WEAK FORM MARKET EFFICIENCY AND INTEGRATION: EVIDENCES FROM SELECT ASIAN AND US MARKETS

PH.D THESIS

by

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ROORKEE- 247 667 (INDIA)
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A THESIS

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled **"WEAK FORM MARKET EFFICIENCY AND INTEGRATION: EVIDENCES FROM SELECT ASIAN AND US MARKETS"** in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Management Studies of the Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during a period from December, 2009 to June, 2013 under the supervision of *Dr Anil K. Sharma*, Associate Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee and *Dr Ashutosh Vashishtha*, Assistant Professor, College of Management, Sri Mata Vaishno Devi University, Katra.

The matter presented in the thesis has not been submitted by me for the award of any other degree of this or any other Institute.

(Neha Seth)

This is to certify that the above statement made by the candidate is correct to the best of our knowledge.

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Date:

The Ph. D. Viva-Voce Examination of **Ms. Neha Seth**, Research Scholar, has been held on . . .
. . . .

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ABSTRACT

The stock markets play an important role in economic growth of developed as well as developing nations, as there is a long run relationship between stock market development and economic growth. The growing importance of stock markets around the world has attracted the researchers to work on different issues relating to the stock markets.

To understand the functioning of the stock markets and to gauge the effectiveness of the pricing of the assets, the stock market efficiency is an important concept. New information takes the market into a particular mode and direction. It is a noted fact that movement of stock market is governed by the flow of information. For international diversification, another critical area for research is the unification of stock markets of different countries.

The stock prices reflect all the relevant information and it would not be possible to forecast stock price in one market on the basis of any kind of transformation in another market. Further, stock markets are said to be integrated if they have tendency to move together in long run. This observation has activated the development and use of several tests of stock market efficiency and stock market integration. Referring to few researches done in past, co-integration implies inefficiency or efficiency implies absence of co-integration.

The end of the year 2007 and the beginning of the year 2008 observed the arrival of the global financial crisis which had wrecked havoc in the financial markets around the world. This global financial crisis has led to new inspection and rejection of the EMH. Thus, on the basis of literature review, the objectives of this thesis are is to identify the change in the informational efficiency of selected Asian and US stock markets during the time periods under study with respect to the recent financial crisis. The second objective is to identify the change in the level of integration among the selected Asian and US stock markets during the time periods under study with respect to the recent financial crisis. The third one is to assess the relationship between efficiency and integration for selected Asian and US stock markets and the last objective is to depict the volatility change during the periods understudy for selected Asian and US stock markets considering the effect of the recent financial crisis.

For the purpose of fulfilling the aforementioned objectives, the stock markets considered in the present study belong to the Asian and the United States (US) region. There are eleven stock

markets that represent the Asian region and to represent US region, only one stock market; i.e., S&P, is taken. The stock markets in Asian region are emerging markets except Japan, South Korea, Hong Kong, Israel and Singapore and the emerging markets that are considered for this study from Asian region are India, China, Malaysia, Indonesia, Taiwan and Pakistan.

A period of the twelve years, starting from 01/01/1999 to 31/12/2010 is used for the analysis. The period considered for the present study starts when the Asian financial crisis ends. The period of study ends till the last day of data collection. In order to provide the time varying results and to see the impact of recent global financial crisis, the total data set of twelve year period is further divided into four equal sub-periods. The four sub-periods are: sub-period-I; i.e., period after the 1997-98 Asian financial crisis from 01/01/1999 to 31/12/2001, sub-period-II; i.e., recovery period from 01/01/2002 to 31/12/2004. Sub-period-III; i.e., period before global financial crisis period (from 01/01/2005 to 31/12/2007), and sub-period-IV; i.e., period during 2008-2010 financial crisis period (from 01/01/2008 to 31/12/2010).

The empirical results indicate that stock returns in the twelve markets are inconsistent with the weak form efficient market hypothesis (EMH). The output of the runs test shows the mixed results in context of market efficiency with the changing course of time. Beside runs test, other tests are also employed for further investigation. The results of unit root (ADF and PP) test show the existence of a unit root in all the twelve index series for the total time period as well as for the four sub-periods. The results obtained from the autocorrelation test also support the outcome obtained from the run test and the unit root test and the variance ratio test also depicts inefficiency in all the markets except a few incidences.

The findings of correlation analysis show that the correlation between the markets is varying from very low to moderate. None of the markets was found to be highly correlated with others. The markets are found to be highly co-integrated in period-3. In line with the results of correlation and co-integration test, the ECM also shows that period-3 has the maximum number of markets with positive coefficients. In addition to this, the bidirectional causality among these stock markets is also highest in this period-3. It is again proved with innovation accounting technique that the markets pre-period are most robust markets that react to the other markets instantaneously but comes back to the equilibrium with the faster speed.

After empirically examining the results of tests for efficiency, it is held that stock markets are inefficient. Thus, markets are co-integrated which is verified by the results of co-integration tests. Hence, it is proved that stock market efficiency and stock market integration are inversely related.

The GARCH (1,1) model was adopted to capture the volatility in the twelve stock markets taken into this study. Volatility clustering was found in these markets but the level or degree of volatility does not vary with the passage of time, more or less it remains same in first three periods. More specifically, the degree of volatility was highest in period-4 only where more markets have shown increasing volatility persistence as compared to previous three sub-periods.

The results shown in this research work has important implications for the transformation of the international financial strategies as a whole. The presence of inefficiency and the increase in the integration between the stock markets signifies a reduction in the diversification opportunities among the stock markets. Stock market integration does not allow the nations to use the international stock markets to diversify their capital and at the same time to hedge against the atypical adverse shocks like the recent financial crisis, especially when these shocks exists for a short while. The study on the subject matter is helpful in providing the information about the effect of international stock market integration and to use this as a base for determining the factors that determine the stock market prices and returns. Such empirical evidences plays very important role because the managers throughout the world can utilize these results to make decisions about the listing of their firm's stocks; i.e., where and how many exchanges to have their stocks listed. This is for the reason that the share prices are the primary indicator of the shareholder's wealth and the manager's decisions may affect it.

Apart from this, investors and policy makers should continuously look into the changing nature of short term relation or causality between the markets. They must assess the varying short term relationship of different Asian markets with US markets, to evolve short term investment strategies.

This study can be extended further by developing formal speed of adjustment with which the new information is reflected in prices of individual stocks or portfolios. Inattention of the investor or any problem in the communication channel also contributes to the delayed reaction to information. So, future research effort may focus on suitable indicator for investor's inattention.

Since the present study is based on the Asian and US stock markets, the results of the study are indicative, and not conclusive, of the world stock markets in general. While the present study focuses on the effect of financial crisis on the market integration of the Asian and US stock markets. There are several other factors might be effecting the integration like nature of industry in the economy, investor's behaviour, investment channels, use of technology etc., which are not studied in this thesis.

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Neha Seth

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LIST OF ABBREVIATION

ACF	Autocorrelation Function
ADF	Augmented Dickey Fuller
AIC	Akaike's Information Criteria
AR	Autoregression
AR(p)	Autoregression of order p
ARCH	Autoregressive Conditionally Heteroskedastic
ARDL	Autoregressive Distributed Lag
ARIMA	Autoregressive Integrated Moving Average
ASE	Athens Stock Exchange
ASEAN	Association of Southeast Asian Nations
BDSL	Brock, Dechert, Scheinkman and LeBaron
BRSE	Bahrain Stock Exchange
BSE	Bombay Stock Exchange
BTSE	Botswana Stock Exchange
DCC	Dynamic Conditional Correlation
DCC-GARCH	Dynamic Conditional Correlation- GARCH
DF	Dickey Fuller
DSE	Dhaka Stock Exchange
DSI	Databank Stock Index
ECM	Error Correction Mechanism
ECT	Error Correction Term
E-GARCH	Exponential GARCH
EMH	Efficient Market Hypothesis
EMU	European Monetary Union
ESEA	East and South East Asian
EU	European Union
FPE	Final Prediction Regression
FTSE	Financial Times and the London Stock Exchange
GARCH	Generalized Autoregressive Conditionally Heteroskedastic
GATT	General Agreement on Tariffs and Trade

GCC	Gulf Cooperative Council
GMM	Generalized Method of Moments
GPH	Geweke and Porter-Hudak
GSE	Ghana Stock Exchange
HKSE	Hong Kong Stock Exchange
HQ	Hannan-Quinn
HSI	Hang Seng Index
IBSE	Istanbul Stock Exchange
IRF	Impulse Response Function
ISE	Indonesia Stock Exchange
JCI	Jakarta Composite Stock Price Index
JSE	Jakarta Stock Exchange
KLCI	Kaula Lumpur Composite Index
KLSE	Kaula Lumpur Stock Exchange
KOSPI	Korea Composite Stock Price Index
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
KS	Kolmogorov-Smirov
KSE	Karachi Stock Exchange
Log L	Log Likelihood
LOOP	Law of One Price
LR	Likelihood Ratio
LSE	London Stock Exchange
MENA	Middle Eastern and North African
MSCI	Microsoft Safety Computing Index
NAFTA	North American Free Trade Agreement
NSE	National Stock Exchange
NYSE	New York Stock Exchange
NZSE	New Zealand Stock Exchange
OLS	Ordinary Least Square
PP	Phillips-Perron
RWH	Random Walk Hypothesis
S&P	Standard and Poor's
SC	Shanghai Composite
SCI	Shanghai Composite Index

SEL	Singapore Exchange Limited
SIC	Schwarz Criterion
SPH	Singapore Press Holdings
SSE	Shanghai Stock Exchange
SSEX	Shenzhen Stock Exchange
SSX	Surabaya Stock Exchange
ST	Strait Times
STOPBREAK	Stochastic Permanent Breaks
SURE	Seemingly Unrelated Regression Equation
TA	Tel Aviv
TAIEX	Taiwan Stock Exchange Capitalisation Weighted Stock Exchange
TARCH	Threshold GARCH
TASE	Tel Aviv Stock Exchange
TSE	Tokyo Stock Exchange
TSEC	Taiwan Stock Exchange Corporation
UAE	United Arab Emirates
US	United States of America
VAR	Vector Autoregression
VDC	Vector Decomposition
VECM	Vector Error Correction Model
VR	Variance Ratio

CHAPTER - 1

STOCK MARKET EFFICIENCY AND INTEGRATION: AN INTRODUCTION

The study of stock markets throughout the world is getting more attention because of the globalization and consequential openness of the economies. The stock markets play an important role in the financial growth of developed as well as developing nations (Fuller, 2005). Shahbaz et al. (2008) further argued that growth and development of stock market is an important factor for upliftment of an economy. As this may leads to establishment of a long run relationship between stock market expansion and economic growth. This growing importance of stock markets around the world, thus, has attracted the researchers to work on different issues of stock markets.

One area of research has been the relationship between financial development and the growth of an economy with a focus on the stock market development of that country. In order to diversify funds, internationally, another critical area for research is the unification of stock markets of different countries. Investing in cross-border stock markets is relatively precarious due to the inherent anomalies involved, greater returns and prospects that can be achieved through effective and efficient asset allocation.

It is evident that an effectively structured and professionally managed stock market further stimulates optimum investment chances by financing productive projects. It would enhance economic activities, mobilize domestic savings and allocate capital optimally. Investments in different stock markets help in diversification of risk (Mishkin, 2001; Caporale et al., 2004; Osei, 2004). In addition to this, stock markets are the best gauge to project economic activities and to depict actual and causal effect between expected economic growth and stock prices. A well-organized and active stock market could help in creating liquidity that eventually enhances the economic growth (Caporale et al., 2004).

It is a well known fact that the movement of the stock markets is governed by the flow of information. New information takes the market into a particular mode and direction. In general terms, a stock market is assumed to be informationally efficient if it absorbs the news and reacts accordingly in minimum possible time. Therefore, to understand the functioning of stock markets and to gauge the effectiveness of pricing of assets the stock market efficiency is a crucial concept. The brief description of stock market efficiency is given in the following section of this chapter.

1.1 Stock Market Efficiency

The term stock market efficiency is used to describe a stock market in which all relevant pieces of information are impounded into the price of financial assets (Dimson and Mussavian, 2000). The concept of stock market efficiency was first introduced by French mathematician Louis Bachelier in 1900 in his Ph.D thesis entitled 'The Theory of Speculation' (Cootner, 1964). Bachelier (1900) stated that "past, present and even discounted future events are reflected in market prices, but often show no apparent relation to price changes". He has also mentioned that "if the market, in effect, does not predict its fluctuations, it does not assess them as being more or less likely, and this likelihood can be evaluated mathematically". The aforementioned explanation forms the basis of the analytical results proposed by the researchers in the later half of the twentieth century. Unfortunately, Bachelier's contributions remained unnoticed until it was taken up by the economist Paul Samuelson in the later part of the 1950s (Bernstein, 1992). Later on, this work was published by Cootner (1964) in English. In 1965, Eugene Fama reviewed the literature on stock price behavior. He also examined the distribution and serial dependence of stock market returns and redefined the Efficient Market Hypothesis (EMH) in his doctoral thesis (Dimson and Mussavian, 2000).

1.1.1 Efficient Market Hypothesis

The EMH and random walk hypothesis (RWH) are associated with each other. These two terms are widely used in the literature of finance. Random walk characterizes a price series where every successive price change represents a random departure from the previous price. The EMH asserts that if a financial market is informationally efficient, one cannot consistently earn abnormal returns, even if the information is available at the time of investment. The EMH states that at any point of time, the prices prevailing in the market absorb and reflect all known information. They also react fast to reflect all newly available information. Consequently, no one can do better than the market with the same information that is already available to all other investors.

The EMH was first given a proper form by Paul Samuelson (1965), whose contributions were summarized under the title 'Proof that properly anticipated prices fluctuate randomly'. According to the EMH, in an efficient market, the investors must not be able to forecast the changes in prices. It has been noticed that Fama's (1965, 1970, 1991) seminal papers contributed towards the statistical properties of stock prices and focused on contrasting technical analysis[1] and fundamental analysis.[2] In the year 1970, Fama published the empirical evidence for the EMH. His paper extended the refined theory and defined three forms of financial market efficiency: weak form, semi-strong form and strong form (Law, 1982; Poshakwale, 1996; Islam et al. 2007; Liu, 2010; Opkara, 2010).

1.1.1.1 Weak Form Market Efficiency:

Weak form market efficiency postulates that the current prices of stocks in the market fully reflect all historical information wherein the past data cannot be used to predict future prices. Share prices depict no serial dependencies. There are no 'patterns' to asset prices. Hence, prices follow a random walk as prices have no memory of the past; i.e., yesterday's price has no impact on that of today. As the future price changes does not depend on past price changes, any attempt to predict prices based on historical information is totally pointless. In the weak form efficient market, it would not be possible for any investor to earn more than market returns by trading stocks on the assumption that the price would rise or fall in the future.

1.1.1.2 Semi-strong Form Market Efficiency:

Under the semi-strong form of the EMH, the prevailing stock prices not only reflect all informational content of historical prices but also reflect all publicly available information. In this form of market efficiency, no investor can earn excess returns by buying or selling stocks on the basis of publicly available information on a consistent basis. Whenever new or unpredictable information is released, stock prices show quick and accurate readjustment to themselves that allow subsequent investors to earn only a risk-adjusted normal rate of return on their investments. Any new information read in newspapers, heard on television or seen on the internet is already reflected in stock prices and forms the part of publicly available information such as information found in the financial statements, announcements made by the governments, published forecasts etc.

1.1.1.3 Strong Form Market Efficiency:

The strong form of EMH represents the most intense case of market efficiency. According to the strong form, the prices of securities completely reflect all available information both public and private. Thus, this form of market information encompasses all the information considered by weak as well as semi-strong form of information and more. The strong form upholds that not only the publicly available information is futile to the investor or analyst but also the fact that both, public and private, the information is of no use. Information, whether it is public or private, cannot be used over and over again to earn superior returns in the strong form.

In an efficient market, the prices of a security reflect the market's best estimate of the expected return and risk of the security. This estimate considers all information that is available about those securities. No undervalued securities would be available in an efficient market. If markets are not efficient, the excess returns can be made by picking undervalued shares. Furthermore, arbitrage is possible only if the markets are inefficient.

The weak form of market efficiency is required for the existence of randomness in the stock market returns whereas randomness may not be a necessary condition for a market to be efficient. To put it differently, presence of randomness in stock market returns is not an assurance of the presence of weak form efficiency in the market returns.

Traders and investors need to value the securities in the market. Valuation of the securities is an important function that leads to the formation of trading strategies by the traders and investors dealing in these markets. The effective valuation of securities is possible by knowing the status of efficiency in the stock market. If the markets are efficient in weak form, buying the undervalued securities and selling them at normal price cannot be possible. It makes it impossible to earn abnormal profits on trading in such markets. Therefore, in order to know the status of stock markets for the above-mentioned purposes, it is required to check the existence of efficiency in these stock markets by way of testing the presence of randomness in these markets.

