effect from the United States to the Asian financial markets. Most importantly, the bidirectional relationship was found when the Asian financial crises were present in the market. Additionally, Mansi et al. (2013) used VAR-GARCH model to study the transmission of volatility between the S&P 500 and commodity price indices for food, gold, energy, and beverages over the period from 2000-2011. Significant results for transmission among the S&P 500 and commodity markets have been found during this period.

Huo and Ahmad, by using GARCH models, investigated the Shanghai-HongKong connect impact by analysing the spillover effect between both markets. He found that the conditional variance has increased after the stock markets connection. He further found that the Shanghai stock exchange played a leading role in both mean and volatility spillover effect, reducing the risk level & market efficiency. It has also been increased in China leading stock markets (2016). They concluded that in post connect period the return spillover from Shanghai to Hong Kong is stronger than the previous periods. Another study found the direct and indirect dynamic linkages using Meteor-shower hypothesis between Pakistan and leading foreign stock markets post and pre-financial crises 2008, by using generalized GARCH type models. It estimated the post and pre-crises spillover effects. They found that there unidirectional spillover effect from leading stock markets to Pakistan in pre Crises period. While there are indirect linkages found from the USA to Pakistan through Dubai stock exchange in post-crisis scenario (Ghoss & Ahmad, 2014).

Hamid et al. (2017), used MGARCH-Bekk model and MGARCH-CCC model to analyse the spillover effect between emerging economies of Asia including Pakistan and China. They found the significant relationship between Pakistan and Bangladesh financial markets but insignificant spill over Shanghai to KSE. They conclude a high triangular effect of KSE to BSE and then BSE to SS. Jebran et al. (2017) analysed the spillover effect using EGARCH model between emerging countries of Asia in normal and turbulent periods, they considered financial crisis 2008 as turbulent period and found that there is a strong relationship in the crisis period. Negative shocks have more influence on volatility than positive shocks of having the same degree. Wang (2014) finds the Chinese economy impact on world economy by using CGARCH model, he examines China's A share and major indices of world with respect to extreme risk spillover. VAR model is used to study the extreme risk spillover, he find the strong long run risk spillover effect and conclude the strong impact of Chinese economy in the world.

Chapter 3

Spillover Effect Elaboration, Defining Data and Volatility Modelling

Risk in the financial markets is a synonym of volatility, time varying volatility is one of the issue in financial econometrics and its predictability is core purpose of financial econometric modelling. To estimate the conditional mean and conditional variance (also known as volatility) is the fundamental purpose of modelling time series in econometrics. These models are used for future volatility prediction, historical behaviour of volatility and persistence of shock.

Co-Movement or transmission of information from one market to other's termed as spillover effect, moreover if the volatility or return of one market affect the other market volatility or return then it is termed as spill over. Transmission of information between markets is quite important to analyse as it creates the dynamic linkages between markets. According to Padhi et al (2012) the transmission of information persist through return and volatility and plays important role in financial integration across the globe. In this study we traced out the linkages between Pakistani and Chinese stock markets after and before the China Pakistan economic corridor.

3.1 Data:

Daily data from 1st January 2010 to 30th of November 2017 are examined to analyse the spillover effect between China and Pakistan stock markets. The data is divided into two subparts for pre and post Analysis. To examining the pre-CPEC announcement, data from 1st January 2010 to 20th April 2015 will be used. For Post CPEC announcement impact, data from 21st April 2015 to 30th November 2017 are considered.

For best and impact full study the data of these financial time series should be synchronized. The return series are used instead of using series at level because the series at level is usually trendy, bimodal and skewed. For robust model estimation, it would be necessary the series should not be trendy otherwise estimations are impossible. As return series is not trendy, uni-modal and leptokurtic, the robust estimation can be done so that the log difference return will be used.

$$R_t = log_e(l_t/l_{t-1})$$

Where l_t is the indices of the stock markets at the end of period ‘t' i.e., closing points at the end of each day, where l_{t-1} is the first lag of financial time series. Where Rt is the return of financial series, and it shows the mean reversion behaviour. Qualitatively log and growth return are same. But in the present day we imply Log return instead of growth because it has certain benefits as under:

- Optimize the value
- Log reduces spread
- Make it uni model
- We can find derivative through continuously compounded function

3.2 Data sources:

We take PSX ‘Pakistan stock exchange' which is also called as KSE-100 index daily data, and Composite indices of Shanghai stock exchange and Shenzhen stock exchange daily data closing prices to check the uni-directional or bi-directional spillover effect. The source of collecting data is yahoo finance for Shanghai stock exchange and PSX while the data of Shenzhen stock exchange is collected from its official website.

3.3 Econometric Methodology:

Engel was the man who first proposed the 'ARCH' model in 1982; he gave the conditional mean equation and Conditional variance equation which depends on ARMA (p, q) process and Square of lag values of its residuals respectively. But it has some drawbacks such as the long lag value problem to overcome those flaws Bollerslev (1986) came forward and extended the ARCH model; he proposed the generalized ARCH model which is commonly known as GARCH model.

We used appropriate uni-variate GARCH family models such as GARCH (p, q) and GJR-GARCH (p, q) for estimations to avoid non-convergence problem and to explore mean and volatility spillover effects. GARCH (p, q) and GJR-GARCH (p, q) uni-variate models are effective to explore volatility transmission Hamao et al. (1990). Following this technique, we traced out the linkages between Pakistani and Chinese stock markets.

3.4 ARCH (q) Model:

To address ARCH effect Engle (1982) proposed Autoregressive conditional heteroscedastic model which overcomes all flaws in existing models. He gave Conditional mean equation and Conditional variance equation which depends on ARMA (p, q) process and Square of lag values of its residuals respectively.

The General equations of ARCH model are as follows;

Conditional mean:

$$R_t = \beta X_t + \varepsilon_t$$

Where $\varepsilon_t \sim D(0, \sigma_t^2)$ given error term following distribution 'D' with mean zero and Variance σ_t^2. ARMA process is represented by βX_tin this equation. Moreover 'R_t'

represent the returns which is a linear function of X_t. According to efficient market hypothesis the return series is un-predictable and shows mean reversion behaviour.

Conditional variance:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-1}^2$$

Where$\alpha_0 > 0,\ \alpha_i \geq 0,$ that is non-negative condition applied. Where σ_t^2 is conditional variance and it depends lag of squared residuals.

3.5 GARCH (p, q):

In Generalised ARCH model, the conditional variance equation depends on Square of lag values of its residuals along with the lag of its conditional variance. He argues that the variance of the series depends not only on its error lag values but also on its variance lag values. The equations of conditional mean and conditional variance for GARCH model are as follows.

Conditional mean:

$$R_t = \beta X_t + \varepsilon_t$$

Where; $\varepsilon_t \sim D(0, \sigma_t^2)$ given error term following distribution 'D' with mean zero and Varianceσ_t^2. ARMA process is represented by βX_tin this equation.

Conditional variance:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_j \, \sigma_{t-1}^2$$

Where$\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0$ that is non-negative condition applied.

3.6 GARCH (1, 1) model:

This model is most common among GARCH (p, q) models and is frequently used for modelling volatility. It is the modest form that provide more robust estimations then other volatility models. Hansen R. P. et al. (2005) forecast comparison of volatility models, they relate 330 ARCH type models in order to their conditional variance forecast capability. Their main findings conclude that there was no such proofs that GARCH (1. 1) was surpassed by other models and significantly better than other models in predicting volatility. Ghoss and Saud (2014) used GARCH (1, 1) And GARCH-GJR model for finding spillover effect between different financial markets. Jabeen and saud (2014) by using GARCH analysed exchange rate instability by macroeconomic fundamentals in Pakistan. This model is mostly used when higher lags are required. The general representation of GARCH (1, 1) is as follows.

Conditional mean equation

$R_t = \beta X_t + \varepsilon_t$

Where; $\varepsilon_t \sim D(0, \sigma_t^2)$

Conditional variance:

$$\sigma_t^2 = \alpha_0 + \alpha_i \varepsilon_{t-1}^2 + \beta_j \sigma_{t-1}^2$$

Where $\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0$ that is non-negative condition applied.

3.7 GARCH (t) model:

Bollerslev (1987) introduced standardized‘t’ distribution in the model, he relaxed the assumption of normality of residuals as return series is leptokurtic, have heavy tails suggesting that series distribution is not normal. He argues that the

standardized error term follows ‘t' distribution with mean zero, variance ‘1' and ‘v' the degree of freedom for t distribution. It can be written as

$$\varepsilon_t = z_t\ \sigma_t,\ z_t \sim t(0,1,v)$$

3.8 GJR Model:

Simple Generalised ARCH models only captures the symmetric effect of good and bad news on volatility and doesn’t take asymmetric effect into account. Whereas asymmetric Generalised ARCH models considers the asymmetric response to good and bad news. As the assets returns increases the volatility of assets returns declines means that good and bad news have different magnitude effect on volatility. Black (1976)

GJR model (1993) which is named on Glosten, Jagannathan, and Runkle who proposed this model to capture the asymmetric effect in the market. Empirically it has been observed that negative shock prevails for a longer period as compared to positive shock. It is because of the panic situation ignition with the arrival of bad news; the people start selling which further worsen the situation.

GJR model capture this asymmetric effect the conditional variance equation proposed by them is as follows.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i\ \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \gamma_i\ \varepsilon_{t-i}^2 D_t + \sum_{i=1}^{p} \beta_j\ \sigma_{t-j}^2$$

Where$\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0$And $0 \leq \gamma_i \geq 1$

Where ‘D’ is a dummy variable, D=1 if there is any negative shock to volatility while D puts equal to zero in case of positive news. If negative news it will shows the impact is more i.e.$(\alpha_i + \beta_i)$

3.9 Structure of Methodology:

The properties of return series are checked with two approaches. First is the graphical approach (visual inspection) and second is the statistical approach. Relevant data is taken from the return of one stock exchange and use different tests to confirm the properties of return series for this purpose applying different tests, excess kurtosis and Jarque-Bera test for normality, ADF and KPSS to check stationary and finally Q^2 stat test to check the ARCH effect in the model.

In mean spillover, we analysed how the PSX (KSE-100 index) returns affect the return of Shanghai stock market & Shenzhen stock market and how return of these two Chinese stock markets affects the performance of Pakistan stock market. For this purpose, the return of one market is introduced as a regressor in return of another market. In volatility spillover effect, we examined how the change in volatility in Pakistan stock market affect the volatility in Shanghai stock market and Shenzhen stock markets and how change in Shanghai stock market and Shenzhen stock market volatility affect the volatility of PSX (KSE-100). For this purpose we regressed the volatility of one market with other market volatility, i.e. The Square of one market series is introduced in other market variance equation.

The equations can be written as follows:

Introducing Return of SSE in PSX Return series:

$$R_{tp} = ARMA\ (m, n) + \ aR_{tshanghai}$$

$$\sigma_{tp}^2 = GARCH \text{ type model}$$

Where R_{tp}&$R_{tshanghai}$ are returns of Pakistan stock exchange and Shanghai stock exchange respectively,σ_{tp}^2 is variance of Pakistan stock exchange.

Introducing volatility of SSE in PSX Volatility equation:

$$R_{tp} = ARMA\ (m, n)$$

$$\sigma_{tp}^2 = GARCH + b\ R_{tshanghai}^2$$

$R_{tshanghai}^2$, represents Variance of shanghai SE, As Square of return series mimics the variance of the series.