1.1.2 Random Walk Theory

As mentioned earlier, in the random walk theory, the stock prices evolve randomly and are independent of their past values. In other words, random walk theory states that the share prices follow no discernible pattern. The present patterns of price could not be used to predict the future values. The random walk theory also considers technical analysis unreliable.

In 1953, Kendall and Hill examined 22 stocks from the UK and commodity price series and concluded that "in series of prices which are observed at fairly close intervals the random changes from one term to the next are so large as to swamp any sympathetic effect which may be present. The data behave almost like wandering series". The empirical observations came to be labeled the 'random walk model' or 'random walk theory'.

Malkiel (1995) had stated that investors believe that events occurring in the stock markets are correlated if the events come in clusters and streaks, even though streaks occur in random data such as coin tosses. Investors who are believer of the random walk theory find it difficult to earn better than the market without taking on additional risk. They further believe that neither fundamental analysis nor technical analysis have any weight and validity. Believers of technical analysis buy and sell only when prices establish some patterns. According to the theory, this happens because stock prices already reflect the information by the time the analyst moves in the stock. Hence, fundamental analysis is ineffectual because investors often collect bad or useless information and then interpret it wrongly or inaccurately in predicting stock prices. Factors external to the system of stock price formation may also affect the stock price proving the fundamental analysis immaterial. Thus, the random walk theory was found to be consistent with the EMH which was proposed by Eugene Fama in 1970.

The EMH or random walk theory contradicts the concept of integration. According to Granger (1986), a pair of series cannot be integrated in an efficient market. In 1988, MacDonald and Taylor proposed a new method for testing the efficiency of stock markets using the co-integration methodology and end up with the conclusion that since price series are co-integrated, it opposed EMH. Sephton and Larsen (1991) also mentioned that if the series are co-integrated one might reject the EMH (pp. 561).

In the light of the current discussion, the purpose of the subsequent section of this chapter is to describe the concept of stock market integration.

1.2 STOCK MARKET INTEGRATION

Stock markets are said to be integrated if they move together in the long-run, while in short-term deviations from the equilibrium relationship are ignored. Integration converges risk-adjusted returns on the assets of similar maturity across the markets. It is seen that markets worldwide are integrating domestically and internationally, spurred by deregulation, globalization and advanced use of information technology.

The concept of stock market integration is based on the Law of One Price (LOOP) in more than one market; i.e., if assets of the same risk in different markets have the same yield, the financial markets are defined as integrated (Stulz, 1981). Augustin Cournot (1927) and Alfred Marshall (1930) are known as the creator of the LOOP which constitutes the fundamental principle on which financial market integration works. According to LOOP, the risk-adjusted returns on identical financial assets should be comparable across different markets in the absence of administrative and informational barriers. The LOOP provides a basic conceptual framework for stock market integration.

The area of stock market integration gained importance during the last few decades. This concept has implications for investment strategies and capital market efficiency. Integrated markets limit the diversification benefits to be achieved by investors across the international stock markets. The key reason for studying integration of world stock markets is to increase globalization of investment to seek higher returns and to avail the opportunity to diversify risk internationally. This is possible when the markets are inefficient since arbitrage is not possible in the efficient markets. In this context, the next part of this chapter will discuss the relation between the stock market efficiency and the stock market integration.

1.3 RELATION BETWEEN STOCK MARKET EFFICIENCY AND STOCK MARKET INTEGRATION

Granger (1986) argued that if two prices are found to be co-integrated, one price can be used to forecast another but it violates the principle of efficient markets hypothesis. The more important research implication emerged out of the co-integration literature of Engle and Granger (1987). They concluded that price series in stock markets cannot be integrated when the markets are informationally efficient. They can be integrated only when the markets are inefficient; i.e., one price can be used to forecast the other price. MacDonald and Taylor (1988) found the spot metals prices were not co-integrated which supported the EMH. Many researchers including Hakkio and Rush (1989), Macdonald and Taylor (1989), Baillie and Bollerslev (1989), Copeland (1991) and Dwyer and Wallace (1992) continued this view in the late 1980s and early 1990s. Wilson and Marashdeh (2007) also answered the question that co-integrated stock process consistent with the EMH as ‘yes’ in the long run and ‘no’ in the short run.

In the light of the viewpoints given by various economists mentioned here, it can be stated that the long-run association among different stock markets may subsist when the stock prices in various markets are affected by some familiar factors. If the stock markets are found to be efficient, then the stock prices reflect all the relevant information and it would not be possible to forecast stock price in one market on the basis of any kind of transformation in another market. This observation has activated the development and use of several tests of market efficiency based on the concept of market co-integration.

If the two series of stock prices are co-integrated, they express, at least, unidirectional causality which makes it possible to predict the future direction of one series based on variations in another. In other words, the validity of the efficient market is challenged when stock prices in one market can be predicted by additional information in other stock markets. Thus, co-integration implies inefficiency meaning, effectively, that efficiency implies the absence of co-integration.

1.4 EFFECT OF RECENT GLOBAL FINANCIAL CRISIS ON STOCK MARKET EFFICIENCY AND STOCK MARKET INTEGRATION

In general terms, the financial crisis is a situation when the value of financial assets drops rapidly. There is panic in the banks in which investors sell off assets or withdraw money from bank accounts as they expect a further fall in the value of those assets. It is related to the lack of liquidity.

The end of the year 2007 and the beginning of the year 2008 observed the arrival of the global financial crisis which had wrecked havoc in the financial markets around the world. This great turbulence has begun in the global scenario with a liquidity shortfall in the US banking system and the continual fall in stock prices on information evidenced on the fall of the investment bankers such as Lehman Brothers and Merill Lynch. The stock markets around the globe suffered huge losses. It is considered to be the spiteful financial crisis from the time of the Great Depression of the 1930s. This crisis has played a major role in the collapse of key businesses and a downfall of economic activities leading to the global recession in 2008–2010.

1.5 OVERVIEW OF STOCK MARKETS IN ASIAN AND US REGION

The stock markets considered in the present study belong to Asia and the United States of America (US). There are eleven stock markets that represent the Asian region and only one stock market, S&P, is taken to represent US region. The stock markets in the Asian region are emerging markets except those in Japan, South Korea, Hong Kong, Israel and Singapore. The emerging markets that are considered for this study from Asian region are India, China, Malaysia, Indonesia, Taiwan and Pakistan. Having been classified as 'emerging markets' does not imply that these markets are insignificant or negligible on the world economic stage. The brief overview of these stock markets with the specific stock exchanges and indices used as a proxy for the respective countries is given hereunder:

1.5.1 S&P CNX Nifty from India (National Stock Exchange)

The National Stock Exchange (NSE) is a stock exchange located in Mumbai, India. It is the largest stock exchange of the country. It has a market share of nearly 70 percent of equity trading and 98 percent in futures and options trading in India. Globally, NSE ranks among the top three stock exchanges in terms of number of contracts traded in single stock futures, index futures and stock options. NSE is among the top four of the stock exchanges around the world in terms of number of transactions and also ranked among the top ten largest derivative exchanges in the world (www.nseindia.com). NSE has a market capitalization of around US$ 985.27 billion and over 1,640 listings as on December, 2011 (www.world-exchanges.org). Though a number of other exchanges exist, NSE and the Bombay Stock Exchange (BSE) are the two most significant stock exchanges in India and amongst them NSE is responsible for the vast majority of transactions of shares. The NSE's key index is the S&P CNX Nifty, also known as the NSE NIFTY (National Stock Exchange Fifty), an index of fifty major stocks weighted by market capitalization accounting for 22 sectors of the economy.

1.5.2 KSE-100 from Pakistan (Karachi Stock Exchange)

The Karachi Stock Exchange (KSE) is a stock exchange located in Karachi, Pakistan. It is Pakistan's largest and oldest stock exchange with many Pakistani as well as overseas listings. A total of 638 companies were listed as of 30th December, 2011 with a market capitalization of US$ 35 billion approximately (www.world-exchanges.org). KSE-100 index is used as a benchmark to compare prices overtime and 100 companies with the highest market capitalization for each sector are selected and included in it to ensure full market representation.

1.5.3 Shanghai Composite from China (Shanghai Stock Exchange)

The Shanghai Stock Exchange (SSE) is a stock exchange that is based in the city of Shanghai, China. It is the fifth largest stock market by market capitalization and one of the two stock exchanges operating independently in the People's Republic of China (www.world-exchanges.org) with the other one being the Shenzhen Stock Exchange (SSEX). As of 30th December, 2011 SSE is the world's fifth largest stock market with market capitalizations at US$ 2357.42 billion with 931 listed stocks on SSE (www.world-exchanges.org). There are two types of stocks being issued in the SSE that are ‘A’ shares and ‘B’ shares. ‘A’ shares are priced in the local Renminbi Yuan currency while ‘B’ shares are quoted in US dollars. The SSE Composite (also known as Shanghai Composite (SC)) Index is the most commonly used indicator to reflect SSE’s market performance. All listed stocks (‘A’ shares and ‘B’ shares) at the SSE forms the constituents for the Shanghai Composite Index (SCI).

1.5.4 Hang Seng Index from Hong Kong (Hong Kong Stock Exchange)

The Hong Kong Stock Exchange (HKSE) is a stock exchange located in Victoria city, Hong Kong. It is Asia’s third largest stock exchange in terms of market capitalization behind the Tokyo Stock Exchange (TSE) and the SSE, and the sixth largest in the world (www.world-exchanges.org). As of 30th December, 2011, the HKSE had 1,496 listed companies with a combined market capitalization of US$ 2258.04 billion (www.world-exchanges.org). The Hang Seng Index (HSI) is a free-float adjusted market capitalization weighted stock market index in Hong Kong. It is used to record and monitor daily changes of the largest companies of HKSE and is the main indicator of the overall market performance in Hong Kong. The aggregate market value of the HSI constituent stocks is maintained at approximately 60 percent of the total market value (www.hsi.com).

1.5.5 Jakarta Composite Index from Indonesia (Indonesia Stock Exchange)

Indonesia Stock Exchange (ISE) is a stock exchange based in Jakarta, Indonesia. It was previously known as Jakarta Stock Exchange (JSE) before it got its name changed in the year 2007 after merging with Surabaya Stock Exchange (SSX). As of 30th December, 2011, the ISE had 440 listed companies with a combined market capitalization of US$ 390.12 billion (www.world-exchanges.org). The Jakarta Composite Stock Price Index (JCI) is a modified capitalization weighted index of all stocks listed on the regular board of the ISE. It is a major stock market index which tracks the performance of large companies based in Indonesia. JCI uses all listed stocks on exchange as constituents for its index calculation (www.idx.co.id).

1.5.6 FTSE Bursa Malaysia Kuala Lumpur Composite Index from Malaysia (Bursa Malaysia Berhad)

Bursa Malaysia Berhad, formerly known as Kuala Lumpur stock exchange (KLSE) is located in Kula Lumpur, Malaysia. By the end of December, 2011, the Bursa Malaysia has 940 companies listed with the market capitalization of US$ 395.62 billion (www.world-exchanges.org). The Kaula Lumpur Composite Index (KLCI) is now known as the Financial Times and the London Stock Exchange (FTSE) Bursa Malaysia KLCI and adopts the FTSE global index standard from 6th July, 2009 onwards and is known as the benchmark for the Malaysian market (www.ftse.com).

1.5.7 NIKKEI 225 from Japan (Tokyo Stock Exchange)

The TSE is located in Tokyo, Japan. It is the third largest stock exchange in the world by aggregate market capitalization of its listed companies (www.world-exchanges.org). It had 2,291 listed companies with a combined market capitalization of US$ 3325.39 billion as of 30th December, 2011 (www.world-exchanges.org). The main index tracking the TSE is the NIKKEI 225 index of companies selected by the Nihon Keizai Shimbun (Japan's largest business newspaper) since 1950. The NIKKEI 225 is a major stock market index which tracks the performance of large companies based in Japan.

1.5.8 FTSE Straits Times Index from Singapore (Singapore Exchange Limited)

Singapore Exchange Limited (SEL) is an investment holding company located in Singapore and providing different services related to securities, derivatives trading and others. As of 30th December, 2010, SEL had 773 listed companies with a combined market capitalization of US$ 598.27 billion (www.world-exchanges.org). The FTSE Straits Times (ST) index is a capitalization weighted stock market index regarded as the benchmark index for the Singapore stock market which tracks the performance of large companies based in Singapore.

1.5.9 Korea Composite Stock Price Index from South Korea (Korea Exchange)

Korea exchange is the one and only securities exchange operator in South Korea. It has its headquarters in Busan and has an office for cash markets and market oversight in Seoul. As of 30th December, 2011, Korea exchange had 1,816 listed companies with a combined market capitalization of US$ 996.14 billion (www.world-exchanges.org). Korea Composite Stock Price Index (KOSPI) is the major stock market index of South Korea. The index represents all common stocks traded on the Korea exchange.

1.5.10 Taiwan Stock Exchange Capitalization Weighted Stock Index from Taiwan (Taiwan Stock Exchange Corporation)

The Taiwan Stock Exchange Corporation (TSEC) is located in Taipei, Taiwan. As of 30th December, 2011, the TSEC had 790 listed companies with a combined market capitalization of US$ 635.51 billion (www.world-exchanges.org). The Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) is the most widely quoted of all TSEC indices and covers all of the listed stocks excluding preferred stocks, full delivery stocks and newly listed stocks that are listed for less than one calendar month.

1.5.11 Tel Aviv-100 from Israel (Tel Aviv Stock Exchange)

The Tel Aviv Stock Exchange (TASE) is located in Tel Aviv, Israel. It is Israel’s sole stock exchange. As of 30th December, 2011, the TASE has 593 listed companies with a combined market capitalization of US$ 156.94 billion (www.world-exchanges.org). The TA-100 Index typically referred to as the Tel Aviv (TA) 100 is a stock market index of 100 most highly capitalized companies listed on the TASE that are included in the TA-25 and TA-75 indices.

1.5.12 Standard & Poor’s 500 from USA (Standard and Poor’s)

Standard & Poor’s (S&P) is an American financial services company. It is a division of the McGraw-Hill Companies that publish financial research and analysis on stocks and bonds. It is well-known for its stock market indices. The company is one of the three big credit rating agencies, which also include Moody’s Investor Service and Fitch Ratings (Blumenthal, 2009). Its head office is located in Lower Manhattan, New York City.

The S&P 500 is a free-float capitalization weighted index based on the common stock prices of 500 American companies from leading industries of the US economy representing about 75 percent coverage of US equities. The index has a market capitalization of US$ 12312.49 billion as of 30th March, 2012 (www.standardandpoors.com).

1.6 MOTIVATION FOR THE STUDY

Keeping in view the effect of globalization on the security markets attracted the attention of various stakeholders in the context of the recent instability in investment levels and the global financial turmoil. Market strategist Jeremy Grantham has argued that "the EMH is responsible for the current financial crisis claiming that the belief in the hypothesis caused financial leaders to have a chronic underestimation of the dangers of asset bubbles breaking" (Nocera, 2009). Former Federal Reserve chairman Paul Volcker identified the causes of the recent financial crisis was an unjustified faith in rational expectations and market efficiencies (Volcker, 2011). After this financial crisis, the need for inspection and rejection of EMH has grown. It is also becoming necessary to look into the existence and relevance of efficiency and integration in international stock markets.

Most of the studies that are reviewed for this research have individually examined the stock market efficiency and stock market integration. However, very few studies have combined the efficiency and integration under same research. There are studies that have considered examining the efficiency for selective Asian stock markets or the markets from any other region of the world. In the same way, the examining the degree of integration between Asian and other stock markets was also considered separately. But the comprehensive studies of stock market efficiency and stock market integration for number of stock markets jointly are very few.

Hence, the present research is an attempt to fill the gap in research conducted in the past based on a comprehensive study of stock market efficiency and stock market integration of Asian and US stock markets with special references to the recent financial crisis. The aim of this research is also to provide the empirical evidence on stock market efficiency and stock market integration in Asian and US market considering the effect of 2007-2010 global financial crisis with the help of the most popular and well-accepted econometric techniques. This study also examines the relation between stock market efficiency and stock market integration in which literature is very limited. At the same time, the present study tries to comment upon the persistence of volatility in these stock markets during the period of study.