Introducing return of PSX in SSE Return series:

$$R_{tshengahi} = ARMA\ (m, n) + \ cR_{tp}$$

$$\sigma_{tshengahi}^2 = GARCH \text{ type model}$$

To check the bi-directional mean spillover effect Return of PSX introduced as a regressor in Shanghai Stock exchange return series.

Introducing volatility of PSX in SSE Volatility equation:

$$R_{tshengahi} = ARMA\ (m, n)$$

$$\sigma_{tshengahi}^2 = GARCH + dR_{tp}^2$$

For bi-directional Volatility spillover effect Return square of PSX introduced as a regressor in Shanghai Stock exchange volatility equation.

Introducing return of Shenzhen SE in PSX Return series:

$$R_{tp} = ARMA + \ eR_{tshenzhen}$$

$$\sigma_{tp}^2 = GARCH \text{ type model}$$

Introducing volatility of Shenzhen SE in PSX Volatility equation:

$$R_{tp} = ARMA\ (m, n)$$

$$\sigma_{tp}^2 = GARCH + f\ R_{tshenzhen}^2$$

Introducing Return of PSX in Shenzhen SE Return series:

$$R_{tshenzhen} = ARMA\ (m, n) + \ gR_{tp}$$

$$\sigma_{tshenzhen}^2 = GARCH \text{ type model}$$

Introducing Volatility of PSX in Shenzhen SE Volatility equation:

$$R_{tshenzhen} = ARMA\ (m, n)$$

$$\sigma^2_{tshenzhen} = GARCH + h\ R^2_{tp}$$

Chapter 4

Estimations & Analysis

4.1 Graphical inspection:

Figure 4.1 (a) Graphical plots for series at level of stock indices:

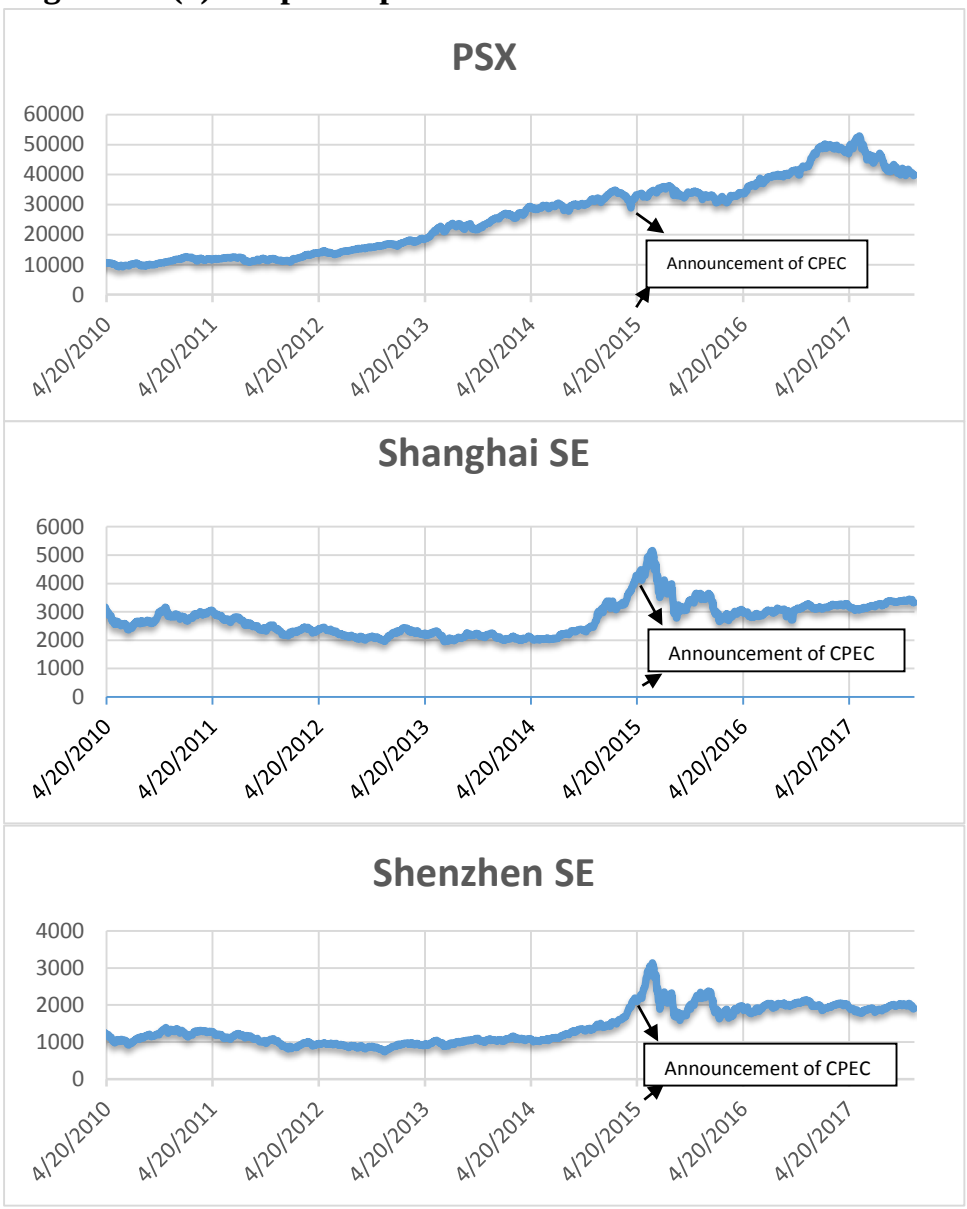

Figure 4.1 (a) Graphical visualisation of series at level

Figure 4.1 (a) Showing that (PSX) Pakistan stock Exchange series have continuous upward trend in the beginning and then a sharp decline in the end, whereas the Shanghai and Shenzhen stock markets series following a decline in the start then in-between a sharp rise in both stock markets and then a decline in the end. This shows that the series

at level are trendy, multimodal and hence non-normal. Daily data has been used from 1st Jan 2010 to 30th November 2017 for this purpose.

Figure 4.1 (b) Graphical inspection of given Return series:

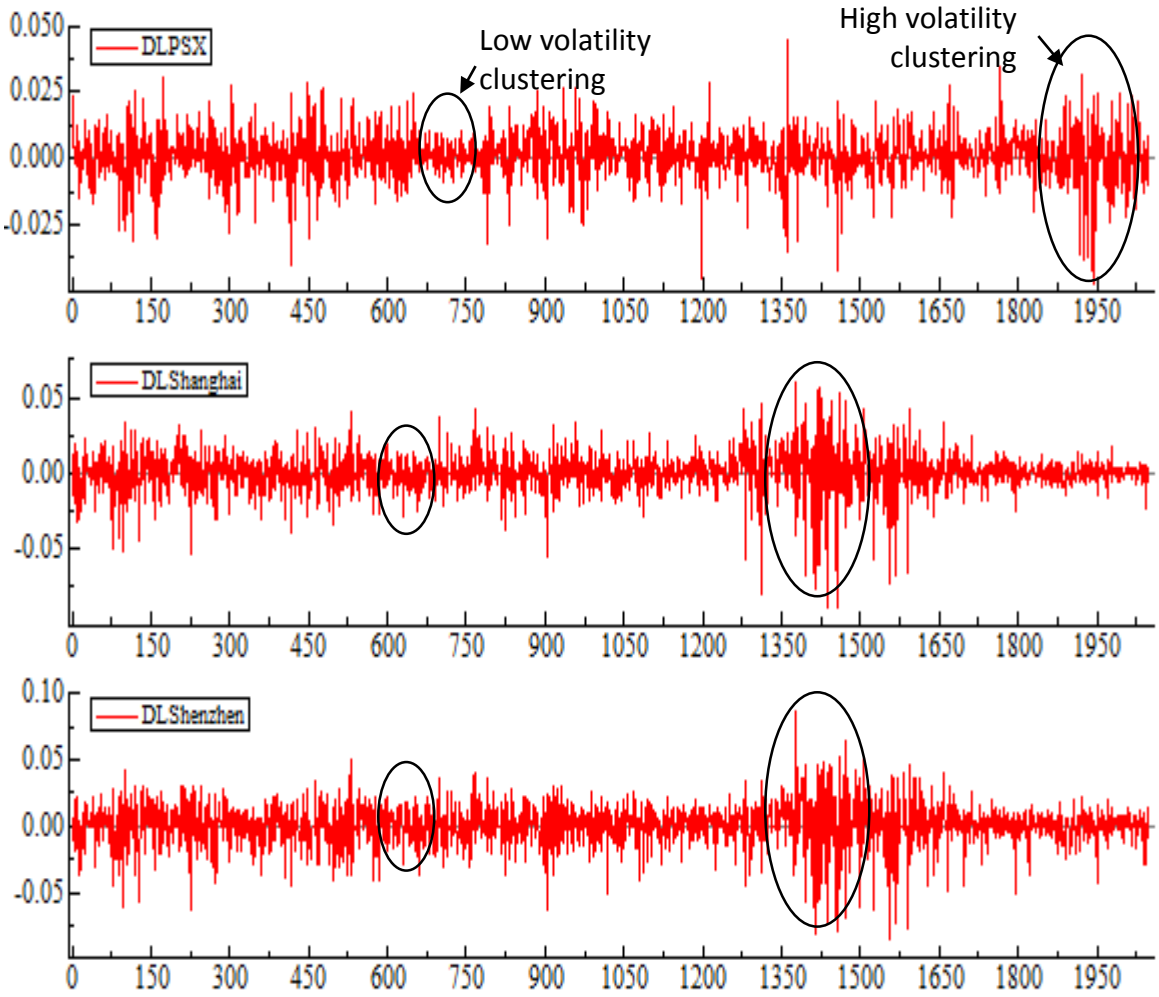

Figure 4.1(b) Graphical visualisation of return series

Figure 4.1(b) represents the returns series of Pakistan stock Exchange, Shanghai stock market and Shenzhen stock markets. As mentioned earlier the series at level are trendy and it is impossible for robust model estimations if the series are trendy, to deal with this trend we use log difference return series. In return series there is Hetroscedasticity problem as spread does not remain constant. The spread in financial econometrics is

termed as volatility. The circles in figure shows the high and low volatility clusters indicating the ARCH (Auto-Regressive Conditional Hetroscedasticity) effect in the series. "According to efficient market hypothesis return series shows mean reversion behaviour and are unpredictable" that's why the return series shows the mean reversion behaviour.

Figure 4.1(c) Graphical inspection of Squared return series:

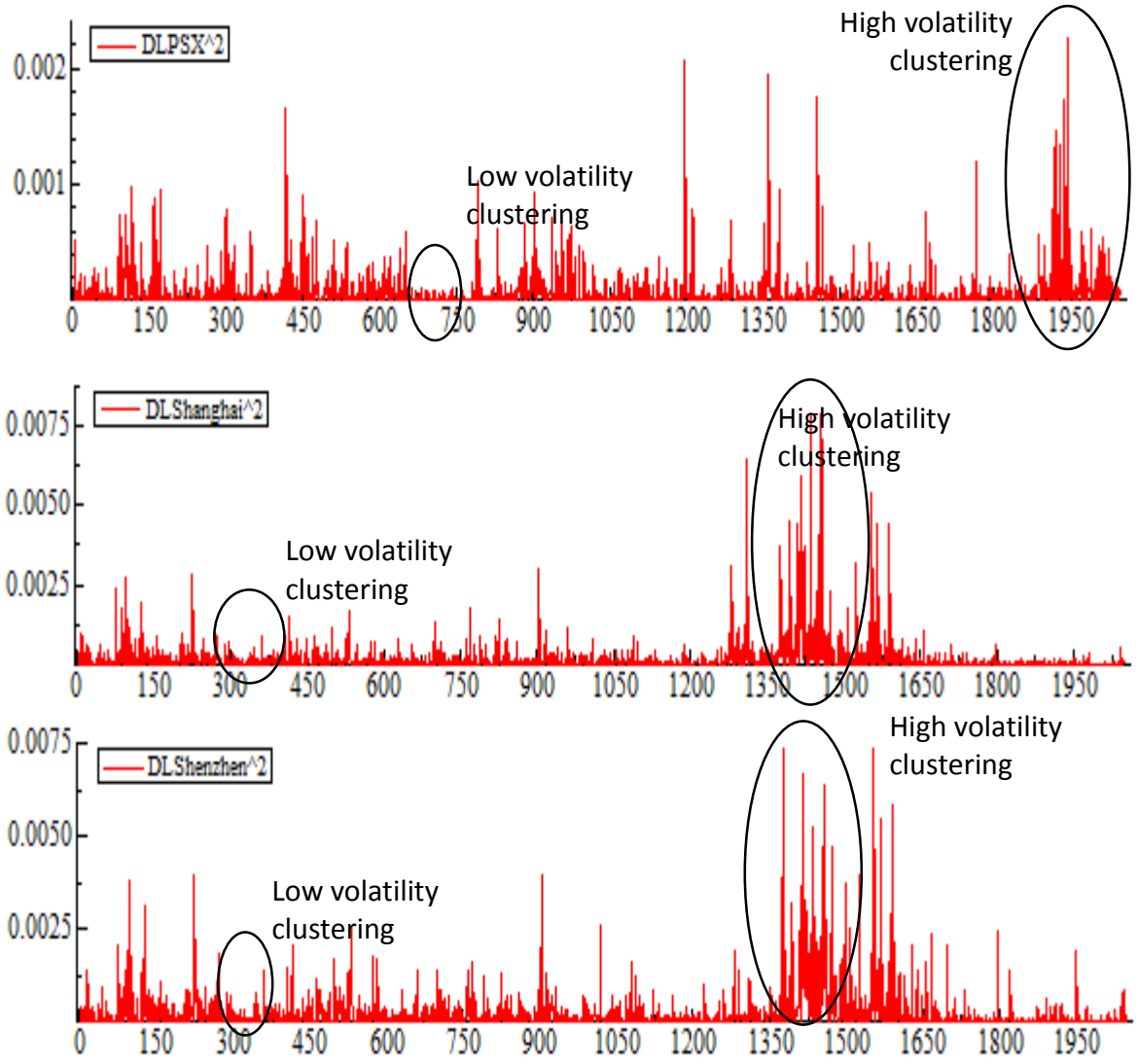

Figure 4.1(C) Graphical visualisation of squared return series

The figure shows squared return series of all three stock markets. Return series square is known as 'return series variance' means the graph illustrate the dispersion. Whereas

circles pointing out high and low volatility clusters. Moreover, the figure illustrate outliers are contributing more to the high volatility.

Figure 4.1(d) Graph of distribution:

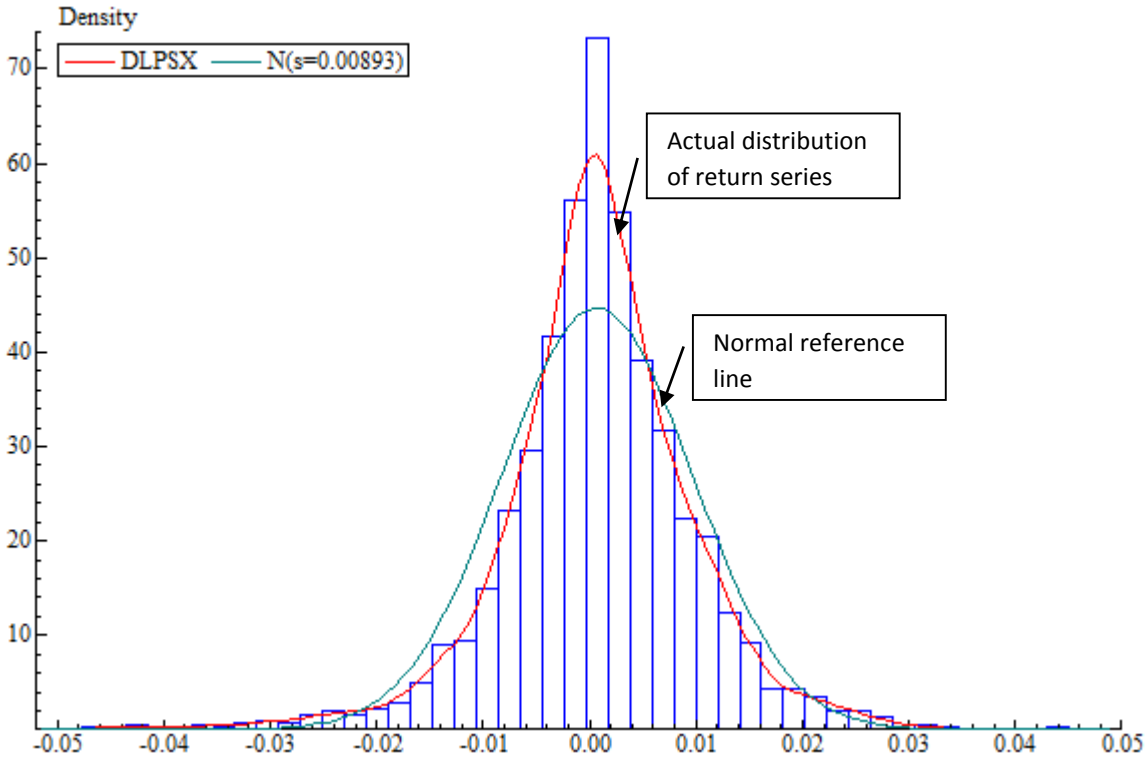

Figure 4.1(d) Distribution graph

The above figure is showing the distribution of return series of Pakistan stock exchange (PSX)

The return series distribution is not normal, have heavy tails and is leptokurtic. This is because of different responses of market players to same information prevailed in the market. Whereas histogram explaining the outliers i.e. extreme values. The below line (green line) is normal reference while the above one indicating the actual series distribution. The graph also shows that the return series is unimodel and hence can be optimised in contrast of series at level. In the same way we can analyse the other two return series as well.

Figure 4.1(e) plots for ACF and PACF of return series:

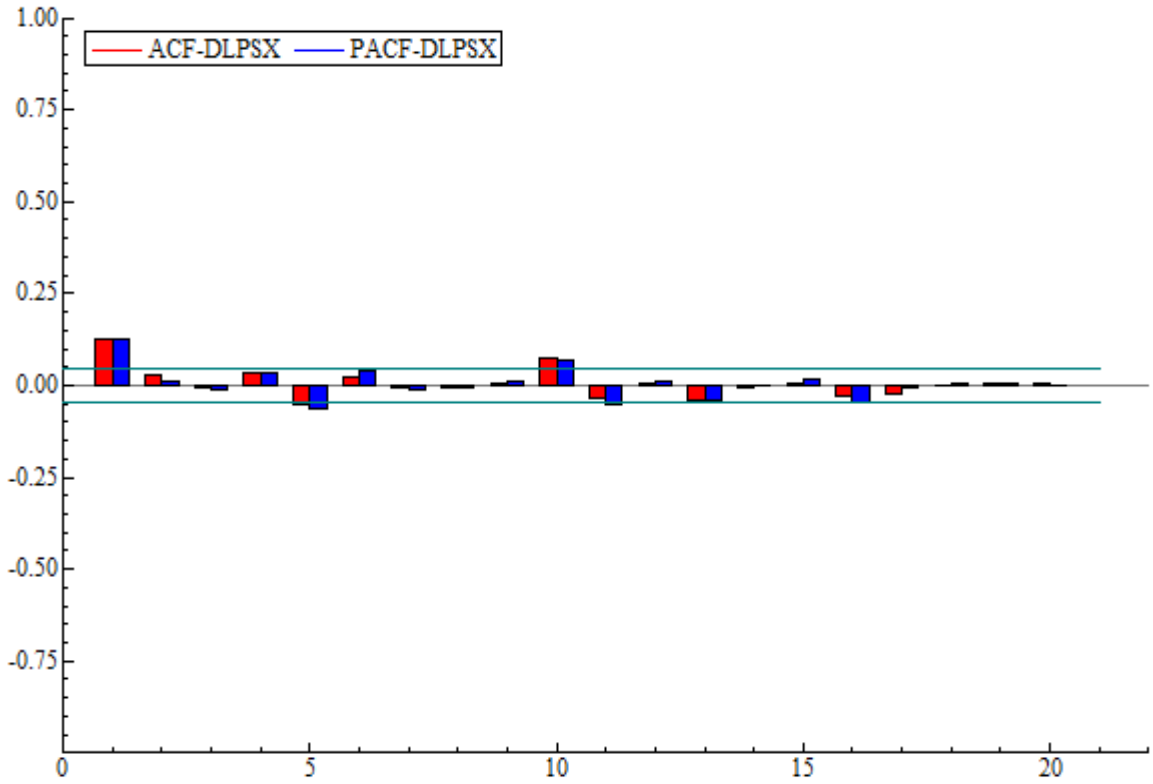

Figure 4.1(e) ACF and PACF plots

Figure 4.1(e) exhibit Auto correlation function and partial autocorrelation for the return series of Pakistan stock market. The green lines show 95% confidence level, if any bar of ACF or PACF is out of the bandwidth it means that at that lag values are auto correlated or in simple words values are significantly higher than '0'. The ARMA (p, q) process determines through the significant lags of ACF and PACF. The AR (p) process has specified through PACF while MA (q) process specify through ACF. These lags form ARMA (p, q) process in conditional mean equation. The graph illustrates significant ACF and PACF lags it means there is autocorrelation and Partial Autocorrelation in return series of PSX. The same analysis of ACF and PACF for other two return series also shows some significant lag values and thus indicate the autocorrelation and Partial autocorrelation in those series as well.

Figure 4.1(f) plots for ACF and PACF for Squared return series (Variance):

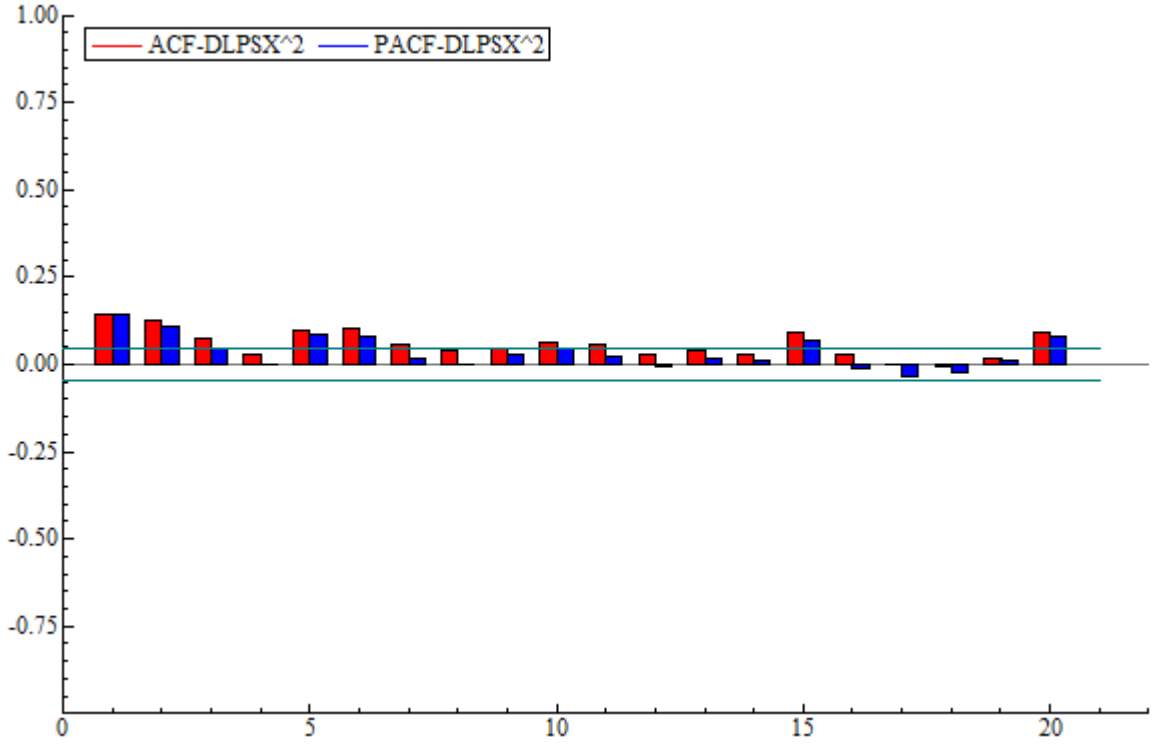

Figure 4.1(f) Graph of ACF and PACF for variance

The above figure shows the graph of ACF and PACF for variance series for Pakistan stock market (formally KSE-100) i.e. squared return series. The values significantly vary from zero indicating the auto correlation and partial autocorrelation in variance series. These critical lags help to structure the GARCH (p, q) process in conditional variance equation.