1.7 CHAPTER-PLAN OF STUDY

The chapter-plan of study is a sequential arrangement of its broad components and sub components. It is considered helpful for a systematic and focused analysis of the problem and, thus, need to be designed carefully to assist in providing an orderly approach towards the attainment of the objectives. The chapter-plan of present study is designed for covering the concerns that are seminal to the study and relevant to various stipulated objectives in an orderly manner. The whole study is covered under six chapters and the chapter plan is as follows:

Chapter 1 – Introduction: The first chapter presents an introductory view of the various aspects of study; i.e., introduction of the stock market efficiency, random walk theory, EMH, stock market integration, relation between stock market efficiency and stock market integration, the impact of financial crisis on stock market efficiency and stock market integration and a brief account on the twelve stock markets considered for this study. The chapter ends with a brief discussion on the motivation for the study.

Chapter 2 – Review of Literature: The second chapter reviews the available literature on stock market efficiency and stock market integration individually, combined studies on stock market efficiency and integration, the studies showing effect of financial crisis on stock market efficiency and stock market integration individually as well as jointly so as to develop the understanding of the issue and to identify the research-gap that needs attention and further exploration.

Chapter 3 – Research Methodology: This chapter contains comprehensive research design that includes the objectives, research questions to be answered in further chapters and hypotheses, data selection and sources and the empirical framework and methods that are undertaken for the present study.

Chapter 4 and Chapter 5 – The Empirics: These two chapters constitute the core of the study as they present the empirical analysis and findings of the sample stock market data using various tests and tools mentioned in the third chapter. Using the results obtained from the tools used, these chapters attempt to predict the status of stock market efficiency, stock market integration and volatility among various stock markets considered in this study.

Chapter 6 – Summary, Conclusions and Suggestions: The last chapter of the thesis provides the summary of the major findings and concludes the research by directly answering the research questions of the present study, followed by a discussion on the practical implications and policy recommendations that can be drawn from the present study. The chapter also highlights the limitations of the study that serves as an avenue for extending the research work in future.

End Notes:

1. Technical Analysis: Technical Analysis is a method of studying the stock individually or overall stock market's reaction through the use of historical information (such as past prices and trading volume etc), charts and other such tools for identifying patterns that can be helpful in prediction market's future behavior. Technical analysts believe that the historical performance of stocks and markets are indications of future performance. It is based on the belief that price reflects all relevant information in the prices before an investor becomes aware of them through other channels. Thus, future prices may be predicted on the basis of past information.

2. Fundamental Analysis: Fundamental Analysis is a method of evaluating a security or stock market as a whole on the basis of related economic, financial and other quantitative and qualitative factors. Fundamental analysts believe that the fundamental information (competitive advantage, earnings, growth, sales, revenue, market share, financial reserves, etc) are true indicator of future performance. Unlike Technical Analysis, fundamental analysis uses fundamental data to judge particular stock's or market's behavior in future. Thus, future prices may be predicted on the basis of not only past but fundamental information.

CHAPTER -2

REVIEW OF LITERATURE

This chapter presents a detailed review of literature on the stock market efficiency, integration and the other related issues. The globalization of financial markets has expanded the scope of investments and opportunities to earn profits while investing in different markets. So, studying the trend and movement in the world's major stock markets is an important prerequisite before investing funds across the boundaries. The movement of the markets can be analyzed through the level of Informational efficiency and integration of such markets. A number of researchers have studied and commented on the behavior of stock markets by testing the efficiency and the integration of such markets. The results from such studies are found to be contradictory making it difficult to comment on the actual state of stock market efficiency and stock market integration with confidence.

The next sections of this chapter report the studies on stock market efficiency, followed by the literature on stock market integration. The researcher also reviewed the studies relating to the combined effect of efficiency and integration and studies considering the effect of the financial crisis for the purpose of understanding the behavior of stock markets.

2.1 STOCK MARKET EFFICIENCY

The concept of stock market efficiency was first anticipated by Louis Bachelier (1900), a French mathematician, in his Ph.D thesis titled 'The Theory of Speculation'. His work remained unnoticed until the Cootner (1964) published Bachelier's contribution in English.

The EMH then took a prominent theoretical position in the mid-1960s. In 1965, Eugene Fama published his Ph.D thesis based on the RWH. Samuelson (1965) too published an evidence for EMH. In 1970, Fama further published a review of both the theory and the evidence for the EMH. The paper advanced and refined the theory further, hence introducing the definitions for weak, semi-strong and strong forms of market efficiency.

Law (1982) tested the EMH for Hong Kong stock market using the monthly data for the period of January 1978 to December 1979. The serial correlation test, regression analysis and runs test were used for the analysis of data. It was found that the Hong Kong stock market does not follow the random walk pattern.

Gupta (1990) examined the random walk model in Indian stock market for the period of April, 1979 to December, 1987. The data on prices for five shares indices from BSE were analyzed using serial correlation and runs test. The results supported the random walk model, and it was concluded that the BSE is very competitive and weak form efficient in pricing the shares.

Chaudhuri (1991) found that the Indian stock market was not efficient in the weak form after analyzing the daily price quotation of 93 shares traded on BSE over the period of January, 1988 to April, 1990. He has reached the conclusion that the results of the serial correlation test and runs test do not support the null hypothesis of weak form market efficiency. The author has also suggested that less than 25 percent of intraday changes in price may be explained by the change in prices of the previous day. Thus, the investors will not be benefited much by studying the historical data.

Nassir et al. (1993) studied the monthly and weekly closing prices of eight indices on Kuala Lumpur Stock Exchange (KLSE) using Unit Root (ADF) test, serial correlation and Q-statistics for the period of January, 1977 to May, 1989 and found that the KLSE was weak form efficient though inefficiency was found for some indices.

Frennberg and Hansson (1993) attempted to test the RWH for Swedish stock market for the period of 1919-1990. They have used variance ratio (VR) test and autoregression for evaluating the monthly data and concluded that in the past 72 years, the Swedish stock prices did not follow random walk.

Dockey and Kavussanos (1996) analyzed the Athens stock market for weak form market efficiency. Unit root (ADF) and Wald test statistics were used to examine the data for the period of February, 1988 to October, 1994. The test rejected the null hypothesis of the random walk for Athens stock market and concluded that the Athens stock market was not efficient in weak form.

Poshakwale (1996) empirically studied the weak form efficiency and the day of the week effect in BSE over the period of 1987-1994 using the daily stock prices. The non-parametric test like Kolmogorov-Smirnov (KS) test, runs test and serial correlation coefficient test were used to examine the data. The results provided the evidence of the day-of-the-week-effect and that explains how the stock market was not weak form efficient.

Seiler and Rom (1997) examined the level of random walk in daily stock prices of all the stocks listed on the NYSE from 17th February, 1885 to 02nd July, 1962 using Box-Jenkins Technique, and the results indicated that the stock returns followed the random walk.

Karemera et al. (1999) used runs test and multiple VR tests (Lo and MacKinley and Chow and Denning) to examine the stochastic patterns of local national currency and US dollar-based equity returns in fifteen capital markets. The data comprised of monthly national stock price indices for a period of nine years. The results of these tests suggested that majority of emerging markets, which were analyzed under this study, were consistent with the RWH and were weak form efficient.

Mobarek and Keasey (2000) had taken the empirical approach to examine the weak form of EMH for Dhaka Stock Exchange using the daily price indices for the period of ten years starting from January, 1988 to December, 1997. The results of both non-parametric (KS normality test and runs test) and parametric test (Autocorrelation test, Autoregression, Autoregressive Integrated Moving Average (ARIMA) model) provided the evidence that the share return series does not follow the random walk model and thus rejected the null hypothesis of weak form efficiency.

Milionis and Moschos (2000) checked the validity of the weak form EMH for London Stock Exchange (LSE). They used GARCH (1,1) model, Autocorrelation function (ACF) and (Brock, Dechert and Scheinkman) BDS test. On the basis of the results, it was concluded that the null hypothesis was rejected.

Kavussanos and Dockery (2001) investigated the Athens stock exchange (ASE) for the period of February, 1988 to October, 1994. The authors have introduced the multivariate generalization to the uni-variate Dickey-Fuller likelihood ratio tests in the system of SURE; i.e., Seemingly Unrelated Regression Equations. SURE takes into consideration the cross correlation between stocks listed on the ASE. The results have rejected the EMH for ASE, and therefore, the market was considered informationally inefficient.

Li and Zu (2002) provide the perspective on the EMH in New Zealand Stock Exchange (NZSE) for weak form and semi-strong form efficiency. The weak form efficiency was tested using unit root (ADF) test and random walk framework but the semi-strong form was tested using co-integration and Granger causality test for the period starting from January, 1993 to April, 2000. The NZSE 10, NZSE 30 and NZSE 40 represented the largest firm share market to a different degree in terms of the market size, whereas the NZSE SC included small firm's share market. The results have shown that the NZSE SC followed the random walk but not co-integrated with large firm indices and not even the returns of a small firm were granger caused by a large firm's return. The results vary with the choice of index in case of large firms, and the index of NZSE 10 was not weak form efficient, and thus were not semi-strong form efficient. But the indices of NZSE 30 and NZSE 40 were weak form efficient but not efficient in semi-strong form.

Pant and Bishnoi (2002) in their research study tested the RWH using for Indian Stock Market using Nifty, NSE-50, Sensex, BSE-100 and BSE-200 during the period April, 1996 to June, 2001. The Box-Pierce Q-Statistic, Dickey Fuller unit root test, ACF and the VR test were used for analysis of data, and the RWH was rejected for Indian stock markets. It was observed that this rejection was due to the absence of time-varying volatilities and ruling out of infrequent trading out for indices, and also the rejection of the null hypothesis of the random walk.

Gilmore and McManus (2003) used the daily sample observation of three main central European economies viz. the Czech Republic, Hungary and Poland for the period 05th July, 1995 through 27th September, 2000 to examine the weak form efficiency in these markets. Various uni-variate and multi-variate tests were used like unit root (ADF and PP) test, VR, Johansen's co-integration test, Granger causality test. ARIMA and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models were also used. The above mentioned tests provided the proof that the stock prices in these stock exchanges reveals a random walk. However, the results from the model-comparison approach showed that there was strong evidence of these markets do not follow a random walk.

Worthington and Higgs (2003) tested the random walk and weak form market efficiency in sixteen developed and four emerging European equity markets using runs test, serial correlation coefficient, unit root test (ADF, PP and Kwiatkowski–Phillips–Schmidt–Shin (KPSS)) and multiple VR test. The daily data were used for the period of 31st December, 1986 to 28th May, 2003. The results indicated that out of emerging markets only Hungary followed the random walk, and hence it was weak form efficient, while in developed markets only Germany, Ireland, Portugal, Sweden and the UK confirmed the random walk theory.

Buguk and Brorsen (2003) clarified the random walk version of the EMH for the Istanbul Stock Exchange (IBSE) using its composite, industrial and financial index weekly closing prices for the period of 1992 to 1999. Unit root (ADF) test, GPH (Geweke and Porter-Hudak) (1983) fractional integration test, LOMAC single VR test, rank and sign-based VR tests were used for the purpose of the study. The results from the four tests indicate that all three series are week form efficient and followed the Random Walk. The unit root, VR, and GPH fractional integration tests could not reject the random-walk, whereas the rank test and sign-based VR test rejected RWH one-third of the time.

Hasan (2004) examined the RWH for Dhaka Stock Exchange (DSE) using daily data over the period of January, 1990 to December, 2000. The econometric techniques such as a random walk model, unit root (ADF) test, VR, Autocorrelation function, Exponential-GARCH (E-GARCH) model and BDS test were used for data analysis and based on the results it was concluded that DSE was not weak form efficient.

Humphrey and Lont (2005) undertook the study which has examined the RWH for New Zealand share market returns and NYSE-AMEX index from US during 1980-2001 using multiple VR tests and found the evidence to support the rejection of the RWH. In addition, results revealed that the behavior of share prices was time dependent. In US index, it was found that the efficiency in US markets had improved with time.

Abrosimova and Linowski (2005) observed the Russian stock market for existence of weak form market efficiency for the period of 01st September, 1995 to 01st May, 2001 using daily, weekly and monthly Russian Trading System index time series. Unit root test, ACF and VR test, ARIMA and GARCH models were used for the analysis of data, and it was found that the null hypothesis of the random walk could not be rejected.

Worthington and Higgs (2005) extended their earlier work by examining the weak form market efficiency for ten emerging and five developed Asian equity markets using serial correlation, runs test, unit root (ADF, PP and KPSS) test and multiple VR test for the daily data from 31st December, 1986 to 28th May, 2003. The serial correlation and runs test concluded that all the markets are weak form inefficient. The unit root tests suggested that the weak form efficiency in all markets with Australia and Taiwan as exceptions and the results of VR tests indicated that none of the emerging markets followed the random walk and thus are not weak form efficient while only the developed markets of Hong Kong, New Zealand and Japan followed the random walk.

Mollah (2006) assessed the predictability of daily return of Botswana Stock Exchange (BTSE) and test the null hypothesis of the random walk. For the purpose of testing random walk model, daily market return of BTSE for the period of 1989-2005 was used. The study included both non-parametric tests (such as KS goodness of fit test and runs test) and parametric tests (such as autocorrelation coefficient test, autoregression test and dynamic time series model; i.e., ARIMA). The empirical evidences generated from the tests reject the hypothesis of the random walk and violate weak form market efficiency. It evidenced autocorrelation of return series, which propose the predictability of stock prices of BTSE.

Omran and Farrar (2006) discussed the efficiency of five Middle Eastern emerging markets (Israel, Egypt, Morocco, Jordan and Turkey) by testing the validity of the RWH and tested for calendar effects in these major Middle East emerging markets, applying various statistical and econometric techniques like runs test, autocorrelation test at various lags, box-pierce test, unit root (ADF) test. In order to test the calendar day effect, Kruskal-Wallis test has been used. The weekly and daily data were collected for the period from January, 1996 to April, 2000. Some evidences found to suggest that the Israel's Tel Aviv 100 index is weak form efficient. Weak form market efficiency was limited in Egypt, Morocco, Jordan and Turkey, which implies predictability of returns in stock markets, under study.

Filis (2006) has studied and highlighted the efficiency level for the ASE for the years 2000-2002 using Unit root (ADF) test, Runs test and GARCH test. The data were divided into two equal sub-periods, and it was noticed that ASE has advanced to a weak form efficient market in the second sub-period, whereas it was inefficient in the first sub-period. It was also found that for the overall period, the ASE was weak form efficient.

Ahmad et al. (2006) addressed the weak form market efficiency of Indian stock markets using the data for the period of 1999-2004 from NSE and BSE. For the purpose of analyzing the data, unit toot (ADF and PP) test, autocorrelation function, Ljung-box Q-statistics, GARCH model, runs test, KS test was used, and the RWH was rejected for both NSE and BSE.

Simons and Laryea (2006) presented the overview of the weak form of an EMH for four African stock markets that are; Ghana, Mauritius, Egypt and South Africa for the period vary from January, 1994 to June, 2003. The authors used runs test, ACF, multiple VR test, autoregressive test and Box-Jenkins ARIMA model for investigating the data and found that among the four markets considered only South African market was a weak form efficient market, and other three markets were inefficient in the weak form.

Hoque et al. (2007) analyzed the RWH for eight emerging equity markets in Asia with various VR tests (Wright's rank and sign, Whang-Kim sub-sampling tests, Lo-MacKinlay and Chow-Denning tests) for the period of April, 1990 to February, 2004. The authors have found that the stock prices of the eight Asian countries do not follow the random walk except for Taiwan and Korea. The opening of these eight stock markets to foreign investors after the Asian financial crisis in 1997 had not changed the mean reversion patterns of stock prices as compared to relative market efficiency.

Al-Abdul qader et al. (2007) drawn some useful results on examining the Saudi Stock Market for weak form market efficiency by studying 45 companies listed on the Saudi stock market for the period of July, 1990 to August, 2000. The filter rule and the moving average strategy were used for data analysis, and the results suggested that the EMH found to be stronger and the efficiency has been improved in Saudi Arab than in previous studies. This improvement in Saudi stock market efficiency may be due to technological and regulatory developments in the country.

Gupta and Basu (2007) focused on two major equity markets in India; i.e., BSE and NSE for testing the weak form efficiency in the framework of RWH. The daily index values for the period 24th May, 1991 to 26th May, 2006 were used for BSE and 27th May, 1991 to 26th May, 2006 for NSE for the research. They have employed unit root (ADF, PP and KPSS) test and found the same results for all the three tests. These empirical proofs suggested that the time series does not follow the random walk and autocorrelation exists in both markets.

Niblock and Sloan (2007) put forward the results of testing the weak form market efficiency of Chinese stock market using the daily data of the Shanghai 'A', Shanghai 'B', Shenzhen 'A', Shenzhen 'B', Hang Seng and Dow Jones Industrial Average Indices from March 2002 to October 2005. The data were divided into two sub samples in order to identify time structural changes in the behavior of the data. Econometric tests such as serial correlation coefficient, runs test, VR test, Johansen's co-integration test and Granger causality test were used for analysis of the data, and the result indicated that despite of continual financial liberalization and unparalleled growth, Chinese stock market were not weak form efficient.