4.2 Descriptive Statistics:

(Table 4.2) The descriptive statistics of stock market indices returns series give a brief view of about behaviour of stock markets. Different tests has been run in this regard i.e. KPSS, Skewness test, Jarque-Bera, LM-ARCH test, Q^2-stat & Q-stat. The mean of all return series are '0' it shows that the returns are following mean reversion behaviour. The standard deviation depicts the spreadness of series, the higher the value of standard deviation higher is the deviation from mean of said series The null hypothesis of all tests are rejected as p-value (in parenthesis) for all tests are less than

0.05 i.e. 5%. Skewness tells us about the asymmetry behaviour of return series. The distribution of all three stock markets under study are negatively skewed which means that there returns are less than average returns. Jarque-bera test shows the series is not normal (as we reject the null hypothesis of normality). Excess kurtosis shows that all three stock markets are leptokurtic, whereas Q^2-stat and LM-ARCH test validate each other that there is serial correlation exist in the squared return series of Pakistani and Chinese stock markets indices (as we reject the null hypothesis of no autocorrelation in the series, p-value<0.05). Q-stat of return series are significant, rejecting the null hypothesis of no autocorrelation in raw series. KPSS test is a unit root test and it is for stationary checking. As KPSS stat value of PSX, Shanghai and Shenzhen doesn't cross the critical values at 5% confidence level so from results we came to the point that the returns series of stock markets under study are stationary. On the basis of these stats we can conclude that our returns series are leptokurtic, have heavy tails, not normal, skewed, have ARCH effect and stationary.

Table 4.2 descriptive statistics

Variables	Descriptive statistics								
	Mean	**Standard deviation**	**Skewness**	**Jarque Bera**	**Excess Kurtosis**	**Q-stat (5)**	**Q^2-stat (5)**	**ARCH 1-2**	**KPSS**
PSX	0.000	0.00893	-0.44548 (0.000)	862.84 (0.000)	3.0533 (0.000)	42.06 (0.00)	108.12 (0.00)	34.135 (0.00)	0.2028 C.V 5%=0.463
Shanghai	0.000	0.013521	-0.96960 (0.000)	4391.5 (0.000)	6.9085 (0.000)	12.81 (0.02)	531.15 (0.00)	119.86 (0.00)	0.196485 C.V 5%=0.463
Shenzhen	0.000	0.016175	-0.78684 (0.000)	1419.1 (0.000)	3.7632 (0.000)	14.44 (0.01)	562.75 (0.00)	122.25 (0.00)	0.127868 C.V 5%=0.463

Null Hypotheses (All H_0's are for n^{th} order)

H_0 for KPSS: Return series is I (0),

H_0 for Q-stat: N0 serial autocorrelation.

H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.

H_0 for JB test: normal. Series distribution.

H_0 for LM_ARCH test: there is no ARCH effect.

H_0 for Skewness: The series is symmetric

Excess kurtosis: The series is Meso-kurtic

'P' values are in the parenthesis.

4.3 Model specification:

Massive empirical studies have been found on volatility modelling and it's been a major issue for market players, academicians, policy makers and portfolio managers. The volatility modelling and predictability is still a challenge for Researchers. This section presents the volatility models of stock markets (under study) which make us able to recognise the data making process for whole return series under study, so that it will be helpful to understand the structure of mean and volatility equations of financial return series. Many Researchers in past used GARCH type models for modelling volatility, the studies employed ARCH-GARCH family models i.e. GARCH, GJR, E-GARCH, Multivariate-GARCH etc. to forecast volatility and for volatility modelling. [Wang and Firth (2004); Qayyum (2006); Sajid et al. (2012); Ghoss and Saud (2014), Jabeen and Saud (2014); Huo and Ahmad (2016)]. In this study we employed GARCH (p, q) and GJR-GARCH (p, q) model for modelling volatility and exploring spillover effect. Thanks to its distinctive characteristics most of researchers used these univariate models. These are best to give a better description of volatility modelling.

4.3(a) Volatility models for all return series:

Table 4.3(a) Volatility models for all return series

Return series / Parameters	PSX ARMA(1,0) GJR (1,1)	Shanghai-composite ARMA(0,0) GARCH (1,1)	Shenzhen-composite ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0	0.000828 (0.0000)	0.000374 (0.0405)	0.001053 (0.0001)
AR(1) r_1	0.174313 (0.000)	----------	----------
Conditional Variance Equation			
Constant α_0	8.123515 (0.0003)	0.006696 (0.0615)	0.019993 (0.0696)
ARCH(1) α_1	0.029494 (0.2258)	0.051819 (0.000)	0.059085 (0.0000)
GARCH(1) β_1	0.728374 (0.0000)	0.949547 (0.0000)	0.936453 (0.0000)
GJR(1) γ_1	0.309913 (0.0000)	----------	----------
t-distribution	5.565394 (0.0000)	3.773738 (0.0000)	4.689370 (0.0000)
Persistence of shock	0.912824	1.00137	0.99554

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

4.3(b) Residual **Testing**:

Table 4.3(b) post estimation results

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q^2-Stat (5)	Q^2-Stat (10)	LM - ARCH (1-2)	LM- ARCH (1-5)
PSX	217.64 (0.0000)	5.9523 (0.202)	15.933 (0.068)	3.84038 (0.279)	7.48578 (0.4852)	0.62429 (0.5357)	0.78532 (0.5602)
Shanghai	581.13 (0.0000)	2.7025 (0.745)	19.193 (0.037)	6.15156 (0.104)	10.8083 (0.2128)	2.7119 (0.0666)	1.2349 (0.2901)
Shenzhen	760.08 (0.0000)	4.2879 (0.508)	18.345 (0.049)	3.3290 (0.343)	5.1665 (0.7396)	0.67527 (0.5091)	0.61988 (0.6847)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Table 4.3(a) showing the estimated parameters of employed volatility models and describing the data generating process for return series. The most parameters are statistically significant at 5% level of significance. PSX return series follows ARMA (1, 0) process while Chinese stock markets return series have ARMA (0, 0) process, for PSX and Chinese stock markets GJR (1, 1), GARCH (1, 1) models are employed respectively. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Chinese markets. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1^{st} lag values. The t-distribution is significant which means the standardised error terms follows t-distribution. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.3(b) showing the residual testing of employed models that is to make sure no ARCH effect should be present in residuals. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.4 Tracing Information Transmission:

Under this section we enquire the linkages between Pakistan (PSX) and Chinese stock markets (Shanghai, Shenzhen). Following the technique of Hamao et al. (1990) we investigate the co-movements among these three stock markets. To answer the research questions, the data is sub-divided into 2 parts i.e. to analyse the pre and post CPEC announcement spillover effect between PSX and Chinese stock markets (Shanghai, Shenzhen). At first we investigate spillover effect among these financial markets by using whole data set i.e. daily data of stock markets indices from 4th January 2010 to 30th November 2017. In next step we separate data into two subparts for pre and post CPEC announcement analysis. For pre CPEC analysis data from 4th January 2010 to 20th of April 2015 has been utilised. As CPEC agreement based on 51 Memoranda of understandings (MOU's) of $46 billion was signed officialy on 20th of April 2015 when the honourable Chinese president 'Mr.Xi Jinping' visited Pakistan. Data from 21st April 2015 to 30th November 2017 is considered as Second subpart i.e. after announcement of CPEC project.

For Mean spillover the return of one market is introduced as a regressor in return of another market. For volatility spillover effect we will regress the volatility of one market with other market volatility, i.e. The Square of one market series is introduced in other market variance equation.

4.4.1 Exploring Mean Spillover effect for whole dataset:

Table 4.4.1(a) Mean spillover effect between PSX and Shanghai stock exchange (bidirectional analysis for whole data set):

Table 4.4.1(a) shows the estimated parameters for return series when they are introduced in others mean equations to check the bidirectional mean spillover effect.

Table 4.4.1(a)

Return series / Parameters		Shanghai to PSX ARMA(1,0) GJR (1,1)	PSX to Shanghai ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.000811 (0.000)	0.000356 (0.0534)
DLShanghai(M) (a)	**DLPSX (M) (c)**	0.034442 (0.0088)	0.030688 (0.1236)
AR(1) r_1		0.174936 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		8.141921 (0.0002)	0.006866 (0.0567)
ARCH(1) α_1		0.025010 (0.2875)	0.051812 (0.0000)
GARCH(1) β_1		0.730702 (0.0000)	0.949363 (0.0000)
GJR(1) γ_1		0.311304 (0.0000)	----------
Persistence of shock		0.911364	1.00117

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0: a=0 and c=0 , No mean spillover effect,
Asymmetry effect H0: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.4.1(b)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	214.27 (0.000)	6.05839 (0.19483)	17.1906 (0.04581)	3.41802 (0.331550)	7.70760 (0.46254)	0.60470 (0.5463)	0.70084 (0.6228)
PSX to Shanghai	566.49 (0.000)	2.66621 (0.75128)	19.3961 (0.03551)	5.85489 (0.1188)	10.6628 (0.22154)	2.5704 (0.0768)	1.1745 (0.3192)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: normal distribution of series.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Table shows that parameter 'a' (shanghai to PSX) is significant at 5% of significance level in conditional mean equation of Pakistan stock market, as we reject the null hypothesis of 'insignificance'. It means that there exist a mean spillover effect from shanghai to PSX. Results also depicts that the parameter 'c' of PSX in conditional mean equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high (12%). So there is no mean spillover effect from PSX to SSE. Results shows that there is 3.4% mean spillover effect from Shanghai to PSX. In simple words there exist a unidirectional spillover from Shanghai SE to PSX. This co-movement between markets indicate a direct linkage between both markets. The most parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shanghai return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shanghai SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1^{st} lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.4.1(b) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-

ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.4.1(c) Mean spillover effect between PSX and Shenzhen SE (bidirectional analysis for whole data set):

Table 4.4.1(c) shows the estimated parameters for return series when they are introduced in others mean equations to check the bidirectional mean spillover effect.