Dorina and Simina (2007) explored eight emerging markets (Romania, Hungary, Czech Republic, Lithuania, Poland, Slovakia, Slovenia and Turkey) for weak form market efficiency using Ljung-box test, serial correlation, BDS and runs test. The time series covered the period from December 1995 to February 2007. The results of these tests informed that most of these emerging equity markets are not weak form efficient.

Mustafa and Nishat (2007) dealt with the existence of the efficiency in Karachi Stock Exchange (KSE) with corrections for thin trading and non-linearity. Daily, weekly and monthly data on stock prices were used for analysis from December, 1991 to May, 2003. The total data were divided into three non-overlapping time periods and one combined period. The results indicated that the Karachi stock market was inefficient in the weak form and do not follow the random walk model for daily, weekly and monthly data without considering thin trading and non-linearity. Nevertheless, when the returns were adjusted for thin trading and non-linearity, the KSE revealed efficient behavior and followed the random walk model for all the three types of data only for non-overlapping sample periods but not for the combined sample period. Therefore, it was concluded that when thin trading is adjusted for in a non-linear random walk model, the results show a greater degree of stock market efficiency than in the unadjusted specifications.

Borges (2007) reported the results of the tests applied to examine the weak form market efficiency for Portuguese stock index from January, 1993 to December, 2006. The total sample period was divided into five periods, defined by different trends in the market index. The authors have used serial correlation test, runs test, unit root (ADF) test and VR test for testing the hypothesis that the Portuguese stock index follows the random walk for daily, weekly and monthly returns. Based on the results, it was concluded that the degree of weak form efficiency has increased since the year 2000 and the serial dependence of returns is decreased.

Smith (2007) analyzed the experience of five stock markets in the Middle East region; i.e., Israel, Jordan, Kuwait, Lebanon and Oman using multiple VR tests for RWH. For testing the hypothesis, the weekly sample data were used for the period starting third week of October, 1996 and ending in the last week of June, 2003. On analyzing, the hypothesis was rejected for Kuwait and Oman but not for other three markets. Thus, the Israel, Jordan and Lebanese stock market were found to follow the random walk and so these markets were considered to be efficient in the weak form.

Asiri (2008) studied the behavior of stock prices in the Bahrain Stock Exchange (BRSE) to measure the weak form efficiency by testing three random walk models. He had used Unit Root test, ARIMA model of the order (1,0,0) and exponential smoothing methods over the period from 01st June, 1990 up until 31st December, 2000 and found that all stock price in BRSE follows the random walk with no drift and trend. Some tests were also performed sector-wise and it was concluded that almost all the sectors provided the evidences that the company's stock prices follow the random walk. This suggested that the market was efficient in terms of information, both overall and sector-wise. Therefore, investor was not expected to take abnormal returns by trading in Bahrain stock prices.

Kim and Shamsuddin (2008) tested the martingale hypothesis for a group of Asian markets for testing the efficiency of the markets. The daily and weekly data from January, 1990 to

April, 2005 was analyzed using multiple VR tests (Chow-Denning, Wild Boot Strap and Joint Sign Test) and Monte Carlo test. The results indicated that the Hong Kong, Japanese, Korean and Taiwanese stock markets are weak form efficient but the stock markets of Indonesia, Malaysia and Philippines are not weak form efficient markets. It was further concluded that the Singaporean and Thai markets have become efficient after the Asian financial crisis. Therefore, it was lastly concluded that the efficiency of a market is determined by the level of development, regulatory framework in equity market, transparency and corporate governance.

Magnus (2008) examined the weak form market efficiency for Ghana Stock Exchange (GSE) using random walk and GARCH model. For Sample data, the daily returns from the Databank stock index (DSI) were used for the period of five years, from June, 1999 to April, 2004 and found that the DSI exhibited volatility clustering and inefficiency in GSE.

Fifield and Jetty (2008) assessed the efficiency of the Chinese A-Share and B-Share markets by applying the parametric and non-parametric VR tests to the daily share price data for the firms listed on Shanghai and Shenzhen stock exchange over the period of January, 1996 to April, 2005. It was found that the returns of Chinese stock market were highly volatile and the A-Share market is generally more weak form efficient than the B-Share market and thus, there was an existence of information asymmetry in Chinese stock markets.

Frimpong and Oteng-Abayie (2008) tested the weak form EMH for GSE. The daily stock market data for the period of 1999 to 2004 was tested by random walk model and GARCH (1,1) Model, and it was revealed that the GSE index return series produced volatility clustering, which was an sign of inefficiency in the GSE.

Chander et al. (2008) have emphasized in examining the price behavior in the Indian stock markets using the weekly price data for a sample of 145 groups A listed stocks on the BSE from July, 1996 to December, 2005. Runs test and ACF were used to test the randomness for the series. The stock return has shown the independent behavior and thus supported the hypothesis for weak form market efficiency. The results also signified that the trading strategies based on historical prices cannot be relied for abnormal gains consistently.

Mobarek et al. (2008) considered Bangladesh's DSE for testing the randomness. The sample for analysis includes daily price index for the listed companies on the DSE over the period of 1988 to 2000. The results of both non-parametric (KS normality test and runs test) and parametric test (autocorrelation test, autoregressive model, ARIMA model) proved that the returns do not follow the random walk model and the significant autocorrelation coefficient at different lags reject the null hypothesis of weak form efficiency.

Wickremasinghe and Kim (2008) examined the Sri Lankan stock market for weak form market efficiency using uni-variate and panel unit root tests. The monthly exchange rates from four major currencies, that are Indian rupee, UK pound, US dollar and Japanese yen were used with Sri Lankan rupee, were considered for the analysis for the period of January, 1986 to December, 2004. The results of this study indicated that these four exchange rates followed random walk and thus supported the validity of the weak form EMH.

Worthington and Higgs (2009) observed the Australian stock market for examining the weak form market efficiency using daily returns from January, 1958 to April, 2006 and monthly returns from February, 1875 to December, 2005. The data were analyzed using serial correlation coefficient and runs tests, unit root (ADF, PP and KPSS) test and multiple VR tests and it was concluded that the monthly Australian returns follow a random walk, but the daily returns do not because of short-term autocorrelation in returns.

Mishra et al. (2009) explained the stock market efficiency for the Indian market in the context of recent global financial crisis. Their sample consisted of daily stock returns from January, 2007 to July, 2009, which was analyzed using Unit root (PP and KPSS) test, and the results confirmed the presence of weak form market inefficiency and existence of mean reversion illusion in Indian stock market.

El-Temtamy and Chaudhary (2009) used the sample of seven financial markets located in the Gulf Cooperative Council (GCC) countries for examining the EMH using runs test and multiple VR tests. The daily prices from June, 2003 to June, 2008 were considered for evaluation of GCC countries. The results indicated that the stock markets in Bahrain, Qatar, Kuwait, Oman and Saudi Arabia were weak form efficient and the price movement was random, whereas, stock market in Abu-Dhabi and Dubai were found to be inefficient in the weak form, this may be because these markets were relatively new and a lack in the level of maturity as compared to the other markets.

Uddin and Khoda (2009a) analyzed the behavior of stock price indices for Dhaka Stock market for random walk processes for the period of January, 2002 to October, 2008. By applying the unit root (ADF) test it was concluded that the Dhaka stock market neither follows the random walk nor is it weak form efficient.

Awad and Daraghma (2009) assessed the weak form efficiency of Palestine Security Exchange for 35 stocks listed on the market. The stock market data from January, 1998 to October, 2008 was used and serial correlation test, runs test and Unit root (ADF and PP) test were used for analysis, and the results showed the evidence of inefficiency in the Palestine Stock Exchange.

Abedini (2009) emphasized on the market efficiency for three stock markets in GCC Countries; i.e., Bahrain, Kuwait and Dubai. He has used daily data for the period of January, 2005 and November, 2008 as the sample and analyzed it using ACF, runs test, VR test and unit root (ADF) test. As a result, it was found that the stock markets in the GCC were efficient in the weak form.

Uddin and Khoda (2009b) investigated the DSE for random walk processes. The daily closing prices of 23 pharmaceutical companies were examined for the period of January, 2002 to October, 2008 using the unit root (ADF) test. The results provided the evidence that the DSE was not efficient in the weak form and thus do not follow the random walk.

Sharma and Mahendru (2009) conducted a study to examine the Indian stock market for the EMH. The authors have taken the sample of eleven securities listed on BSE for the period of 30th June, 2007 to 27th October, 2007 and applied runs test and the autocorrelation test to judge the efficiency of Indian stock market. After evaluation, it was concluded that the BSE was efficient in the weak form.

Kompa and Janika (2009) checked the weak form market efficiency for Warsaw Stock Exchange considering the period January, 2000 to December, 2006. The authors use daily stock market data for three indices, and five gold companies were used for analysis, and the data have been analyzed using runs test and VR test and concluded that the sectors of medium-size companies were not efficient in the weak form.

Azad (2009) empirically tests the RWH and weak form efficiency for twelve Asia-Pacific foreign exchange markets. This hypothesis was tested using Ng-Perron and Panel unit root tests and LOMAC and Wright's VR tests. This study covers the daily and weekly post-Asian financial crisis spot exchange rate data ranging from January, 1998 to July, 2007. The results obtained differ for the daily data and weekly data and resulted that the markets are weak form efficient with the daily data but not with the weekly data.

Siddiqui and Seth (2009) attempted to seek the evidence for the weak form EMH using the daily data for Indian stock market using NSE Nifty as a proxy for the period of 01st January, 2000 to 31st October, 2008. The authors have used KS test, runs test and Unit root (ADF and PP) test for testing weak form efficiency and concluded that that Indian stock markets do not exhibit weak form of market efficiency.

Chigozie (2010) revealed that the Nigerian Stock market was weak form efficient on investigating the Nigerian stock market for a random walk considering the period of 1984 to 2006 using the GARCH (1,1) model.

Raja and Sudhahar (2010) tested the efficiency of Indian stock market related to the bonus issue declaration by IT companies. For such examination, 43 IT companies were selected which were listed on BSE and trading actively. The sample data covered the period of January, 2000 to December, 2007 and analyzed using abnormal returns, average security returns variability and cumulative abnormal returns. On the basis of results, it was concluded that the security prices are influenced by the announcement of the bonus issue and thus, the Indian capital markets, for IT sector were efficient to an announcement of bonus issue in IT sector.

Okpara (2010) applied the methodology used by various researchers like runs test and correlogram/ partial autocorrelation function to examine the weak form market efficiency for the Nigerian stock market using monthly stock prices of one hundred and twenty one randomly selected securities listed on the Nigerian stock market throughout the period January, 1984 to December, 2006. The results of these tests revealed that the Nigerian stock market was efficient in the weak form and therefore, follows a random walk process.

Siddiqui and Gupta (2010) examined the Indian stock market for weak form market efficiency using daily data for stock indices of the NSE for the period of 01 January, 2000 to 31 October, 2008. The authors have used runs test and unit root test for analyses and found that Indian stock market does not exhibit a weak form of market efficiency.

Liu (2010) employed the unit root (ADF and KPSS) test, ACF, VR test; Brock. Dechert, Scheinkman and LeBaron (BDSL) test, ARIMA, GARCH, artificial neural network and bootstrap test to test the market efficiency of Chinese stock market over 04th January, 2005 to 31st December, 2008, and the results showed that the Chinese stock markets were not weak form efficient.

Hamid et al. (2010) considered the monthly closing values of stock market indices for the period of January, 2004 to December, 2009 to analyze the weak form market efficiency for fourteen Asia-Pacific countries. The ACF, Ljung-box Q-statistic test, runs test, unit root (ADF) test and VR test were used to test the hypothesis that the stock market follows a random walk, and it was concluded that the monthly prices of the Asia-Pacific markets do not follow the random walk.

Srinivasan (2010) carried out the unit root test (ADF and PP) to examine the RWH for two major stock markets in India; i.e., BSE and NSE. The daily stock prices were used as the sample data for the period of 01st July, 1997 to 31st August, 2010. The results of ADF and PP test revealed that the Indian stock markets do not follow the random walk and thus are not efficient in the weak form.

Surya Bahadur (2010) conducted various econometric tests like autocorrelation test, runs test, unit root tests (ADF, PP and KPSS), VR test and the GARCH (1,1) model to examine the weak form of market efficiency in Nepalese stock market. Daily data from the year 2003 to 2009 of the general NEPSE index was taken beside seven different sector wise indices and concluded that the Nepalese stock market was not efficient in the weak form.

Gupta (2010) analyzed the Indian stock market for weak form market efficiency using daily data from NSE and BSE, two indices from each market from 01st January, 2006 to 31st December, 2010. The KS test, Unit root (ADF) test, Durbin Watson statistics and Runs test were employed for data analysis, and it was found that the Indian stock markets are weak form efficient and follow the random walk.

Srivastava (2010) examined the Indian stock market for weak form market efficiency for the sample period of January, 1998 to December, 2009. The sample data consist of daily closing values of five leading stock indices from NSE; i.e., Nifty, Defty, Nifty Junior, CNX Midcap and CNX 500. The author has used runs test, autocorrelation function and Unit root (ADF and PP) test for examining the data for the random walk and concluded that the Indian stock market does not follow the random walk and thus, it was not efficient in the weak form.

Sharma and Seth (2010) reported the same results given by Siddiqui and Seth (2009) using the same methodology but for different sample. They have used both NSE and BSE for testing efficiency of Indian stock market for different time period that starts from 01st January, 2000 to 28th February, 2010.

Ntim et al. (2011) investigated and compared the weak form efficiency of 24 African continent-wide stock price indices and eight individual African national stock price indices for 2000-2007 using VR tests. The authors found that the African continent-wide stock price indices have significantly been better in terms of the weak form informational efficiency than their national counterparts.

Sharma and Seth (2011a) studied the two stock indices of NSE; i.e., S&P CNX Nifty and Nifty Junior for the period of ten years using KS test, runs test, and unit root test to test the weak form market efficiency and on analyzing the data, it was concluded the indices studied does not exhibit a weak form of market efficiency and thus does not follow a random walk.

2.2 STOCK MARKET INTEGRATION

Integration of stock markets is a process where in different stock markets started moving in same direction; i.e., they are trending together and allows convergence of risk adjusted returns on the assets of similar maturity across the markets. The process of integration is facilitated by an unimpeded access of participants to various market segments. Markets all over the world have witnessed the growing integration within as well as across national stock markets.

The law of one price (LOOP), pioneered by Augustin Cournot (1927) and Alfred Marshall (1930), constitutes the fundamental principle underlying financial market integration. According to the LOOP, in the absence of administrative and informational barriers, risk-adjusted returns on similar assets should be comparable across markets. While the LOOP provides a generalized framework for financial market integration, finance literature provides alternative principles that establish operational linkages among different financial market segments.

Following studies provide an insight of the literature on the subject of market integration:

Smith et al. (1993) examined the causality between the US, Great Britain, West Germany and Japan using bi-variate causality tests during the period 17th January, 1979 to 26th June, 1991. The authors found that after the October 1987 world-wide crash, the Granger causality is uni-directional from the US to the other countries, except for linkages from the US to the German market. Smaller periods of causality, from the other markets to the US were also found.

Malkamaki et al. (1993) identified whether Scandinavian markets lead each other. For analysis, the daily stock market returns for February, 1988 to April, 1990 were used from four Scandinavian stock markets; i.e., Sweden, Norway, Denmark, and Finland. The Granger causality test has been applied to all the four markets and the effect of worldwide returns on these four Scandinavian markets was also analyzed. The Swedish market was the leading market of total four markets. Other markets seemingly have no influence on the other stock markets. The world-wide returns appeared to have significant effects on Scandinavian market returns.

Huth (1994) tested the linkages among equity markets of the major Western General Agreement on Tariffs and Trade (GATT) trading partners. Co-integrating regression and Granger causality had been used to test the international market efficiency and interconnection between the United States of America (US), the UK, France, Germany, Canada, and Japan for the period starting from 01st August, 1984 to 29th August, 1990. The Unit root test (ADF), Johansen's co-integration test and the Granger causality test had been used for the analysis purpose, and it was found that international equity markets tended to trend together in time, which implies that from a broader perspective equity markets were not weak form efficient even though the individual markets were.

Chou et al. (1994) tried to investigate the degree of integration of six international stock markets, including the USA, Canada, the UK, France, Germany, and Japan. The unit root test and multivariate co-integration test of Johansen have been used to test the weekly closing prices from July, 1976 to December, 1989. Based on the results, it was found that the set of six countries was co-integrated. The results also suggested that there was a long-run equilibrium relationship between the stock market prices and the relationship becomes stronger over the period of time.