Table 4.4.1(c)

Parameters \ Return series		Shenzhen to PSX ARMA(1,0) GJR (1,1)	PSX to Shenzhen ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.000811 (0.000)	0.001020 (0.0001)
DLShenzhen(M) (e)	**DLPSX (M) (g)**	0.02425 (0.0225)	0.044480 (0.1539)
AR(1) r_1		0.175995 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		8.159819 (0.0003)	0.020118 (0.0676)
ARCH(1) α_1		0.026681 (0.2607)	0.059278 (0.0000)
GARCH(1) β_1		0.729324 (0.0000)	0.936256 (0.0000)
GJR(1) γ_1		0.310179 (0.0000)	----------
Persistence of shock		0.911094	0.99553

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0: e=0 and g=0 , No mean spillover effect,
Asymmetry effect H_0: γ_i= 0 No leverage effect.
'P' values are in the parenthesis

Residual Testing:

Table 4.4.1(d)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shenzhen to PSX	213.54 (0.000)	5.96993 (0.20140)	16.6918 (0.05376)	3.39937 (0.33405)	7.48292 (0.48553)	0.59626 (0.5510)	0.69839 (0.6247)
PSX to Shenzhen	753.78 (0.000)	4.39061 (0.49465)	18.0686 (0.05381)	3.01532 (0.38926)	5.01546 (0.75592)	0.5999 (0.5489)	0.5639 (0.7277)

Null Hypotheses(All H_0's are for n^{th} order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Furthermore, it shows that parameter 'e' (Shenzhen to PSX) is significant at 5% of significance level in conditional mean equation of Pakistan stock market, as we reject the null hypothesis of 'insignificance'. It means that there exist a mean spillover effect from Shenzhen to PSX. Similarly Results also depicts that the parameter 'g' of PSX in conditional mean equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high (15%). So there is no mean spillover effect from PSX to Shenzhen SE. Results shows that there is 2.6% mean spillover effect from Shanghai to PSX. In simple words there exist a unidirectional spillover from Shenzhen SE to PSX. This co-movement between markets indicate a direct linkage between both markets. The most parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shenzhen return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shenzhen SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1^{st} lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three

stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.4.1(d) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.4.2 Exploring Volatility Spillover effect for whole data:

Table 4.4.2(a) Volatility spillover effect between PSX and Shanghai stock exchange (bidirectional analysis for whole data set):

Table 4.4.2(a) shows the estimated parameters of conditional mean and conditional variance equations when squared return series introduced in each other variance equations to check the bidirectional volatility spillover effect.

Table 4.4.2(a)

Return series / Parameters		Shanghai to PSX ARMA(1,0) GJR (1,1)	PSX to Shanghai ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.000828 (0.000)	0.000376 (0.0392)
AR(1) r_1		0.174709 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		7.9391 (0.0001)	0.008920 (0.0393)
DLshanghai^2(V) (b)	**DLPSX^2(V) (d)**	0.00410 (0.1419)	-0.002028 (0.3447)
ARCH(1) α_1		0.03291 (0.1760)	0.050986 (0.0000)

GARCH(1) β_1	0.71375 (0.0000)	0.949741 (0.0000)
GJR(1) γ_1	0.32236 (0.0000)	----------
Null Hypotheses(All H_0's are for nth order) H_0 for AR(p) : r_i= 0 AR Process is insignificant, H_0 for MA (q) : m_i= 0, MA process is insignificant, H_0 for ARCH: α_i= 0 No ARCH effect, H_0 for GARCH: β_i= 0 No GARCH effect, H_0 for Asymmetry affect: γ_i= 0 No leverage effect. volatility spillover H_0: b=0 and d=0 , No volatility spillover effect, H_0 for asymmetry affect: γ_i= 0 No leverage effect. 'P' values are in the parenthesis.		

Residual Testing:

Table 4.4.2(b)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	214.73 (0.000)	5.74753 (0.21881)	16.2956 (0.06095)	4.30103 (0.23073)	8.5939 (0.37770)	0.89834 (0.4074)	0.88149 (0.4926)
PSX to Shanghai	582.11 (0.000)	2.64114 (0.75510)	19.2241 (0.03750)	6.7449 (0.08048)	11.3932 (0.18039)	3.0218 (0.0489)	1.3551 (0.2384)
Null Hypotheses(All H_0's are for nth order) H_0 for Q-stat: N0 serial autocorrelation. H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series. H_0 For JB test: distribution of series is normal. H_0 for LM_ARCH test: there is no ARCH effect. 'P' values are in the parenthesis							

Moreover, it shows that parameter 'b' (Shanghai to PSX) is insignificant at 5% of significance level in conditional variance equation of Pakistan stock market, as we do not reject the null hypothesis of 'insignificance'. It means that volatility spillover effect from Shanghai to PSX doesn't exist. Similarly Results also depicts that the parameter 'd' of PSX in conditional variance equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high (34%). So there is no volatility spillover effect from PSX to Shanghai SE. Simply we can conclude that there is no volatility spillover effect between both markets neither PSX to shanghai nor from shanghai to PSX. The other parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shanghai return

series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shanghai SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock couldn't calculate because there is a regresser in conditional variance equation.

Table 4.4.2(b) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to confirm the validity of model.

4.4.2(c) Volatility spillover effect between PSX and Shenzhen SE (bidirectional analysis for whole data set):

Table 4.4.2(c) shows the estimated parameters of conditional mean and conditional variance equations when squared return series introduced in each other variance equations to check the bidirectional volatility spillover effect.

Table 4.4.2(c)

Return series / Parameters	Shenzhen to PSX ARMA(1,0) GJR (1,1)	PSX to Shenzhen ARMA(0,0) GARCH (1,1)
Conditional Mean Equation		
Constant α_0	0.000828 (0.000)	0.001054 (0.0001)

AR(1) r_1	0.174908 (0.0000)	----------
Conditional Variance Equation		
Constant α_0	7.812075 (0.0001)	0.024334 (0.0520)
DLshenzhen^2(V) (f) / **DLPSX^2(V) (h)**	0.004649 (0.1140)	-0.004712 (0.4864)
ARCH(1) α_1	0.030014 (0.2099)	0.058690 (0.0000)
GARCH(1) β_1	0.709852 (0.0000)	0.936532 (0.0000)
GJR(1) γ_1	0.326680 (0.0000)	----------

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
volatility spillover H_0: f=0 and h=0 , No spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.4.2(d)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shenzhen to PSX	219.87 (0.000)	5.56422 (0.23414)	16.0327 (0.06620)	4.13863 (0.24687)	8.89787 (0.35098)	0.93566 (0.3925)	0.84940 (0.5146)
PSX to Shenzhen	833.91 (0.000)	4.37613 (0.49662)	18.6181 (0.04539)	3.35676 (0.33981)	4.94336 (0.76361)	0.64899 (0.5227)	0.62559 (0.6803)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Moreover, it shows that parameter 'f' (Shenzhen to PSX) is insignificant at 5% of significance level in conditional variance equation of Pakistan stock market (p-value 11%), as we do not reject the null hypothesis of 'insignificance'. It means that volatility spillover effect from Shenzhen to PSX doesn't exist. Similarly Results also depicts that the parameter 'h' of PSX in conditional variance equation of Shenzhen Stock market is

insignificant i.e. the chance of occurrence of null hypothesis is high (48%). So there is no volatility spillover effect from PSX to Shenzhen SE. Simply we can conclude that there is no volatility spillover effect between both markets neither PSX to Shenzhen nor from Shenzhen to PSX. The other parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shenzhen return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shenzhen SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock couldn't calculate because there is a regresser in conditional variance equation.

Table 4.4.2(d) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to confirm the validity of model.

4.5 Exploring Mean Spillover effect for Pre-CPEC period (4th Jan 2010 to 20th April 2015):

Table 4.5.1(a) Mean spillover effect between PSX and Shanghai stock exchange (bidirectional analysis for Pre-CPEC period):

Table 4.5.1(a) shows the estimated parameters for return series when they are introduced in others mean equations to check the bidirectional mean spillover effect.

Table 4.5.1(a)

Return series / Parameters		Shanghai to PSX ARMA(1,0) GJR (1,1)	PSX to Shanghai ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.001038 (0.000)	0.000141 (0.6036)
DLShanghai(M) (a)	**DLPSX (M) (c)**	0.014591 (0.3859)	0.053696 (0.1366)
AR(1) r_1		0.139495 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		8.119308 (0.0001)	0.015662 (0.1318)
ARCH(1) α_1		0.032099 (0.2218)	0.024506 (0.0025)
GARCH(1) β_1		0.727815 (0.0000)	0.966548 (0.0000)
GJR(1) γ_1		0.304714 (0.0000)	----------
Persistence of shock		0.912271	0.99105

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0: a=0 and c=0 , No mean spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.5.1(b)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	143.83 (0.000)	4.45840 (0.34750)	11.8740 (0.22050)	1.56377 (0.66763)	7.63970 (0.46943)	0.31531 (0.7296)	0.31334 (0.9051)
PSX to Shanghai	375.73 (0.000)	0.604384 (0.73919)	17.4847 (0.01452)	10.4041 (0.015425)	13.1686 (0.02185)	1.9198 (0.0388)	2.1678 (0.0553)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Table shows that parameter ‘a’ (shanghai to PSX) is insignificant at 5% of significance level in conditional mean equation of Pakistan stock market, as we do not reject the null hypothesis of ‘insignificance’. It means that there is no mean spillover effect from shanghai to PSX in pre-CPEC period. Results also depicts that the parameter ‘c’ of PSX in conditional mean equation of Shanghai Stock market is also insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no mean spillover effect from PSX to SSE either. In simple words there exist no unidirectional or bidirectional spillover between both financial markets in pre-CPEC period. The most parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shanghai return series have ARMA (0, 0) process. ‘γ’ term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shanghai SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1^{st} lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.5.1(b) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation (at 1% level of significance). Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it

accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.5.1(c) Mean spillover effect between PSX and Shenzhen SE (bidirectional analysis for Pre-CPEC period):

Table 4.5.1(c) shows the estimated parameters for return series when they are introduced in others mean equations to check the bidirectional mean spillover effect.

Table 4.5.1(c)

Parameters \ Return series		Shenzhen to PSX ARMA(1,0) GJR (1,1)	PSX to Shenzhen ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.001036 (0.000)	0.001026 (0.0055)
DLShenzhen(M) (e)	**DLPSX (M) (g)**	0.014385 (0.3226)	0.048096 (0.2752)
AR(1) r_1		0.140181 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		8.101169 (0.0001)	0.468500 (0.0927)
ARCH(1) α_1		0.032015 (0.2214)	-0.031293 (0.5563)
GARCH(1) β_1		0.728249 (0.0000)	0.702158 (0.0000)
GJR(1) γ_1		0.303663 (0.0000)	----------
Persistence of shock		0.912095	0.99553

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0:e=0 and g=0 , No mean spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.5.1(d)

Parameter \ Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shenzhen to PSX	142.26 (0.000)	4.44252 (0.34941)	11.8428 (0.22231)	1.50875 (0.68025)	7.58327 (0.47519)	0.29782 (0.7425)	0.30222 (0.9117)
PSX to Shenzhen	189.04 (0.000)	4.86656 (0.43238)	32.3180 (0.01035)	3.84074 (0.27918)	10.5788 (0.22672)	1.6877 (0.1853)	0.5639 (0.74254)

Null Hypotheses(All H_0's are for n^{th} order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Furthermore, it shows that parameter 'e' (Shenzhen to PSX) is insignificant at 5% of significance level in conditional mean equation of Pakistan stock market, as we don't reject the null hypothesis of 'insignificance'. It means that there exist no mean spillover effect from Shenzhen to PSX. Similarly Results also depicts that the parameter 'g' of PSX in conditional mean equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no mean spillover effect from PSX to Shenzhen SE either. In simple words there exist neither unidirectional nor bidirectional spillover from PSX to Shenzhen SE and Shenzhen SE to PSX In pre-CPEC period. The others parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shenzhen return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shenzhen SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.5.1(d) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for

normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.5.2 Exploring Volatility Spillover effect for pre-CPEC period:

Table 4.5.2(a) Volatility spillover effect between PSX and Shanghai stock exchange (bidirectional analysis for pre CPEC period):

Table 4.5.2(a) shows the estimated parameters of conditional mean and conditional variance equations when squared return series introduced in each other variance equations to check the bidirectional volatility spillover effect.