Bekaert and Campbell (1995) considered twelve emerging markets (Chile, Colombia, Greece, India, Jordan, Korea, Malaysia, Mexico, Nigeria, Taiwan, Thailand, and Zimbabwe) for analyzing the integration among these markets from December, 1969 to December, 1992. A conditional regime switching model was used for the study, and it was found that a number of emerging markets showed time-varying integration. Some stock markets are found to be more integrated than the expectations.

Gjerde and Saettem (1995) analyzed the causal relationship and dynamic interaction among ten countries of the world by using multivariate vector autoregression (VAR) framework. They use daily data from UK, Germany, France, Switzerland, Italy, Sweden, Denmark, Norway, Japan and the USA for the period 1983-1994. The results of variance decompositions (VDC) indicated that high degree of international co-movement among the stock price indices of these stock markets. It was also found that the US stock market has a remarkable influence on stock market performance in all countries under study, except Italy. There was no inter-continental influence of European stock markets on the world's two largest equity markets in New York and Tokyo. The patterns of the impulse response functions also showed a transmission of stock market events, which authenticate the hypothesis of international stock market efficiency.

Markellos and Siriopoulos (1997) discussed the diversification benefits available to US and Japanese investors in seven European stock markets over the period from 1974 to 1994. The seven European stock markets were Austria, Belgium, Greece, Holland, Ireland, Italy, and Spain. The Pearson's Correlation, principal components and co-integration analysis were used to study the monthly observations. The evidences of interdependencies and integration were found between the European markets and with the US market. The results of co-integration analysis did not find any significant common trend shared between the European markets and the US and Japanese markets.

Christofi and Pericli (1999) dealt with the important issue of the short-run dynamics between five major Latin American stock markets (Argentina, Brazil, Chile, Colombia, and Mexico) for the period of 25th May, 1992 to 16th May, 1997. The VAR and Exponential GARCH process was used for the estimation of the joint distribution of stock returns. The results revealed that these countries have significant time dependencies, and these markets exhibited stronger volatility spillovers than other regions of the world.

Masih and Masih (1999) analyzed the experience of the dynamic causal linkages among eight stock market indices consisting of four developed (the US, Japan, the UK, and Germany) and four south Asian emerging stock markets (Singapore, Malaysia, Hong Kong and Thailand) and then quantified the extent of their dynamic interdependencies from 14th February, 1992 to 19th June, 1997. The recent time series econometric techniques used for the analyses: unit root (KPSS and modified Dickey fuller) test, multivariate co-integration analysis, VECM, VAR, and VDC analysis. The results confirmed the leadership of the US over both the short and long-term relationship between the developed and emerging markets, whereas at regional level, Hong Kong played the leading role. It was also confirmed that the stock market's movements in the Asian markets are due to their regional and local markets rather than the other developed markets.

Huang et al. (2000) examined the co-integration and causality relationships among the stock markets of the US, Japan and South China Growth Triangle region by applying unit root test, Co-integration technique and Granger causality test over the sample period of 02nd October, 1992 to 30th June, 1997. The results indicated that no co-integration exists among these markets except between Shanghai and Shenzhen. From the results of Granger causality test, it was concluded that stock price movement in the US more impact the Chinese markets than those of

Japanese; i.e., stock price changes in the US can be used to forecast Hong Kong and Taiwan market on the next day. Price changes in the Hong Kong stock market impact the Taiwan market by one day.

Siklos and Ng (2001) verified the integration of stock markets of Asia-Pacific regions with each other and with US and Japan for the period beginning from January, 1976 to August, 1995. The Asia-Pacific markets considered for the study are Hong Kong, Korea, Singapore, Taiwan and Thailand. The data had been analyzed using both ADF and PP test of unit root, VAR and Johansen's co-integration test. The results suggested that all seven countries shared a single common stochastic trend and hence found to be integrated with each other.

Seabra (2001) explored the existence of long-run relationships among the two Latin Mercosur stock markets (Latin American); i.e., Argentine stock market (Merval) and Brazilian stock market (Ibovespa) and two major international stock markets; i.e., Japanese stock market (Nikkie) and US stock market (Dow Jones) from January, 1990 to January, 2000. They have also projected short-run influences of these two emerging stock markets. Co-integration tests were used using the Engle and Granger two step estimation techniques and the standard Johansen's maximum likelihood methodology for testing co-integration in the markets. On the basis of bi-variate and multi-variate test results, it was concluded that there was no alike trend joining the Argentine and Brazilian stock indices, which was proven to be the drawback to a proposal of stock market integration in Mercosur. While, co-integration was found between two Latin American stock markets and the Dow Jones. It was also found that the Ibovespa index reacted more to changes in the Dow Jones than Merval index.

Huang and Fok (2001) focused on the relationships of the US stock market with the Japanese and Eight European stock markets (Belgium, Germany, Netherland, Switzerland, Denmark, Ireland, Norway, and Spain) by applying the Stochastic Permanent Breaks (STOPBREAK) model from January, 1990 to June, 1998. The results of the STOPBREAK model indicated that the US stock market was temporarily co-integrated with the markets in Japan, Germany, Netherland and Switzerland. It was found that the US market is co-integrated with the market in Netherlands only, according to the Johansen (1998) co-integration test. It was finally concluded that the conventional co-integration test is not sufficient when comes to investigate the dynamic relations between two markets.

Tan and Tse (2001) documented the variation in capital market integration of East and South East Asian (ESEA) economies (Hong Kong, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand) with respect to the world's two largest economies, the US and Japan, over the period 1988-2000. The Geweke's measure of feedback for different pairs of markets was employed to show how co-movements in daily returns of stock prices are varying over time. The VAR and IRF examine the basic linkages between the stock markets in ESEA region. The data had been analyzed before and after the Asian financial crisis period and the results depicted that the linkages and interactions between the markets have increased remarkably in the post-crisis era. It suggests more interdependence between the national markets. The results from the IRF provide evidence in favor of the strong responses of these markets towards the US.

Fratzscher (2002) emphasized on the integration process of sixteen countries, some of which were part of the Euro area (Austria, Belgium, Finland, Germany, Italy, Netherlands, and Spain), and some of which have not adopted the Euro (Denmark, Sweden and the UK), and five countries from outside the European Union (Australia, Canada, Japan, Norway, Switzerland). The daily frequencies were used for the period starting from January, 1986 to June, 2000, and the data had been analyzed by using the tri-variate GARCH model. The major findings of the study were that the European equity markets have become highly integrated only since 1996, and the integration of European equity markets was explained by the drive toward the EU, and in particular, the elimination of exchange rate volatility and uncertainty in the process of monetary unification.

Alam and Hasan (2003) investigated the short-run and long-run causality between stock market development and economic growth for US by using quarterly data for the period of 1948-2000. They have adopted Unit root test (ADF and PP), Johansen-Juselius multivariate co-integration test followed by VECM and Granger causality test for the analyses of data. The evidences suggested that the stock market, GDP, nominal interest rate, the price level, and the unemployment rate are co-integrated and stable long-run equilibrium relationships exist among the variable, and thus the stock market contains information about future changes in real income.

Jeon and Jang (2004) presented the relationship between stock prices in the US and Korea by applying the VAR model. The daily stock prices at three levels of aggregation; i.e., the national aggregate index level, the high-tech industry level and the semiconductor firm level for the period of July, 1996 to February, 2001 were taken. They found that the US stock market plays a dominant role over the Korean market at every level. The reverse direction of influence; i.e., from Korea to the US, was not found. They also found that the influence of the US stock prices on Korean stock prices, which was measured by the innovation transmission using the IRF analysis. The stock prices in Korea, national stock price indices and individual high-tech stocks alike, have become much more responsive to innovations in the US stock prices during the post-1997 financial crisis period than the pre-crisis period.

Ahmad et al. (2005) recognized the interlinkages and causal relationship of the Sensex and Nifty from Indian stock market with the stock markets in the US (Nasdaq) and Japan (Nikkie) during the period January, 1999 to August, 2004, using daily closing data. The unit root test, Johansen's co-integration test and Granger causality test were used to analyze the data, and the results did not reveal any long-term relationship of the Indian equity market with the markets of US and Japan. It was further concluded that the Nasdaq and Nikkei enjoyed a stronger causal relationship in 1999–2001 which diminished or becomes very weak in 2002–2004. There is an evidence of disassociation in the movements of the Nasdaq and Nikkei with that of the Sensex and Nifty.

Kyaw and Aggarwal (2005) attempted to identify the integration of the three participating equity markets; i.e., US, Canada, and Mexico for the thirteen year period (1988-2001), divided into sub-periods pre-NAFTA (North American Free Trade Agreement) (1988 to 1993) and post-NAFTA (1994-2001) based on daily, weekly, and monthly data from January, 1988 to December, 2001. The unit root test, correlation coefficient and co-integration test were used for the analysis. The stock prices were found to be non-stationary, but the stock returns were found to be stationary for all the three markets, and it was concluded that the countries had become more integrated after the passage of NAFTA.

Oyefeso and Fraser (2005) had brought out the long-run convergence between US, UK and European stock markets by using the data on the monthly basis of real (inflation adjusted) stock prices for the period of 27 years starting from January, 1974 to January, 2001. The European markets are denoted by Belgium, Denmark, France, Germany, Italy, Spain and Sweden. Johansen's multivariate co-integration test, residual autocorrelation test and simple correlation and unit root (ADF) test have been adopted for analysis. The results of the data analysis explain that the sample real stock prices shared a common stochastic trend. Further they are perfectly correlated in the long-run too. It was also concluded that US and UK markets were less influenced than European markets and have a tendency to display more variability in deviations from the common trend, in relative terms. It was also found that the US and UK markets were less bound to a common trend, which result in increased stock market merger activity.

Lucey and Voronkova (2005) had drawn the useful lessons on analyzing the relationship between Russian and other Central European and developed countries over the period from 31st

December, 1994 to 14th October, 2004 using traditional and multivariate co-integration test, Gregory-Hansen co-integration test, non-parametric co-integration test and Dynamic Conditional Correlation-GARCH (DCC-GARCH) approach. The results suggested that after the Russian crisis of 1988, level of co-movements of the Russian market with markets of developed nations has increased, but not with Central European developing markets. These results were confirmed by the DCC-GARCH model and Gregory-Hansen approach.

Hardouvelis et al. (2006) investigated whether the integration exists among the stock markets of individual Eurozone countries during 1990s. The weekly Deutsch mark denominated, dividend-adjusted, and continuously compounded stock returns based on Friday closing prices have been used from eleven European Union (EU) countries for the period of February, 1992 to June, 1998. They found that the Eurozone stock markets did not show an increment in their level of integration with the other world market as they share it with other EU stock market. It led to the conclusion that the level of integration of EU stock markets during the 1990s was basically related to the prospect of the monetary union.

Mukherjee and Bose (2006) addressed the co-movement of Indian stock market with the developed markets like the US, Japan and other Asian markets, including Hong Kong, Malaysia, South Korea, Singapore, Thailand, and Taiwan for the period January, 1999 to June, 2004 using the tools like pair-wise and group wise co-integration and Granger causality tests. It was found that Indian markets were highly correlated with the stock market in Singapore, Malaysia, South Korea, Taiwan and Thailand, and Hong Kong while, least correlated with the US and Japanese market and this integration may not be due to free mobility of capital, but may depend on institutional factors like the liquidity of concerned market, the reliability of available information or transparency in the market and availability and quality of infra-structural facilities.

Segot and Lucey (2007) studied the capital market integration in MENA (Middle Eastern and North African) countries. They studied the implications for international portfolio investment allocation also. Daily stock indices were used for Morocco, Tunisia, Egypt, Lebanon, Jordan, Turkey, and Israel from January, 1998 to November, 2004. Based on co-integration tests, the hypothesis for stable, long-run bi-variate relationship between each of these markets and the European Monetary Union (EMU), the US, and a regional benchmark was rejected, which indicated the prospects of significant diversification opportunities for three distinct categories of investors; i.e., EMU, world, and regional investors. It was found that these markets reacted differently to the different categories of shocks. Finally, it was found Israel and Turkey were the most emerging markets in the region, followed by Egypt, Jordan, and Morocco. Tunisia and Lebanon are lagging behind.

Antoniou et al. (2007) highlighted the presence of time-varying correlations and volatility spillovers among the US, European and UK stock markets. The data set included weekly US dollar denominated indices from 04th November, 1988 to 11th July, 2003. To analyze time-varying conditional correlations between the UK, US and European stock markets DCC model has been used. The multivariate GARCH has also been used to assess the transmission of volatility from the US and European stock markets to the UK. The results suggested that the UK market was more correlated and integrated with Europe than US. The results of GARCH test also suggested that the US stock market produced the highest market-wide volatility transmission effects.

Gutierrez and Otero (2007) conducted research to explain the linkages between two parallel stock exchange trading the same shares in Colombia, namely the Bogota Stock Exchange and the Medellin Stock Exchange of the shares of thirteen companies, using monthly average prices for the shares over the period January, 1963 to June, 2001. They have used unit root (ADF) test, ARCH Test and Ordinary Least Square (OLS) for the analysis and found that these two markets were integrated for almost four decades, which was consistent with the view that arbitrage opportunities are only possible in the short-run but not in the long-run.

Simpson (2007) addressed basic informational efficiency and integration in the stock markets of the United Arab Emirates (UAE) and other states of the GCC (Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia) during the period of January, 2000 to January, 2003 to demonstrate the early development of GCC financial markets. The serial correlation, unit root (ADF) test and Durbin-Watson model were used to test the efficiency. Whereas, Johansen's co-integration test and causality test were used to test the degree of integration among the markets. Over the period of study, it was found that the markets under the study were not informationally efficient, but they were co-integrated and interdependent.

Lucey and Zhang (2007) studied and highlighted the time-varying relationship between seven Latin American stock markets, the US and a regional benchmark for the period covering January, 1993 to April, 2007 using daily closing price indices. The correlation analysis using DCC-GARCH, static test, Johansen's co-integration test, Recursive Akdogan score analysis has been used to analyze the data. The results of correlation analysis depicted that there exist strong short-term co-movements between larger Latin American markets, the regional benchmark and the US markets. Whereas, the co-integration tests suggested that the Latin

American markets have not become integrated within the region, which suggested long-term diversification benefits to the US and other international investors.

Li and Majerowsk (2008) investigated the dynamic linkages between the two emerging markets in Warsaw and Budapest. They further identified the impact of the developed markets in Frankfurt and the US and applied a multivariate asymmetric GARCH approach to the daily stock indices from January, 1998 to December, 2005. It was found that the evidence of linkages, are there in terms of returns and volatility, among the markets.

Kazi (2008) clarified the interrelation between the Australian stock market and its major trading partners; i.e., the US, UK, Canadian, German, French and Japanese stock markets by using annual data for the period 1945 to 2002. The results of Johansen's co-integration test and VECM depicted the long-run relationship of Australia with other equity markets. Even though, all the markets were not found to be equally influential but then also these markets were integrated. The significant overseas markets for Australia were the UK, Canada and Germany out of which the UK was most dominating.

Stasiukonyte and Vasiliauskaite (2008) evaluated the integration process within and between the Baltic States and the Scandinavian stock markets. The unit root (ADF) test, correlation analysis, Engle Granger co-integration test, Granger causality test and VAR were used for such evaluation for the sample data of period 2000-2006. The results of unit root test indicated non-stationary in time series, and the correlation test specified increasing financial integration between regions, but co-integration test indicated an opposite effect. The Granger causality test shows increasing integration within the regions but highlighted decreasing integration between the regions. The VAR confirmed that Stockholm was the most dominant in Scandinavia, and Tallinn was dominant in Baltic States.

Jawadi and Arouri (2008) studied the stock market integration between France and the US stock markets, within a nonlinear framework, on a short-term and long-term basis using daily data for the period of January, 1988 to September, 2007. They have applied two error correction models (ECM) that are, the Exponential Switching Transition ECM and the nonlinear ECM-Rational Polynomial. The results confirmed the evidence of integration between France and American stock markets. It was also confirmed that the stock market integration process was non-linear and time-varying, and that it has strengthened over time.

Siddiqui (2008) clarified the relationship between selected European stock markets and Indian stock market using the daily closing prices of nine stock markets for the period from October, 1999 to April, 2008. Unit root test, Granger causality test and Johansen's co-integration test have been employed as research methodology. The results of the tests adopted indicate that the stock markets under the study were integrated. The degree of correlation between the SENSEX from India and other European market indices vary from low to high and the returns of all stock markets were not normally distributed and have shown a stochastic pattern in the returns. The results also revealed co-integration among the markets under study, but it was also seen that no market was playing the dominant role in influencing other markets. Indian stock market granger causes all European stock markets under study, but none of the European markets except Austria's granger cause Indian stock market.

Valadkhani and Chancharat (2008) explained the existence of co-integration and causality between the stock market price indices of Thailand and its major trading partners using the monthly data from December, 1987 to December, 2005. The major trading partners that were considered for the study are Australia, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, the UK and the US. Engle-Granger two-step procedure and the Gregory and Hansen test were used for testing the presence of co-integration among these markets. No evidence of long-run relationships between stock price indices was found between Thailand and its major trading partners on the basis of Co-integration test, which signifies a reduction in systematic risk and long-run diversification benefits. But, in short-run, three uni-directional Granger causalities were found whereby the returns in Hong-Kong, Phillippines and the UK granger cause Thailand. In addition, there were also two uni-directional Granger causalities exists from Thailand to Indonesia and the US, which means any unusual change in Thailand stock market could be reflected in Indonesia and the US. Finally, the existence of bi-directional granger causality was also found between the Thailand stock market returns and Malaysia, Singapore and Taiwan.

Abimanyu et al. (2008) explored the international linkages of the Indonesian capital market using visual inspection with the help of graphs, unit root (PP) test for testing stationarity of data and Johansen's multivariate co-integration tests to examine the long-run equilibrium relationship between the stock markets of Indonesia with China, France, Germany, Hong Kong, Japan, Korea, Malaysia, Netherlands, Philippine, Singapore, Thailand, Taiwan, the UK, and the US. To examine the international linkages of the Indonesian capital market, the stock indices from the sample are further sub-divided into three groups: amongst the stock markets of Indonesia and ASEAN countries (Malaysia, Singapore, Philippine and Thailand), amongst the stock markets of Indonesia with developed market and Asia-Pacific countries (US, Japan, Hong Kong, Korea, Taiwan and China), and amongst the stock markets of Indonesia and west Europe countries (UK, France, Germany and Netherlands). The sample period starts from January, 2005 to December, 2007 and the results have shown the existence of co-integration between these stock market indices except between Indonesia and Philippine.

Samitas et al. (2008) analyzed the long-run relationship among five Balkan emerging stock markets (Bulgaria, Romania, Croatia, Turkey, and Serbia), the US and three European markets (UK, Germany and Greece) during the period January, 2000 to December, 2006. The Unit root (ADF and KPSS) test, Johansen's co-integration test, VECM and Monte Carlo Simulation had been used for the analysis of data. The results of the tests indicated that long-run co-integration relationship among Balkan markets and between Balkan and developed markets.

Siddiqui (2009a) extended their earlier work to study the extent of integration among the world stock markets by examining the relationship between the selected Asian and the US stock markets over the period through October, 1999 to April, 2008 using the daily closing data of twelve stock market indices (Shanghai Composite, Hang Seng, BSE 30, Jakarta Composite, KLSE Composite, Nikkie 225, Strait Times, Taiwan Weighted, TA-100, Dow Jones and S&P). He had applied Jarque-Bera test, Pearson's Correlation, Unit Root (ADF and PP) test, Johansen's co-integration test and Granger Causality test. By applying these tests, the author found that the markets under the study were integrated and there was a degree of correlation between the markets, but Japan, varies between moderate to very high. Furthermore, he found that no stock market was playing a very dominant role in influencing other markets.

Mukhopadhyay (2009) undertook the study that examined the market integration for the regional indices, country indices as well as sectoral indices from 46 country indices, 23 developed and 23 emerging-market indices. Both monthly and daily data have been used for the period 1995 to 2008, wherein the 1995-2002 was the relatively calmer period for the world markets. Moderate growth was noticed during 2003-2007, and in 2008, global markets have faced the worst recession. Simple correlation has been used to analyze the data and found that market integration was more prominent in the markets, which are at a comparable development stage, the market integration was mostly lead by developed markets, and finally, the emerging markets were found to be more vulnerable than the developed markets during times of distress. As far as the sectoral level analysis was concerned, it was found that the service sectors were more likely to be financially integrated than others.

Yi and Tan (2009), using the GARCH (1,1) model, calculated the integration of the domestic equity markets in Singapore and Malaysia with equity markets in the regional and developed economies. Weekly equity indices were used for the period of January, 1985 to December,

2004. The study had also discussed the influence of country-specific factors on the volatility of the domestic equity markets during the Asian financial crisis. The Ljung-box statistic and GARCH model was used for the analysis and on the basis of results, it was concluded that the level of integration of domestic markets with external markets was higher when Microsoft Computing Safety Index (MSCI) regional and global data were used, as compared to when individual country data were used for proxy regional and global markets.

Bhaduri and Samuel (2009), applying Logistic Smooth Transition Regression method, estimated the extent of correlation and integration of Indian stock market (NSE and BSE) with the nine other world markets. The other markets around the globe, that were considered for this study, were US, UK, Germany, Malaysia, Indonesia, Singapore, South Korea, Japan and Taiwan. These markets were tested for the post Asian crisis period starting from July, 1997 to December, 2005 using daily market returns from ten countries. The results evidenced that since the post-Asian crisis Indian stock market was gradually getting integrated to the rest of the Asian and developed markets, with the level of correlation being highest with the Asian countries, but the rate of integration remained extremely low among these counties.

Menon et al. (2009) examined the level of co-integration between Indian and some other stock market using the NSE Nifty index from India and other major and prominent stock indices of US, China, Singapore and Hong Kong for the period of ten years, from April, 1997 to May, 2007. The Engle Granger test of co-integration was used to testify the interdependence between the four capital markets. The results of the test showed that there was no co-integration existed between Indian and American stock market and Hong Kong stock market. There was some extent of co-integration exist between Indian and Chinese stock market. Whereas, the contegration was very strong between Indian and Singapore stock market that lead to strong interdependency between these markets.

Siddiqui (2009b) revisited the association between Asian and US stock markets for the period of ten years. The Asian stock markets were represented by India (BSE and NSE), China, Hong Kong, Indonesia, Malaysia, Japan, Singapore, South Korea, Taiwan and Israel. Whereas, two stock markets are considered for representing US stock markets; i.e., Dow Jones and S&P 500. The daily stock market prices were used for the period starting from 01st June, 1999 to 01st June, 2009. For time-varying results, the total time period was divided into two equal sub-periods of five years each (Period-I and Period-II). Pearson's correlation, Unit Root test (ADF and PP), Johansen's co-integration test and the Granger causality test were used to test the pace of integration among these stock markets. Based on results obtained, it was concluded that the returns were not normally distributed in both periods, and volatility has gone down in period-II. The study suggested that the correlation of returns has increased in the case of most of the countries in Period –II. It was further derived that the interdependencies among the indices understudy has increased in period-II, and none of the markets was playing a dominant role in influencing other markets. Even, both the US markets were unable to granger cause various Asian markets.

Arouri and Jawadi (2009) assessed the stock market integration for two emerging countries; i.e., Philippines and Mexico as compared to World index for the last three decades. Unit root test, nonlinear co-integration test and VECM had been used for the analysis of monthly stock market index data over the period of December, 1988 to December, 2008. The results of the study have shown that both stock markets were nonlinearly integrated with world markets, but the degree of integration was higher in Mexico as compared with the Philippines. It was also concluded that the stock market integration process is nonlinear, asymmetric and time-varying.

Siddiqui and Seth (2010) disclosed the relationship between S&P CNX Nifty and BSE 30 from India and Shanghai Composite from China using unit root test (ADF and PP), Pearson's correlation and Granger causality test. The study is based on daily closing figures from 01/06/2004 to 1/06/2009. The results of the study showed that Indian Indices were not integrated with Chinese Index. Hence, the Indian and Chinese markets were not integrated.

Marashdeh and Shrestha (2010) put forward the extent of stock market integration among the GCC countries, namely, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE. The study also tested the integration between the GCC stock markets and the developed markets. These markets were from the US and Europe. The autoregressive distributed lag (ARDL) approach to co-integration has been used for the purpose. The monthly stock price indices were used from May, 2002 to April, 2009 for such examination. The results suggested that the GCC markets were not co-integrated with developed markets, which leads to opportunities for investors to diversify their portfolios at an international level and obtain long-term gains by investing in GCC stock markets.

Seth (2011) examined the integration between Indian and Japanese stock markets for the period of latest ten years starting from 01st January, 2001to 31st December, 2010. They have used the Unit root test (ADF), Johansen's co-integration test and Granger causality test and found that the Indian and Japanese stock markets were co-integrated with each other, but variations in these markets do not influence (granger cause) each other.

2.3 STOCK MARKET EFFICIENCY AND INTEGRATION

On searching the literature for the comprehensive combined work on stock market efficiency and integration only few studies could be located. These studies are briefed asunder:

Chan et al. (1997) examined the stock market efficiency and integration of eighteen nations by covering 32 year period from January, 1961 to December, 1992. By applying unit root (ADF) test and Johansen's co-integration test it was found that a small number of markets were co-integrated with other markets.

Yuhn (1997) studied whether the globalization of financial markets enhances the efficiency of stock markets. For this purpose, the stock markets of US, Canada, Japan, UK and Germany were tested for efficiency using Unit root (PP) test and co-integration test for the period of January, 1970 to March, 1991. The results of the empirical analysis suggest that the US and Canadian stock markets were found to be integrated thus, these markets were informationally efficient but the Japanese, British and German markets were not integrated hence these markets were informationally inefficient.

Mishra and Paul (2008) analyzed the integration and the efficiency of Indian stock market and the foreign exchange markets. The authors have employed time series OLS regression, unit root test, Grangers causality test, VAR techniques for monthly data of stock return and for the period of February, 1995 to March, 1995. On analyzing the data, the weak form market efficiency hypothesis was accepted for stock mad foreign exchange markets.

Samaratunga (2008) investigated the stock market efficiency and integration for eight selected economies of Asia-Pacific region, out of which four are developing markets (Sri Lanka, China, Malaysia and Pakistan) and four developed markets (Australia, Hong Kong, Japan and Singapore) from 11th July, 1997 to 16th May, 2008. The unit root (ADF, PP and KPSS) test, ACF and VR tests were used for testing the RWH and co-integration test, impulse response analysis, VDC and Granger causality test were used to examine the integration among the markets. The results of the study revealed that there was no evidence against the efficiency of the Japanese stock market whereas the markets of Sri Lanka, Pakistan and Australia were proved to be inefficient but the results remained doubtful about China, Malaysia, Hong Kong and Singapore. The results of integration confirmed that there were no long-run co-movements between the stock prices, and therefore, there existed the opportunities for international diversification in these markets.

Seth (2012) studied and presented the results of testing weak form market efficiency and stock market integration for Indian and US stock markets for the period of 01/04/1999 to 30/06/2010. They have used runs test and unit root test for examining the weak form market efficiency and Pearson's correlation test, Johansen's co-integration test and Granger causality test to identify the degree of integration among these markets. Based on the results, it was concluded that the markets under the study do not follow random walk and therefore inefficient in weak form but were correlated and co-integrated.

2.4 IMPACT OF FINANCIAL CRISIS ON STOCK MARKET EFFICIENCY AND INTEGRATION

Financial crisis results in reduction in the value of the firms which has an impact on the return of the investors. It shows a significant impact on the economies worldwide. Financial crisis affects all stakeholders of the society in one and another way. The impact of financial crisis on the stock market has been assessed by various researchers around the globe. A few studies reporting on the effect of the financial crisis on stock market efficiency and integration are listed hereunder:

Jeon and Seo (2003) highlighted the impact of the 1997 financial crisis in four Asian countries for the period of January, 1996 to February, 2001. The results based on bi-variate and multivariate co-integration tests and threshold effects suggested that the market efficiency be weaker immediately after the financial crisis and exhibited weaker co-integrating relationships between the forward rates and corresponding spot rates of the Asian currencies.

Islam et al. (2007) applied non-parametric tests; i.e., Runs test and ACF test to examine the efficiency of the Thai stock market for before and after the 1997 financial crisis. The daily and monthly data set index has been used for the analysis and it was found that the runs test rejects the null hypothesis for random walk and an autocorrelation on Thai stock market returns exists particularly during the post-crisis period. From the results it was finally concluded that the Thai stock market was inefficient in weak form in post-crisis period.

Lim et al. (2008) recognized the impact of the financial crisis of the year 1997 on weak form of efficiency of eight Asian stock markets by applying the rolling bi-correlation test statistics for the three sub-period of pre-crisis, crisis, and post-crisis. The data covered the sample period from January, 1992 to December, 2005. The results revealed that the crisis adversely affected the efficiency of most Asian stock markets. Hong Kong suffered the most, followed by the

Philippines, Malaysia, Singapore, Thailand and Korea. But, most of these markets have shown improved efficiency in the post-crisis period.

Mahmood et al. (2010) tried to examine the impact of the recent financial crisis on the efficiency of Chinese stock market by dividing the stock price data from Shanghai and Shenzhen stock market for the period of six years, starting from January, 2004 to December, 2009, divided into two sub-periods; i.e., before crisis and during the crisis period. The sample data were analyzed by using the runs test, VR test, Durbin-Watson test and unit root (ADF) test. It was found after conducting the tests that the Chinese stock market was weak form efficient Global financial crisis has no significantly impacted the efficiency of Chinese stock market.

Sharma and Seth (2011b) added to the literature of stock market efficiency by studying the Indian stock market (BSE and NSE) for the period of ten years starting from 01/11/2000 to 31/10/2010. The authors have divided the whole sample period into two equal sub-periods for time-varying analysis and used KS test, runs test, unit root (ADF and PP) test and ACF. Based on the analysis, it was noted that the Indian stock market was not a weak form efficient in a total time period and both sub-periods and thus, it was concluded that the recent financial crisis did not impact the behavior of Indian stock markets to a greater extent.

Hamao et al. (1990) studied the short-run interdependence of prices and price volatility across three major international stock markets; i.e., Japan, UK and US, for the period of three years starting from 01st April, 1985 to 31st March, 1988. The daily closing and opening prices of Tokyo, London and New York were examined using GARCH models. The evidence of price volatility spillovers was found from US and UK to Japanese stock market and from US to UK stock market for after-October 1987 period, which shows the existence of international financial integration.

Choudhry (1996) investigated the long-run relationship between the stock indices of six European markets during the period of 1925-1936 using the Johansen's multivariate co-integration. The results highlighted a stationary long-run relationship between the indices during the period of 1925-1936. This relationship repeated during the pre-October 1929 stock crash period (1925-1929). There was no stationary relationship found during the post-crash period.

Hassan and Naka (1996) provided the perspective of the dynamic linkages between the US, Japan, UK and German stock market indices using daily data for 01st April, 1984 to 31st May,

1991. Correlation coefficient, unit root test, multivariate co-integration test, Johansen's VECM was used to examine the short-run and long-run relationship among these markets. The evidences were found to defend both short-run and long-run relationships among these four stock market indices. It was also found that the US stock market leads other stock markets in the short-run during the pre and post-October 1987 crash, but leads all other markets in the long-run in all periods examined. It was found that the US-Japan-Germany stock market indices and Japan-UK-Germany indices were not co-integrated with each other. Finally, it was concluded that contradicting results from co-integration tests were found, which cannot be used as concrete evidence on international stock market efficiency.

Masih and Masih (1997) assessed the dynamic linkages between six major world stock markets the US, Japan, Canada, France, Germany and the UK. The total data consist of two non-overlapping samples; i.e., pre-crash (January 1979 to September 1987) and post-crash (November 1987 to June 1994). For analyses of data, various techniques, like unit root test, co-integration test, Vector Error Correction Mechanism (VECM) and forecast error VDC analysis had been used. The results point out that the crash has not affected the leading role played by the US market over other markets. The German and British markets have become more dependent on other markets after the post crash period once compared with the pre-crash era. It confirmed that the crash has initiated a greater interaction among markets.

Ewing et al. (1999) tested the co-movement of the North American stock markets over the post-US stock market crash period, starting from November, 1987 through March, 1997. The monthly data, taken from three countries, US, Canada and Mexico, had been analyzed using the unit root test, Cochrane VR, and Johansen-Juselius Co-integration tests. The results evidenced the absence of co-integration in these markets even after the passage of NAFTA, and no contagion effect associated with the 1987 US stock market crash.