Table 4.5.2(a)

Return series / Parameters	Shanghai to PSX ARMA(1,0) GJR (1,1)	PSX to Shanghai ARMA(0,0) GARCH (1,1)
Conditional Mean Equation		
Constant α_0	0.001050 (0.000)	0.000217 (0.4074)
AR(1) r_1	0.141452 (0.0000)	----------
Conditional Variance Equation		
Constant α_0	7.413797 (0.0003)	0.015583 (0.1685)
DLshanghai^2(V) (b) / **DLPSX^2(V) (d)**	0.008057 (0.3658)	0.001850 (0.8212)
ARCH(1) α_1	0.033285 (0.2010)	0.024400 (0.0039)
GARCH(1) β_1	0.718639 (0.0000)	0.965758 (0.0000)
GJR(1) γ_1	0.311747 (0.0000)	----------

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
volatility spillover H_0: b=0 and d=0 , No spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.5.2(b)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	127.69 (0.000)	4.27926 (0.36952)	12.0660 (0.20961)	2.11511 (0.54886)	8.39286 (0.39606)	0.43505 (0.6473)	0.42182 (0.8338)
PSX to Shanghai	395.50 (0.000)	2.72366 (0.74249)	27.7289 (0.01994)	11.0039 (0.01170)	17.7756 (0.02297)	5.0063 (0.0168)	2.2903 (0.0437)

Null Hypotheses(All H_0's are for n^{th} order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Moreover, it shows that parameter 'b' (Shanghai to PSX) is insignificant at 5% of significance level in conditional variance equation of Pakistan stock market, as we do not reject the null hypothesis of 'insignificance'. It means that volatility spillover effect from Shanghai to PSX doesn't exist. Similarly Results also depicts that the parameter'd' of PSX in conditional variance equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no volatility spillover effect from PSX to Shanghai SE. Simply we can conclude that there is no volatility spillover effect between both markets neither PSX to shanghai nor from shanghai to PSX in pre-CPEC period. The other parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shanghai return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shanghai SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1^{st} lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock couldn't calculate because there is a regresser in conditional variance equation.

Table 4.5.2(b) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant at 1% level of significance i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to confirm the validity of model.

4.5.2(c) Volatility spillover effect between PSX and Shenzhen SE (bidirectional analysis for pre-CPEC period):

Table 4.5.2(c) shows the estimated parameters of conditional mean and conditional variance equations when squared return series introduced in each other variance equations to check the bidirectional volatility spillover effect.

Table 4.5.2(c)

Return series / Parameters		Shenzhen to PSX ARMA(1,0) GJR (1,1)	PSX to Shenzhen ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.001056 (0.000)	0.001107 (0.0026)
AR(1) r_1		0.143693 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		6.075212 (0.0001)	0.098436 (0.1989)
DLshenzhen^2(V) (f)	**DLPSX^2(V) (h)**	0.018672 (0.0097)	-0.000769 (0.9610)
ARCH(1) α_1		0.022381 (0.3941)	0.045092 (0.0143)
GARCH(1) β_1		0.708383 (0.0000)	0.906820 (0.0000)
GJR(1) γ_1		0.317609 (0.0000)	----------

Null Hypotheses(All H_0's are for n^{th} order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,

H_0 for Asymmetry affect: γ_i= 0 No leverage effect. volatility spillover H_0: a=0 and c=0 , No spillover effect, H_0 for asymmetry affect: γ_i= 0 No leverage effect. 'P' values are in the parenthesis.

Residual Testing:

Table 4.5.2(d)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shenzhen to PSX	123.29 (0.000)	4.08394 (0.39476)	11.4919 (0.24349)	2.55699 (0.46508)	9.30138 (0.31751)	0.56043 (0.5711)	0.50607 (0.7718)
PSX to Shenzhen	181.97 (0.000)	4.03649 (0.54417)	29.7647 (0.001935)	4.09906 (0.25096)	6.64664 (0.57519)	1.5509 (0.2124)	0.82090 (0.5347)
Null Hypotheses(All H_0's are for n^{th} order) H_0 for Q-stat: N0 serial autocorrelation. H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series. H_0 For JB test: distribution of series is normal. H_0 for LM_ARCH test: there is no ARCH effect. 'P' values are in the parenthesis							

Moreover, it shows that parameter 'f' (Shenzhen to PSX) is significant at 5% of significance level in conditional variance equation of Pakistan stock market, as we reject the null hypothesis of 'insignificance'. It means that there is volatility spillover effect from Shenzhen to PSX in pre-CPEC period. Similarly Results also depicts that the parameter 'h' of PSX in conditional variance equation of Shenzhen Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no volatility spillover effect from PSX to Shenzhen SE. The other parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shenzhen return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shenzhen SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the

return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock couldn't calculate because there is a regresser in conditional variance equation.

Table 4.5.2(d) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to confirm the validity of model.

4.6 Post CPEC Analysis:

4.6.1 Exploring Mean Spillover effect for Post-CPEC period (21st April 2015 to 30th November 2017):

Table 4.6.1(a) Mean spillover effect between PSX and Shanghai stock exchange (bidirectional analysis for Post-CPEC period):

Table 4.6.1(a) shows the estimated parameters for return series when they are introduced in others mean equations to check the bidirectional mean spillover effect.

Table 4.6.1(a)

Return series / Parameters		Shanghai to PSX ARMA(1,0) GJR (1,1)	PSX to Shanghai ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.000364 (0.2966)	0.000573 (0.0234)
DLShanghai(M) (a)	**DLPSX (M) (c)**	0.052244 (0.0059)	0.017557 (0.4683)
AR(1) r_1		0.243441 (0.0000)	----------
Conditional Variance Equation			
Constant α_0		7.990838 (0.1422)	0.009301 (0.0523)
ARCH(1) α_1		0.007920 (0.8822)	0.080329 (0.0015)

GARCH(1) β_1	0.741765 (0.0000)	0.917550 (0.0000)
GJR(1) γ_1	0.319071 (0.0122)	----------
Persistence of shock	0.909221	0.99788

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0: a=0 and c=0 , No mean spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.6.1(b)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	76.781 (0.000)	6.65730 (0.15514)	12.8806 (0.16808)	4.30726 (0.23014)	11.0531 (0.19870)	0.23947 (0.7871)	0.86534 (0.5040)
PSX to Shanghai	254.60 (0.000)	1.38872 (0.92554)	9.04609 (0.52773)	0.353320 (0.94970)	2.28717 (0.97091)	0.029332 (0.9711)	0.060437 (0.9976)

H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Table shows that parameter 'a' (shanghai to PSX) is significant at 5% of significance level in conditional mean equation of Pakistan stock market, as we reject the null hypothesis of 'insignificance'. It means that there exist a mean spillover effect from shanghai to PSX in post-CPEC period. Results also depicts that the parameter 'c' of PSX in conditional mean equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no mean spillover effect from PSX to SSE either. In simple words there exist unidirectional spillover between both financial markets in post-CPEC period. The most parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shanghai return series have ARMA (0, 0) process. 'γ' term capturing the

asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shanghai SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.6.1(b) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation (at 1% level of significance). Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.6.1(c) Mean spillover effect between PSX and Shenzhen SE (bidirectional analysis for Post-CPEC period):

Table 4.6.1(c) shows the estimated parameters for return series when they are introduced in others mean equations to check the bidirectional mean spillover effect.

Table 4.6.1(c)

Return series / Parameters		Shenzhen to PSX ARMA(1,0) GJR (1,1)	PSX to Shenzhen ARMA(0,0) GARCH (1,1)
Conditional Mean Equation			
Constant α_0		0.000363 (0.2994)	0.000862 (0.0180)
DLShenzhen(M) (e)	**DLPSX (M) (g)**	0.030502 (0.0394)	0.024257 (0.6073)
AR(1) r_1		0.243089 (0.0000)	----------

Conditional Variance Equation		
Constant α_0	8.076810 (0.1765)	0.016296 (0.1899)
ARCH(1) α_1	0.007390 (0.8947)	0.077710 (0.0035)
GARCH(1) β_1	0.740258 (0.0000)	0.925124 (0.0000)
GJR(1) γ_1	0.320621 (0.0205)	----------
Persistence of shock	0.907959	1.00283

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0: e=0 and g=0 , No mean spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.6.1(d)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shenzhen to PSX	75.625 (0.000)	6.41719 (0.17008)	11.9180 (0.21797)	4.32879 (0.22808)	10.7704 (0.21505)	0.26200 (0.7696)	0.85767 (0.5093)
PSX to Shenzhen	769.56 (0.000)	3.15777 (0.67567)	7.73135 (0.65505)	0.703083 (0.87247)	2.49438 (0.96199)	0.10532 (0.9000)	0.14245 (0.9822)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Furthermore, it shows that parameter 'e' (Shenzhen to PSX) is significant at 5% of significance level in conditional mean equation of Pakistan stock market, as we reject the null hypothesis of 'insignificance'. It means that there exist a mean spillover effect from Shenzhen to PSX. Similarly Results also depicts that the parameter 'g' of PSX in conditional mean equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no mean spillover effect from PSX to

Shenzhen SE. In simple words there exist a unidirectional spillover effect from Shenzhen SE to PSX In post-CPEC period. The others parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shenzhen return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shenzhen SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.6.1(d) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.6.2 Exploring Volatility Spillover effect for post-CPEC period:

Table 4.6.2(a) Volatility spillover effect between PSX and Shanghai stock exchange (bidirectional analysis for post CPEC period):

Table 4.6.2(a) shows the estimated parameters of conditional mean and conditional variance equations when squared return series introduced in each other variance equations to check the bidirectional volatility spillover effect.

Table 4.6.2(a)

Return series / Parameters	Shanghai to PSX ARMA(1,0) GJR (1,1)	PSX to Shanghai ARMA(0,0) GARCH (1,1)
Conditional Mean Equation		
Constant α_0	0.000383 (0.2626)	0.000567 (0.0242)
AR(1) r_1	0.236205 (0.0000)	----------
Conditional Variance Equation		
Constant α_0	8.126403 (0.1906)	0.009212 (0.0998)
DLshanghai^2(V) (b) / **DLPSX^2(V) (d)**	0.002590 (0.5295)	-0.000057 (0.9851)
ARCH(1) α_1	0.017850 (0.7921)	0.080222 (0.0016)
GARCH(1) β_1	0.715959 (0.0001)	0.917748 (0.0000)
GJR(1) γ_1	0.338578 (0.0340)	----------

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
volatility spillover H_0: a=0 and c=0 , No spillover effect,
H_0 for asymmetry affect: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.6.2(b)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	84.727 (0.000)	6.70447 (0.15235)	11.8873 (0.21973)	4.33362 (0.22761)	14.2345 (0.07585)	0.43802 (0.6455)	0.85834 (0.5088)
PSX to Shanghai	255.96 (0.000)	1.34777 (0.92994)	8.92076 (0.53963)	0.360635 (0.94824)	2.29437 (0.97063)	0.029527 (0.9709)	0.062405 (0.9974)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Moreover, it shows that parameter 'b' (Shanghai to PSX) is insignificant at 5% of significance level in conditional variance equation of Pakistan stock market, as we do

not reject the null hypothesis of 'insignificance'. It means that volatility spillover effect from Shanghai to PSX doesn't exist. Similarly Results also depicts that the parameter 'd' of PSX in conditional variance equation of Shanghai Stock market is insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no volatility spillover effect from PSX to Shanghai SE. Simply we can conclude that there is no volatility spillover effect between both markets neither PSX to shanghai nor from shanghai to PSX in post-CPEC period. The other parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shanghai return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shanghai SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1st lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock couldn't calculate because there is a regresser in conditional variance equation.

Table 4.6.2(b) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10th lags are insignificant at 1% level of significance i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to confirm the validity of model.

4.6.2(c) Volatility spillover effect between PSX and Shenzhen SE (bidirectional analysis for post-CPEC period):

Table 4.6.2(c) shows the estimated parameters of conditional mean and conditional variance equations when squared return series introduced in each other variance equations to check the bidirectional volatility spillover effect.

Table 4.6.2(c)

Return series / Parameters	Shenzhen to PSX ARMA(1,0) GJR (1,1)	PSX to Shenzhen ARMA(0,0) GARCH (1,1)
Conditional Mean Equation		
Constant α_0	0.000386 (0.2621)	0.000857 (0.0186)
AR(1) r_1	0.236728 (0.0000)	----------
Conditional Variance Equation		
Constant α_0	7.712841 (0.1891)	0.013873 (0.3298)
DLshenzhen^2(V) (f) / **DLPSX^2(V) (h)**	0.000857 (0.7446)	0.002354 (0.8156)
ARCH(1) α_1	0.007091 (0.9070)	0.077192 (0.0038)
GARCH(1) β_1	0.739466 (0.000)	0.925614 (0.0000)
GJR(1) γ_1	0.323966 (0.0322)	----------
Null Hypotheses(All H_0's are for nth order) H_0 for AR(p) : r_i= 0 AR Process is insignificant, H_0 for MA (q) : m_i= 0, MA process is insignificant, H_0 for ARCH: α_i= 0 No ARCH effect, H_0 for GARCH: β_i= 0 No GARCH effect, H_0 for Asymmetry affect: γ_i= 0 No leverage effect. volatility spillover H_0: a=0 and c=0 , No spillover effect, H_0 for asymmetry affect: γ_i= 0 No leverage effect. 'P' values are in the parenthesis.		

Residual Testing:

Table 4.6.2(d)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shenzhen to PSX	70.117 (0.000)	6.57691 (0.16000)	11.7668 (0.22677)	4.39447 (0.22189)	11.2341 (0.18878)	0.29451 (0.7450)	0.85732 (0.5095)
PSX to Shenzhen	735.78 (0.000)	3.07582 (0.68829)	7.68470 (0.65960)	0.762120 (0.85850)	2.61828 (0.95598)	0.10541 (0.9000)	0.15204 (0.9794)
Null Hypotheses(All H_0's are for nth order) H_0 for Q-stat: N0 serial autocorrelation. H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series. H_0 For JB test: distribution of series is normal.							

H_0 for LM_ARCH test: there is no ARCH effect. 'P' values are in the parenthesis

Moreover, it shows that parameter 'f' (Shenzhen to PSX) is insignificant at 5% of significance level in conditional variance equation of Pakistan stock market, as we do not reject the null hypothesis of 'insignificance'. It means that there is no volatility spillover effect from Shenzhen to PSX in post-CPEC period. Similarly Results also depicts that the parameter 'h' of PSX in conditional variance equation of Shenzhen Stock market is also insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no volatility spillover effect from PSX to Shenzhen SE. The other parameters are statistically significant at 5% level significance. PSX return series follows ARMA (1, 0) process while Shenzhen return series have ARMA (0, 0) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant only in PSX return series. Which means that current returns are correlated with future volatility, no effect found in Shenzhen SE. The significant term of AR (1) depicts that the current return series of Pakistan stock market depends on its 1^{st} lag values. The ARCH and GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock couldn't calculate because there is a regresser in conditional variance equation.

Table 4.6.2(d) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals after estimations. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the

null off no ARCH effect in residuals. This analysis helps us to confirm the validity of model.

4.7 Exploring Impact of 40% Shares buying by Chinese of Pakistan stock market on mean spillover effect: Post buying Analysis (Special case)

Chinese consortium on December 23, 2016 bids the highest price of 28rs per share to buy 40percent shares of Pakistan Stock Exchange. The value of transaction is approximately $85 million. The huge investment may impact the linkages between both neighbouring countries' financial markets and hence required to be investigated. For this purpose, the data is further divided in third part that is from December 23, 2016 to 30th of November 2017. Before exploring the mean spillover effect, the properties of return series are checked with two approaches, first graphical approach and secondly statistical approach.

4.7(a) Graphical inspection:

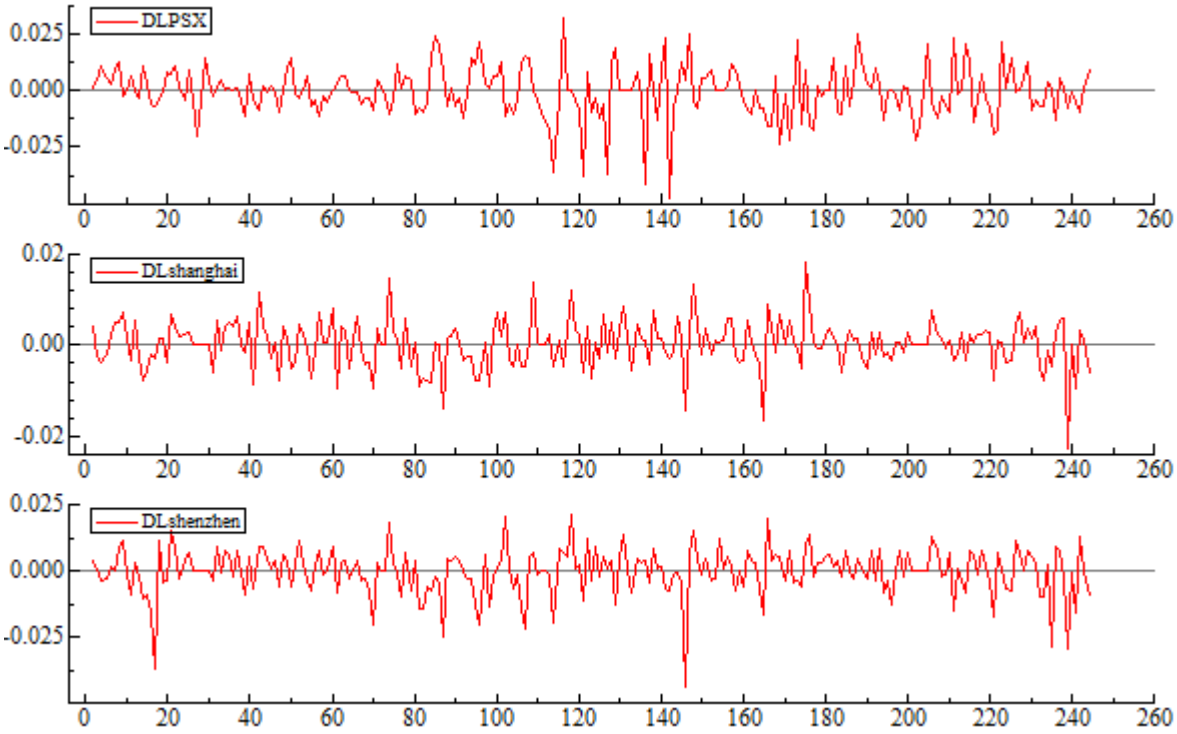

Figure 4.7(a) Actual series graphs for Post Chinese acquiring of PSX shares

The Graphs depicts no volatility clustering hence giving the idea that returns series have no ARCH effect in it.

4.7 (b) ACF and PACF plots:

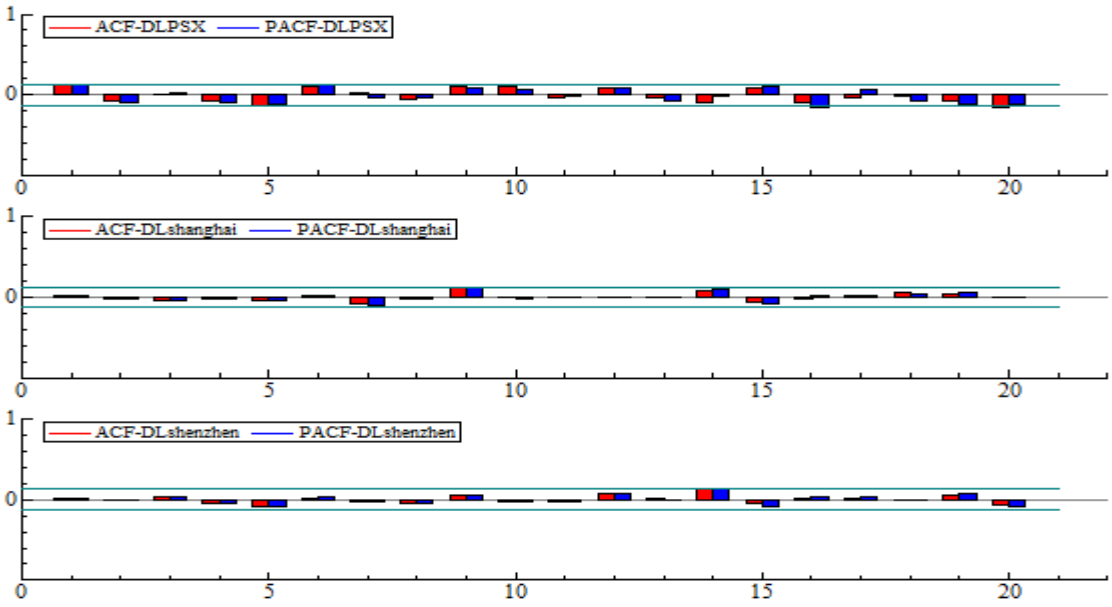

Figure 4.7 (b) shows the ACF and PACF plots for all three stock markets. The ARMA (p, q) process determines through the significant lags of ACF and PACF. The insignificant lags of AR & MA for all return series give insight that the series follows ARMA (0, 0) process.

Descriptive Statistics:

Table 4.7(c) shows the descriptive statistics of stock market indices returns series after 23rd December 2016. Different tests has been run in this regard i.e. KPSS, Skewness test, Jarque-Bera, LM-ARCH test, Q^2-stat & Q-stat. The mean of all return series are zero it shows that the returns are following mean reversion behaviour. The standard deviation depicts the spreadness of series, the higher the value of standard deviation higher is the deviation from mean of said series The null hypothesis of all tests for PSX series are rejected as p-value (in parenthesis) for all tests are less than 0.05 i.e. 5%. Whereas for Chinese's financial markets the Q-stat, Q^2-stat and LM-ARCH tests null hypothesises are significant i.e. there is no ARCH effect in the series. The distribution of all three stock markets under study are negatively skewed which means that there returns are less than average returns. Jarque-bera test shows the series is not normal (as we reject the null hypothesis of normality). Excess kurtosis shows that all three stock markets are leptokurtic, whereas. KPSS test is a unit root test and it is for stationary checking. As KPSS stat value of PSX, Shanghai and Shenzhen doesn't crossed the critical values at 5% confidence level so we can conclude that the returns series of stock markets under study are stationary I(0). On the basis of these stats we can conclude that our returns series are leptokurtic, have heavy tails, not normal, skewed, and stationary. Only PSX series have ARCH effect while the rest two series are not subject to ARCH Effect.