Wang et al. (2003) discussed the long-run co-integrating relationships and short-run causal linkages between the five emerging African continent stock markets, South Africa, Egypt, Morocco, Nigeria, and Zimbabwe, and the US market. Focus was on the 1997-98 global emerging, market crises. Daily data, from 01st January, 1996 to 31st May, 2002, has been analyzed using the co-integration test to estimate long-run relationships between markets, and generalized impulse response functions were used to analyze the short-run causal linkages between these markets. On the basis of results, it was concluded that the dependence between the African markets and the influence of the US market on these markets was limited during 1996-2002. The results of both long-run relationships and short-run causal linkages have shown that the integration between different African stock markets was weakened after the 1997-1998 crisis. The level of global integration of various African stock markets was found to be very limited except for the South African market and the influence of the US market on African market was not much strengthened after the financial crisis.

Yang et al. (2003) examined the long-run relationships and short-run dynamic causal linkages among the US, Japanese, and ten Asian emerging stock markets (Hong Kong, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Singapore, Thailand, and Taiwan), with special reference to the 1997- 1998 Asian financial crisis. The daily closing data have been taken from 02nd January, 1995 to 15th May, 2001, which is divided into the pre-crisis period (02nd January, 1995 to 31st December, 1996, during-crisis period (01st July, 1997 to 30th June, 1998) and post-crisis period (01st July, 1998 to 15th May, 2001). Johansen's co-integration test and VECM were employed to estimate the long-run relationships between markets and generalized impulse response analysis was used to provide the insight into short-run causal dynamic linkages between Asian and developed stock markets. The results highlighted that in the case of Asia, long-run co-integration relationship and short-run causal relationships among these markets showed signs of strength during the crisis. These markets have become more integrated after the crisis than before the crisis period. It has been concluded that the degree of integration among countries is time varying, specifically around periods marked by the financial crisis.

Yusof and Majid (2006) considered the dynamic dependence of the Malaysian stock market (Kuala Lumpur Composite Index) on two most developed stock markets in the worlds, the US (S&P 500) and Japan (Tokyo Price Index) by employing time-series analysis; i.e., co-integration test, VDC, and IRF from the period from 01st June, 1996 to 30th September, 2000 divided into four sub-periods. They tried to investigate that which market leads the Malaysian stock market before, during, and after the 1997 Asian financial crisis periods. The Malaysian stock market was found to be more integrated with the Japanese stock market, during the post 1997 financial crisis period compared with US stock market. This integration was due to a growing proportion of bilateral trade between Malaysia and Japan during this period.

Ameer (2006) examined the global and regional integration for six South Asian stock markets that are India, Indonesia, Malaysia, Pakistan, Korea, and Thailand and studied the volatility spillover effect for these countries. The data comprised of the weekly stock prices in terms of the US dollar from the period of 01st January, 1990 to 31st December, 2004, the period of the Asian financial crisis and post-crisis period. For analysis, the author had used correlation coefficients, VAR model, Granger causality tests, co-integration technique and Threshold-

GARCH (TARCH) model. The results have evidenced that Malaysia, South Korea and Thailand have shown significant movement towards international financial integration. The estimates based on TARCH model supported the returns and volatility effects from the World as well as regional markets to all the stock markets except Pakistan.

Majid et al. (2008) tried to examine the market integration among five Association of Southeast Asian Nations (ASEAN) emerging markets (that are Malaysia, Thailand, Indonesia, Philippines, and Singapore) and their interdependence from the US and Japan using the unit root test, co-integration test, Granger causality test and Generalized Method of Moments (GMM). Daily closing stock indices were used from January 1988 to December 2006 for this study. The results of the tests revealed that the ASEAN stock markets were moving toward greater integration among themselves and also with the US and Japan, particularly in post-1997 financial turmoil. As far as the long-run causal relations between ASEAN stock markets with the US and Japan was considered, the study determined that Indonesia was not dependent of both the US and Japan; Malaysia was found to be more dependent on Japan rather than the US; Thailand was found to be relatively independent of the US. It was found, to some extent, dependent on Japan; the Philippines is more affected by the US than Japan; and the US and Japan have bi-directional Granger casualties with Singapore.

Gooijer and Sivarajasingham (2008) in their study investigated the long-term linear and non-linear causal linkages among eleven stock markets, out of which six are major stock markets (Germany, Hong Kong, Japan, Singapore, UK, and US) and five are emerging stock markets of South-East Asia (India, Malaysia, South Korea, Sri Lanka, and Taiwan). The data consist of daily stock market price indices from 02nd November, 1987 to 01st December, 2006. For taking the Asian financial crisis into account, the whole data are divided into two sub-periods: Period-1, from 02nd November, 1987 to 30th June, 1997, denoted the pre-Asian financial crisis period and Period-2, from 01st June, 1998 to 01st December, 2006, denoted the post-Asian financial crisis period. On applying a multivariate test of non-linearity, substantial differences were found between pre and post-crisis period in terms of the total number of significant nonlinear relationships and on applying the parametric and non-parametric causality test, it was found that the Asian stock markets have become more internationally integrated after the Asian financial crisis with Sri Lanka as an exception because it had no significant long-term linear and nonlinear causal linkages with other markets. VAR filtered residuals and VAR filtered squared residuals were used to ensure causality for the post-crisis sample and a few remaining significant bi-directional and uni-directional causal nonlinear relationships were found in these series.

Wang and Moore (2008) tried to investigate the co-movement of three major Central-Eastern emerging stock markets with the aggregate Euro zone market over the sample period starting from 06th April, 1994 to 29th December, 2006. The markets considered for the study were Czech Republic, Hungary, Poland, and twelve EMU member markets that have already adopted the Euro (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain). The stationarity of the data had been tested using unit root (ADF) test, and the market interdependence and volatility transmission had been done by using bi-variate EGARCH model with DCC specification. The authors found the significant dynamic correlations in the emerging markets with the Eurozone markets during the financial crisis. A higher level of linkages found was in the aftermath of crisis. It was also identified that the development of financial markets is an important factor behind higher co-movement in the Czech Republic and Hungary with the Eurozone. It shows that the financial market integration depends on existing levels of financial sector development.

Raj and Dhal (2008) used correlation and unit root test, VECM and co-integration test to measure the integration of Indian stock market with global markets such as the US, the UK and Japan, and with major regional markets such as Singapore and Hong Kong, which are key financial centers in Asia. The sample period considered for the study was started from April, 1993 to January, 2008. The whole sample period was divided into two phases; i.e., from April, 1993 to March, 2003, including the Asian financial crisis in 1997-98 and the post-crisis period from March, 2003 to January, 2008. The results derived, supported the international integration of India's stock market. It was also concluded that India's stock market provides better opportunities for attaining higher returns than other global and regional markets. The correlations calculated of daily stock price and returns point out strengthening of the integration of Indian stock market with other markets in the more recent period since 2003. The co-integration test suggested that the Indian market's dependence on global markets, such as the US and the UK was remarkably higher than on regional markets such as Singapore and Hong Kong.

Gklezakou and Mylonakis (2009) analyzed the experience of seven South European markets for the period during and after the recent financial crisis; i.e., from 01/11/2000 to 20/02/20009. The seven South European markets, Romania, Bulgaria, Croatia, Slovenia, Turkey, Greece, and Germany, were studied using correlation function, unit root (ADF) test and Granger causality test. In order to study the integration among these markets under different market conditions, the whole set of data were divided into two sub-period extending from 01/11/2000 to 19/07/2007 and from 20/07/2007 to 20/02/2009. The results of the study suggested that these markets, which were loosely related in the period of normal economic activity, exhibited strong interrelationships under conditions of economic recession. The ex-ante believed that the developed stock exchanges exerted a dominant influence to their developing counterparts were verified, with the ASE to strongly affect the markets in the sample. In addition, the indices under consideration seemed to reflect a great part of the volatility of the German market, which is the European leading index.

2.5 CONCLUSION

This chapter studied the literature available on the subject of stock market efficiency and integration separately. It further contains studies, which highlight the combined effect of stock market efficiency and integration. The researcher reviewed 138 studies from various dependable sources. Most of the studies considered here are empirical studies conducted on all the major stock markets in the world. Researchers from all parts of the globe made efforts to establish their point of view.

As mentioned earlier that these studies aimed to study stock market efficiency and integration. So these studies use daily, monthly or annual closing price's data from the markets considered under these studies. Some of the techniques that are adopted to study the efficiency and integration are runs test, ACF, unit root test, VR test, Pearson’s correlation test, Johansen’s co-integration test, VECM, Granger causality test, IRF, VAR, GARCH (1,1) model etc.

The main objective of providing this array of studies taken from a broad literature is to highlight the existing gaps in the literature. However the studies reviewed by the researcher do not necessarily represent the overall existing literature on stock market efficiency and integration, and yet the proportional representation of the studies is there.

It is again a notable fact that the review done in this chapter provides contradictory results on the same markets for stock market efficiency as well as for stock market integration. It is perceived that it may be due to the difference in the time, the period of study and the tools used. The researchers have also tried to show the effect of US on other markets too. It may be due to the dominant position of the US.

It is concluded from the available literature that the joint studies on stock market efficiency and stock market integration are few in number or the researches on stock market efficiency and stock market integration are also reviewed. It is also seen that the number of the studies providing the effects of both efficiency and integration are not comparable with the studies showing their effect separately.

So, the lack of studies on the combined effect of stock market efficiency and integration between Asian and US Markets considering the effect of recent global financial crisis, acts as motivation to undergo a study along the same lines.

CHAPTER – 3

RESEARCH DESIGN

The issue of international portfolio diversification is of paramount importance to the investors. A numbers of studies have been conducted on the related issues of the stock market efficiency and integration as compiled in the previous chapter. In the present era of globalization as all economies are working in the liaison with others it is imperative to study the efficiency and integration for stock market in the developing countries too. In recent years the fast moving emerging economies attracted the attention of both the practitioners and the academicians (Cheng, 2000; Piyaporn, 2008).

Ample work has been done in past on stock market efficiency and integration separately using various world markets and their indices. However, efforts are inadequate when it comes to addressing the research issues that combine both efficiency and integration of developed as well as developing stock markets. Hence, the field of study combining both efficiency and integration demands more exploration.

As the review suggests the results as concluded by various researchers on the same issue are contradictory in nature. Therefore, it is essential to approve or disapprove the existence of efficiency and integration in stock markets internationally with special reference to the recent financial crisis. This comprehensive work is imperative for policy making to develop effective portfolio management policies.

The broad objective of this study is to fill the gap of research work on a combined issue of stock market efficiency and integration and provide a path that will be useful for both practitioners and academicians to research in this field of study. In addition to this the present study would also identify the relation between the efficiency and integration by assessing whether the free flow of information effects the integration and vice versa. In the light of the viewpoints mentioned, the following are the specific objectives of this thesis:

3.1 OBJECTIVES OF THE STUDY

On the basis of literature review, the objectives of the study are:

1. To identify the change in the informational efficiency of select Asian and US stock markets during the time periods under study with respect to the recent financial crisis.
2. To identify the change in the level of integration among the select Asian and US stock markets during the time periods under study with respect to the recent financial crisis.
3. To assess the relationship between efficiency and integration for select Asian and US stock markets.
4. To depict the volatility change during the periods understudy for select Asian and US stock markets considering the effect of the recent financial crisis.

3.2 RESEARCH QUESTIONS TO BE ANSWERED

The research questions that are to be answered to fulfill the above mentioned objectives are mentioned here below:

1. Does the level of informational efficiency vary with time for select Asian and US stock markets?
2. Does the level of integration vary with time for select Asian and US stock markets?
3. Is there any relationship that exists between informational efficiency and integration for select Asian and US stock markets?
4. Does the level of volatility vary with time for select Asian and US stock markets?

3.3 HYPOTHESES

Based on the research questions following are the basic assumptions that are framed to continue the research work based on the topic undertaken:

$\mathbf{H_{01}}$ = Level of informational efficiency does not vary with time for select Asian and US stock markets.

$\mathbf{H_{02}}$ = Level of integration does not vary with time for select Asian and US stock markets.

$\mathbf{H_{03}}$ = There is no relationship that exists between the informational efficiency and integration for select Asian and US stock markets.

$\mathbf{H_{04}}$ = Volatility persistence does not vary with time for select Asian and US stock markets.

3.4 SAMPLE DATA AND DATA SOURCES

To fulfill the above mentioned objectives answering the research questions and to test the above stated hypotheses, twelve stock markets are considered for this study out of which eleven stock markets represent the Asian region and one stock market is used as the proxy for the US region. The indices considered for the present study are: (i) S&P CNX Nifty from India (NSE), (ii) KSE 100 from Pakistan (KSE), (iii) Shanghai Composite from China (SC), (iv) Hang Seng from Hong Kong (HS), (v) Jakarta Composite from Indonesia (JC), (vi) KLSE Composite from Malaysia (KLSE), (vii) Nikkie 225 from Japan (NIK), (viii) Straits Times from Singapore (ST), (ix) KOSPI Composite from South Korea (KSP), (x) Taiwan Weighted from Taiwan (TW), (xi) TA 100 from Israel (TA), and (xii) S&P 500 from USA (SP). The Abbreviations given in the parenthesis represents the symbols which are used only for analysis of data and presentation of results obtained from the analysis.

In order to represent the Middle East region in Asia, the most significant market of the region, TA from Israel, is considered. KSE from Pakistan is one of the less-researched markets in the South Asian region. Because of this reason the KSE has been studied in the present work. This study has also considered one Chinese market for the reason that it has shown notable development in the recent past.

The present study is based on the secondary data which are retrieved from the websites of respective stock exchanges and econstat. In order to obtain the robust results, the daily closing prices of the indices in question covering the period of twelve years starting from 01/01/1999 to 31/12/2010 are used for the analysis. The period considered for the present study starts when the Asian financial crisis ends.

In order to provide the time varying results and to see the impact of the recent global financial crisis, the total data set of twelve year period is further divided into four equal sub-periods. The four sub-periods are: period-I; i.e., period after the 1997-98, the Asian financial crisis (from 01/01/1999 to 31/12/2001), period-II; i.e., recovery period (from 01/01/2002 to 31/12/2004), period-III; i.e., period before global financial crisis (from 01/01/2005 to 31/12/2007); and period-IV; i.e., period during global financial crisis (from 01/01/2008 to 31/12/2010).

For the purposes of analysis, the available data are adjusted according to time variation in the country and for the missing values. The returns are calculated in the price for further calculation, wherever required on the basis of the following formula:

$$r = \ln (P_t / P_{t-1})$$

where, ln = natural log

3.5 RESEARCH TECHNIQUES

To achieve the objectives mentioned in the section above, the following econometric tools have been used. The returns of the indices are used to examine the granger causality, the randomness and correlation between the stock markets. Prices of the respective indices are used to check the stationarity of the series and co-integration among the stock markets.

The brief definitions and implications of these tests are given hereunder:

3.5.1 Runs Test

The runs test (Bradley, 1968), also known as Geary test, is a non-parametric test that is widely used for testing statistical interdependencies; i.e., randomness, in share price movements. It compares the likely number of random runs from a course with the observed number of runs. A run is defined as a series of the same signs that are preceded or are followed by a different sign or no sign at all; i.e., given a sequence of observations, such as "+" or "-" and length of a run can be defined as the number of elements or signs in it (Gujarati and Sangeetha, 2007).

This analysis is performed by probing a series of returns and testing for successive price gains or drops. The gain in price is represented by '+' sign and the drop in price is shown by '-' sign and "0" shows that there is no change in the returns. The runs test compares the actual number of runs to the expected number of runs assuming price changes independence.

The null hypothesis of the test is that the observed series is random series.
H_0 = stock returns depict a random walk through time.
H_1 = stock returns do not depict a random walk through time.

According to Gujarati and Sangeetha, 2007, null hypothesis is that the succeeding outcomes are independent of the previous ones; the total anticipated number of runs is distributed as normal with the following mean:

$$E(R) = \frac{2N_1N_2}{N} + 1$$

and the following standard deviation:

$$\sigma_R^2 = \frac{2N_1N_2(2N_1N_2 - N)}{(N)^2(N-1)}$$

where, $N = N_1 + N_2$
N = total number of observations = $N_1 + N_2$

N_1 = number of + symbols (i.e., + residuals)

N_2 = number of – symbols (i.e., - residuals)

R = number of runs

Poshakwale (1996) opined that the number of runs lower than expected, point toward the over-reaction of market to information. But a higher number of runs is a sign of a lagged response to information. The number of runs is a measure of randomness. Too many or too few runs suggest dependence between observations which is an indication of non randomness in the returns. The runs test, in addition, converts the total runs into Z statistics. The null hypothesis is rejected if the Z value is found to be greater than or equal to ± 1.96.

Since one of the objectives of the present study is to test the weak form market efficiency of the stock markets considered in this study and this objective can be achieved by testing the presence of randomness in the stock returns. So, runs test is used to test the randomness among the markets taken for this research work.