Table 4.7(c)

Variables	Descriptive statistics								
	Mean	**Standard deviation**	**Skewness**	**Jarque Bera**	**Excess Kurtosis**	**Q-stat (10)**	**Q^2-stat (10)**	**ARCH 1-10**	**KPSS**
PSX	0.0006	0.01111	-0.5548 (0.000)	72.872 (0.000)	2.4425 (0.000)	20.83 (0.02)	36.395 (0.000)	3.831 (0.00)	0.190166 C.V 5%=0.463
Shanghai	0.0002	0.00516	-0.3346 (0.0321)	50.855 (0.000)	2.1388 (0.000)	7.262 (0.70)	6.1078 (0.806)	0.727 (0.69)	0.079917 C.V 5%=0.463
Shenzhen	-0.0001	0.00881	-1.166 (0.000)	189.98 (0.000)	3.6503 (0.000)	3.87 (0.95)	2.8360 (0.985)	0.247 (0.99)	0.073701 C.V 5%=0.463

Null Hypotheses (All H_0's are for n^{th} order)

H_0 for KPSS: Return series is I (0),

H_0 for Q-stat: N0 serial autocorrelation.

H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.

H_0 For JB test: distribution of series is normal.

H_0 for LM_ARCH test: there is no ARCH effect.

H_0 for Skewness: The series is symmetric

Excess kurtosis: The series is Meso-kurtic

'P' values are in the parenthesis.

4.7 (d) Tracing mean spillover effect from Shanghai to PSX and from Shenzhen to PSX:

Table 4.7(d) shows the estimated parameters for PSX return series when Chinese Stock Markets Returns series are introduced in PSX mean equation to check the mean spillover effect.

Table 4.7(d)

Return series / Parameters	Shanghai to PSX ARMA(0,1) GJR (1,1)	Shenzhen to PSX ARMA(0,1) GJR (1,1)
Conditional Mean Equation		

Constant α_0		-0.000552 (0.4515)	-0.000545 (0.4566)
DLShanghai(M) (a)	**DLShenzhen(M) (e)**	0.025237 (0.8151)	-0.008187 (0.9091)
MA(1) m_1		0.271843 (0.0006)	0.270407 (0.0006)
Conditional Variance Equation			
Constant α_0		0.080968 (0.1569)	0.081816 (0.1684)
ARCH(1) α_1		0.039561 (0.5133)	0.035617 (0.5750)
GARCH(1) β_1		0.777434 (0.0000)	0.777777 (0.0000)
GJR(1) γ_1		0.251133 (0.0349)	0.255782 (0.0302)
Persistence of shock		0. 942562	0.941285

Null Hypotheses(All H_0's are for nth order)
H_0 for AR(p) : r_i= 0 AR Process is insignificant,
H_0 for MA (q) : m_i= 0, MA process is insignificant,
H_0 for ARCH: α_i= 0 No ARCH effect,
H_0 for GARCH: β_i= 0 No GARCH effect,
H_0 for Asymmetry affect: γ_i= 0 No leverage effect.
Mean spillover H_0: a=0 and c=0 , No mean spillover effect,
Asymmetry effect H0: γ_i= 0 No leverage effect.
'P' values are in the parenthesis.

Residual Testing:

Table 4.7(e)

Parameter / Series	Jarque Bera	Q-Stat (5)	Q-Stat (10)	Q-Stat^2 (5)	Q-Stat^2 (10)	ARCH (1-2)	ARCH (1-5)
Shanghai to PSX	12.358 (0.000)	4.81369 (0.30695)	10.0080 (0.34983)	5.04210 (0.16874)	19.5400 (0.01222)	0.12986 (0.8783)	1.0523 (0.3877)
Shenzhen to PSX	12.442 (0.000)	4.99446 (0.2878)	10.0565 (0.3459)	5.11845 (0.16332)	19.8227 (0.011028)	0.13718 (0.8719)	1.0706 (0.3774)

Null Hypotheses(All H_0's are for nth order)
H_0 for Q-stat: N0 serial autocorrelation.
H_0 for Q^2 –stat: N0 serial autocorrelation in squared return series.
H_0 For JB test: distribution of series is normal.
H_0 for LM_ARCH test: there is no ARCH effect.
'P' values are in the parenthesis

Table shows that parameter 'a' (shanghai to PSX) is insignificant at 5% of significance level in conditional mean equation of Pakistan stock market, as we do not reject the null hypothesis of 'insignificance'. It means that there is no mean spillover effect from

shanghai to PSX in the particular. Results also depicts that the parameter 'e' of Shenzhen in conditional mean equation of Pakistan Stock market is also insignificant i.e. the chance of occurrence of null hypothesis is high. So there is no mean spillover effect from Shenzhen to PSX either. The most parameters are statistically significant at 5% level significance. PSX return series follows ARMA (0, 1) process. 'γ' term capturing the asymmetric or leverage effect in stock markets and is statistically significant in PSX return series. Which means that current returns are correlated with future volatility. The significant term of MA (1) depicts that the current return series of Pakistan stock market depends on its Past variations. The GARCH terms in these models are also significant which depicts that the return series are subject to ARCH effect. The ARCH term in PSX return series becomes insignificant. The persistence of shock for all three stock markets are closer to 1 which means that the ARCH and GARCH effect take long time to decay.

Table 4.7 (e) showing the residual analysis of employed models that is to make sure no ARCH effect should be present in residuals. Jarque bera test for normality analysis shows that the residuals are non-normal. Q-stat up to 10^{th} lags are insignificant i.e. chance of null is high so we cannot reject the hypothesis of no serial correlation. Q stat for squared standardised residuals shows no serial correlation in squared residuals. LM-ARCH test also affirms the results of Q-stats as it accepts the null off no ARCH effect in residuals. This analysis helps us to affirm that our employed models are interpretable.

4.7 (f) Mean spillover effect from PSX to shanghai and from PSX to Shenzhen: By Using ARFIMA Model

It is evident from the summary statistics and Graphical visualisation that Chinese stock market's returns series doesn't possess ARCH effect so we cannot apply GARCH type models. To explore mean spillover effect we used ARFIMA models, we utilised

maximum likelihood estimation method for this purpose. Both Shanghai and Shenzhen stock markets are financially integrated of '0' i.e. I=0, as evident from unit root tests {table 4.7(c)}, so we can say I(d) ~ I (0) and ARFIMA = ARMA. We can write the equations as follows.

$$R_{tshenzhen} = ARMA\ (m, n) + \ gR_{tp}$$

$$And$$

$$R_{tshengahi} = ARMA\ (m, n) + \ cR_{tp}$$

Table 4.7(f) Maximum likelihood estimation of ARFIMA (0, 0, 0) model

Parameter / Series	Constant α_0	DLPSX		Residual Testing on Residuals	Normality Test Chi^2(2)	ARCH 1-1 test F(1,239)
PSX to Shanghai	0.000263423 (0.428)	g	0.00284184 (0.924)		30.962 (0.000)	0.00060577 (0.9804)
PSX to Shenzhen	-0.00016286 (0.774)	c	-0.0250055 (0.623)		39.542 (0.000)	0.0071943 (0.9325)

Table 4.7(f) showing the estimated parameters of employed model. The parameters are statistically insignificant at 5% level of significance. Chinese stock markets return series have ARMA (0, 0) process and I(0). Moreover it shows that parameter 'g' (PSX to Shanghai) and 'c' (PSX to Shenzhen) are insignificant at 5% of significance level in mean equation of Shanghai stock market and Shenzhen stock market, so we do not reject the null hypothesis of 'insignificance'. So there is no mean spillover effect from PSX to Shenzhen stock exchange nor from PSX to Shenzhen Stock market in the period from 23rd December 2016 to 30th of November 2017. The residual testing validates our model results. The ARCH effect is not there in residuals and residuals are non-normal.

Chapter 5

Conclusion & policy implication

5.1 Conclusion:

This study traced out the impact of China Pakistan Economic corridor project on information transmission between Pakistan's stock market PSX (formally KSE-100 index) and Chinese stock markets i.e. Shanghai Stock market and Shenzhen Stock market. The investigation of level of linkages developed between both neighbour countries financial markets after CPEC project is helpful as well as important in making future policies, portfolios, for academicians and financial institutes. This study also finds the impact of Chinese purchasing of 40% of PSX shares on spillover effect between both countries financial markets which give more insights and brighter view of financial linkages development between the two countries'.

Daily data from 1st January 2010 to 30th of November 2017 is utilised for tracing information transmission (can also be called spillover effect) between both countries stock markets. To analyse the pre and Post impact of CPEC on financial markets the data is subdivided into two parts. First subpart contains data from 1st January 2010 to 20th April 2015 for pre-CPEC analysis, as CPEC project was officially announced on 20th April 2015 when respected Chinese president visited Pakistan. 2nd subpart contains data from 21st April 2015 to 30th of November 2017 for post CPEC analysis. The data from 23rd December 2016 to 30th of November 2017 is also analysed as a special case to check out the impact of Chinese investment in purchasing Pakistan stock market shares on mean spillover effect between both countries' financial markets.

For tracing information transmission and volatility modelling appropriate univariate GARCH type models are used i.e. GARCH (p, q) and GJR-GARCH (p, q). Returns series has utilised rather than series at level. The descriptive statistics of stock markets indices return series depicts that all returns series have stylised properties of financial return series. Return series are non-normal, not symmetric and skewed. All return series are stationary and have ARCH effect. The mean and volatility spillover effect captured by employing standard GARCH and GJR model.

By analysing the whole data set we conclude that there is unidirectional mean spillover effect exist from Shanghai SE to PSX and Shenzhen SE to PSX. While there is no volatility spillover effect between these financial markets neither unidirectional nor bidirectional. While by analysing the pre-CPEC data set we found that there is no mean spillover effect neither unidirectional nor bidirectional between Pakistan, Shanghai and Shenzhen stock markets. In case of volatility spillover effect we found unidirectional volatility spillover effect from Shenzhen SE to PSX, while there is no volatility spillover effect observed between PSX and Shanghai in pre-CPEC period. While Post-CPEC period analysis lead us to conclude that there is unidirectional mean spillover effect exist from Shanghai SE to PSX and Shenzhen SE to PSX. While there is no volatility spillover effect between these financial markets neither unidirectional nor bidirectional. By analysing the post period of Chinese investment in PSX shares the results shows there exist no mean spillover effect neither from PSX to Chinese stock markets nor from Chinese to Pakistan stock market in a said period.

All this means that CPEC project announcement has influenced the spillover effect between both countries financial markets. There exist a unidirectional mean spillover effect in post CPEC period in contrast of Pre-CPEC results. So there is a linkage developed between the two countries financial markets.

5.2 Policy implications:

The investigation of level of linkages developed between both neighbour countries financial markets after CPEC project is helpful as well as important in making future policies, portfolios, for academicians and financial institutes. The financial managers get more insights about portfolio management. The market players may also use this information for portfolio diversification and hedging. The policy makers can minimize the effects of spread of stock prices as the stock prices stability is very important for portfolio and foreign direct investments, which improves macroeconomic stability and positively impacted the economic growth. Through these results the investor or market player of one market can guess the performance of other markets.

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