3.5.2 Autocorrelation Function (ACF)

Autocorrelation means correlation of a time series with its past and future values Autocorrelation also referred to lagged correlation or serial correlation, refers to the correlation between items of a series arranged in time. The correlation (or autocorrelation) between the observations at different times is calculated using autocorrelation coefficient. In other words, the ACF measures the correlation between the current and lagged observation of the time series of stock returns and it is represented as follows:

$$p_k = \frac{\sum_{t=1}^{n-k} (r_t - \bar{r})(r_{t+k} - \bar{r})}{\sum_{t=1}^{n} (r_t - \bar{r})^2}$$

where, k = number of lags,

r_t = returns of the price series,

$\bar{r}$ = mean return

The autocorrelation coefficient at the grouped level can be measured using Ljung-Box Q-statistic. The Q-statistic test seeks if a group of autocorrelation is differ from zero, significantly. Ljung-Box (1978) used the sample autocorrelation to figure out the statistic.

$$Q_{LB} = N(N+2)\sum_{t=1}^{k}\frac{r_t^2}{N-t} \sim \chi_k^2$$

Under $H_0 : r_1 = \ldots\ldots\ldots = r_t = 0$, where Q asymptotically follows the χ_k^2 distribution with m degree of freedom. The higher the sample autocorrelation the larger would be the value of Q. If the calculated value of Q exceeds the appropriate χ_k^2 values, the H_0 of no significant autocorrelation will be rejected and H_a of at least one autocorrelation is not zero will be accepted.

3.5.3 Unit Root Test

The unit root test is a widely used test used for testing stationarity (or non-stationarity). The unit root model can be represented as the Markov First Order Autoregressive model. This can be symbolized as AR(1) model of time series Y_t and it can be represented as (Gujarati and Sangeetha, 2007):

$$Y_t = \rho Y_{t-1} + v_t, -1 \leq \rho \leq 1$$

where,

v_t = the random disturbance with zero mean and constant variance.

ρ = coefficients to be estimated

If ρ=1 then the above equation become a random walk model (without drift) and this situation shows the existence of unit root; i.e., existence of non-stationary stochastic process in the series. So the terms non-stationarity, random walk and unit root are synonymous..

The general idea of a unit root test is to regress the Y_t series on its own lagged value Y_{t-1} to know whether ρ is statistically equal to 1 or not and if it is then the series is said to be non-stationary, having unit root and follows a random walk. Hence the null hypothesis for testing unit root is that $\rho = 1$ against the alternate hypothesis $|\rho| < 1$, or simply $\rho < 1$.

In econometrics, models are to be constructed using non-stationary time series, except co-integration regression. Hence, the series is required to be transformed into a stationary series. If trend element is present in the series, it should be de-trended using a suitable trend regression. If the series does not have trend it should be differenced by taking first difference. So series Y_t can be made stationary by taking first difference of that series as follows

$$\Delta Y_t = Y_t - Y_{t-1}$$

If a series is differenced d many times to make stationary then it is called, integrated of order d, *I(d)*.

3.5.3.1 The Augmented Dickey Fuller (ADF) Test:

The ADF test is most frequently-used test of a unit root. The ADF test follows a simple logic that a non-stationary process has an infinite memory as it does not show decay on a shock that takes place in the process. Every random shock carries away the process from its earlier level not to return back again unless another random shock push it towards its previous level. Therefore, it behaves like an AR(1) process with $\rho=1$.

Let;

$$Y_t = \rho Y_{t-1} + v_t$$

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + v_t$$

$$\Delta Y_t = (\rho - 1) Y_{t-1} + v_t$$

$$\Delta Y_t = \delta Y_{t-1} + v_t$$

For ADF test, the null hypothesis $\delta=0$.

The ADF test uses regression of the first difference of the series against the series lagged. It is presented as follows:

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \sum_{i=1}^{n} a_i \, \Delta Y_{t-i} + v_t$$

where, Y_t = logarithm of the price for the considered market at time t,

$\Delta Y_t = Y_t - \Delta Y_{t-1}$,

δ = coefficients to be estimated

a = coefficients to be estimated,

n = number of lagged terms,

t = trend term, and

v_t = pure white noise error term and

$\Delta Y_{t-1} = (Y_{t-1} - \Delta Y_{t-2}), \Delta Y_{t-2} = (Y_{t-2} - \Delta Y_{t-3})$ and so on.

The number of lags to be included can be determined empirically.

3.5.3.2 The Phillips-Perron (PP) Test:

The PP test is an non-parametric method which control for serial correlation while testing for a unit root. It estimate the non-augmented Dickey-Fuller test equation and modifying the test statistics so that it asymptotic distribution remain unaffected by serial correlation.

The objective of this research work is to test the weak form efficiency and integration of the considered stock markets. The unit root test helps in testing the weak form efficiency of the markets under consideration by analyzing the randomness of the series. On the other hand, for the purpose of examining the integration among the markets, Johansen's co-integration test is to be undertaken which is only possible when the series is stationary and the test of stationarity possible using a unit root test.

3.5.4 Variance Ratio (VR) Test

The VR test is another technique to test the randomness for the stock markets. The VR test developed by Lo and Mackinlay (1988) is based on the property that if a return series follow a random walk, then the variance of *q*-difference of an interrelated series is *q*-times the variance of its first difference. In other words, for a time series which is characterized by random walks, one q^{th} of the variance of ($p_t - p_{t-q}$) is expected to be the same as the variance of ($p_t - p_{t-1}$). This can be represented in the form of an equation:

$$\text{Var} (p_t - p_{t-q}) = \text{q Var} (p_t - p_{t-1})$$

where *q* is any positive integer. The variance ratio is then denoted as the following equation such that under the null hypothesis *VR(q) = 1.*

$$VR(q) = \frac{\frac{1}{q} Var(p_t - p_{t-q})}{Var(p_t - p_{t-1})} = \frac{\sigma^2(q)}{\sigma^2(1)}$$

3.5.5 Pearson's Correlation Test

Pearson's *r*, is a measure of the correlation or linear dependence between two variables *X* and *Y* .It gives a value between +1 and −1. .It is represented by following equation:

$$\rho_{X,Y} = \frac{Cov(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X - \mu_X)(Y - \mu_Y)]}{\sigma_X \sigma_Y}$$

The *r* can also be obtained by substituting estimates of the covariances and variances based on a sample into the formula above.

That formula for *r* is:

$$r = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}}$$

Pearson's correlation is used to find out the short-run relation between the movements of the stock markets. It is used to measure the extent of the association between the stock markets returns.

3.5.6 Johansen's Co-integration Test

Co-integration Test was introduced by Johansen and Juselius (1990). This test is used for indicating the long-run relationships between the stock markets. It point out that in the long-run the variables would move on the same course without moving apart from each other. The test for the presence of co-integration is done only when the variables under deliberations are non-stationary and integrated of the same order. Series are said to be co-integrated when the linear combination of non-stationary variables is stationary.

Johansen and Juselius (1990) have given the following general autoregressive representation for the vector *Y*.

$$Y_t = A_o + \sum_{i=1}^{n} A_i Y_{t-i} + e_t$$

where Y_t = *nx1* vector of non-stationary variables,
A_o = *nx1* vector of constants, *n* is the number of lags,
A_i = *nxn* matrix of coefficients and
e = assumed to be a *nx1* vector of error term.

The above equation can be turned into an error correction model for the purpose of using co-integration test as follows:

$$\Delta Y_t = A_0 + \sum_{i=1}^{n=1} X_i \Delta Y_{t-i} + ZY_{t-n} + e_t$$

where, $X_i = -\sum_{j=i+1}^{n} A_i$ and

$$Z = -I + \sum_{j=i+1}^{n} A_i$$

Δ = difference operator and

I = identity matrix.

The co-integration test is tested by comparing both the sides of the above-mentioned equation. Since ΔY_t and ΔY_{t-i} is stationary, so both the sides of the equation will be stationary, if ZY_{t-n} is stationary. Now the co-integration test focuses on testing Z matrix and Z can be interpreted as a long-run coefficient matrix, since in equilibrium, all ΔY_{t-i} will be zero and setting e_t to their expected value of zero will leave $ZY_{t-n} = 0$.

There are two statistical aspects that can be used to test the characteristic roots that are insignificantly different from unity that are, the trace and maximum eigenvalue test.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i) \quad \text{and}$$

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})$$

Where $\hat{\lambda}_i$ is the estimated values of the characteristic roots obtained from the estimated Z matrix, T is the number of usable observations and r is the number of co-integrating vectors.

The trace statistic tests the null hypothesis that the number of distinct co-integrating vectors is less than or equal to r. The maximum eigenvalue statistic tests the null hypothesis that the number of co-integrating vectors is less than or equal to r against the alternative of $r+1$ co-integrating vectors.

This test will generate results about the long-run co-movement of different stock markets under study.

3.5.7 Error Correction Mechanism (ECM)

The presence of co-integrating relation among the variables forms the basis of error correction mechanism (ECM). The ECM was first used by Sargan (1984) and then Engle and Granger (1987) popularized it (Gujarati, 2004). The ECM reconciles the short-term behavior of the variables if these variables are co-integrated in the long-term. The ECM can be represented as follows:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{j=1}^{k-1} X_j \Delta Y_{t-j} + A_t + e_t$$

Where, α is the matrix of adjustment or feedback coefficients, which measures how strong is the deviations from equilibrium, the *r* stationary variables $\beta' Y_{t-1}$, feedback onto the system. If there are $0 < r < p$ co-integrating vectors, then some of the elements must be non zero, that is there must be some grange causality involving in the elements of X_t from diverging (Hoque, 2007).

3.5.8 Granger Causality Test

Granger (1969) proposed the Granger causality test to deduce cause and effect relationship between two or more time series. This test also identifies that whether one series has significant explanatory power for another series. This test is based on the simple logic that effect cannot precede cause. It is used to ascertain the short-term relationship among the stock markets under study. The granger causality test is based on the following regression equations:

$$X_t = \alpha_0 + \sum_{i=1}^{k} \beta_i Y_{t-i} + \sum_{i=1}^{k} \gamma_i X_{t-i} + e_t$$

$$Y_t = \alpha_0 + \sum_{i=1}^{k} \gamma_i X_{t-i} + \sum_{i=1}^{k} \beta_i Y_{t-i} + e_t$$

Where, γ_i and β_i, i = 0,1,2…..,k are parameters and α's are constants, e_t's are error terms with zero mean and finite variances. The null hypothesis that Y_t does not granger cause X_t is not accepted if the i > 0 in first equation. Similarly, X_t granger cause Y_t is the i > 0 in the second equation.

This test will generate results about the short-run causal effects of one market on other markets under study.

3.5.9 Vector Autoregression (VAR)

VAR models are econometric tool that are used to forecast the system of interrelated time series by capturing the linear interdependencies among multiple time series and analyzing the impact of random disturbances on the system of variables. It generalizes the uni-variate autoregression (AR) models and treats all variables on equal footing. Under VAR, each variable has an equation explaining whose values are based on its own lags and the lags of all other variables in the model. VAR models were popularized by Sims (1980), who has given the mathematical form of the VAR models as follows:

$$Y_t = A_1 Y_{t-1} + \dots\dots\dots\dots + A_p Y_{t-p} + B X_t + \varepsilon_t$$

where, $Y_t = k$ vector of endogeneous variables

$X_t = d$ vector exogeneous variables

$A_1, \dots\dots\dots A_p$ and B = matrices of coefficients to be estimated

ε_t = vector of innovation that may be contemporaneously correlated but are uncorrelated with their own lagged values and with all the right hand side variables.

The error term, also known as innovations, can provide a source of new information about the movements in the variables during current period.

The impulse response function and the variance decomposition are derived from VAR. Sims (1980) described these tests as Innovation Accounting. These tests allow access to the direction and strength of the variables in the system. Moreover, unrestricted VAR model can also be used for appropriate lag selection, to be used for other tests using lag selection criteria or Lag Exclusion Wald test.

The VAR model is used for lag selection and for conducting further tests of innovation accounting in this present study.

3.5.10 Impulse Response Function (IRF)

A shock to the *i*-th variable not only directly affects the *i*-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. An IRF traces the affect of one-time shock to one of the innovations on current and future values of the endogenous variables.

If the innovations are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. The *i*-th innovation is simply a shock to the *i*-th endogenous variable. Innovations, however, are usually correlated and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses it is common to apply a transformation to the innovations so that they become uncorrelated.

3.5.11 Variance Decomposition (VDC)

While IRFs trace the affects of a shock to one endogenous variable on to the other variables in the VAR, VDC separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the VDC provides information about the relative importance of each random innovation in effecting the variables in the VAR. VDC is nothing more, but the tabular presentation of the IRF and IRF is the graphical representation of the VAR results.

3.5.12 GARCH (1,1) Model

The Generalized Autoregressive Conditionally Heteroskedastic (GARCH) model helps the researcher to capture the volatility linkages between each time series/market independently. Volatility of a financial time series can be measured by simple unconditional standard deviation but this standard deviation tends to ignore the necessary information on random process generating variables and also deform the nature of volatility pattern owing to smoothing (Bini-Smaghi, 1991). The volatility of a stock market return series appears to be serially correlated. So, in order to identify this serial correlation of volatility, Engle (1982) introduced the class of Autoregressive Conditionally Heteroskedastic (ARCH) models. Bollerslev (1986) extended Engle's original work and suggested the GARCH model. The GARCH (1,1) model is more popular in practice. This model for the stock returns can be presented as follows:

$$R_t = \mu + R_{t-1} + \varepsilon_t \text{ (Mean Equation)}$$

where, R_t = Return Series

μ = Mean

R_{t-1} = Return series at previous time period

ε_t = residual at time t

$$h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \text{ (Variance Equation)}$$

where, ht = conditional variance at time t

ω, α, β = non-negetive constraints for all the coefficients, where ω represents constant value, α symbolizes ARCH term, and β stands for GARCH term

ε_{t-1}^2 = square of residual at time t-1

h_{t-1} = conditional variance at time t-1

According to Chou (1988), the dynamic structures of conditional variance can be captured more flexibly by GARCH framework. In GARCH (1,1), when $\alpha + \beta$ approaches unity the persistence of shocks to the volatility of asset returns is greater and continue over a long time. The consequence of any shock on volatility dies out at a rate of $(1 - \alpha - \beta)$.

If $(\alpha + \beta) > 1$, the effect of shock will never die out or terminate. The volatility will be defined only if $(\alpha + \beta) < 1$. Therefore, this condition is imposed while estimating the GARCH model.

GARCH (1,1) model is also used to test the weak form market efficiency of stock markets. These models also capture the existence of volatility clustering in the stock market which is a sign of market inefficiency.

Since one of the objectives of the present study is to investigate the sudden changes in volatility, so the focus is on the estimation of a simple but most commonly used standard GARCH model; i.e., GARCH (1,1).

3.6 CONCLUSION

The purpose of this chapter is to describe the research methodology used in this thesis. Its first section specifies the research objectives, followed by research questions and hypotheses to be tested in order to achieve the mentioned objectives of the study. The second section is dedicated to the sample data and the sources from which the data are collected. The last section describes the research techniques adopted for analysis of the data and to answer the research questions of the present study. This study applies to various econometric techniques to test the hypotheses framed in this study and the detailed description of these techniques is given in this section. The chapter ends here with the conclusion that summarizes all the headings covered in the chapter on research methodology.

CHAPTER - 4

STOCK MARKET EFFICIENCY:

EMPIRICAL ANALYSIS

The purpose of this chapter is to analyze the data pertaining to the daily closing prices of eleven Asian and one US stock markets. Analysis incorporates testing the weak form market efficiency of the stock markets as stated earlier. It is devoted to examining the first research question mentioned in the previous chapter. It further fulfils the first objective of the study; i.e., to test the informational efficiency of the selected stock markets from Asia and the US.

The time series data analyzed here is for a period of twelve years which is divided into four equal sub-periods. The equal sub-division provides time varying results and the impact of the global financial crisis could be captured. The analysis puts forward the characteristics of the stock market data which is presented here initially through descriptive statistics followed by the summarized results of the runs test, ACF test, unit root (ADF and PP) test and the variance ratio test. The results of these tests are presented in the following sections.

4.1 DESCRIPTIVE STATISTICS

The descriptive statistics provides the basic features of the data and forms the basis for quantitative analysis for any form of data. In the present kind of research, large numbers of numerical figures are available for analysis. The descriptive statistics helps to simplify this large amount of data into simple, sensible and manageable summary, that further help in simpler interpretation of the data. The summary statistics of the return of the respective series is presented in the tables given below. The values provide precise statistical measurements to describe the basic characteristics of the time series.

It is seen from the table 4.1 that all the stock markets have positive mean return except NIK (-8.47E-05), which has the lowest mean returns and amongst the markets with positive mean returns, JC (0.00787) has the highest mean return. KSE (16.65%) was found to be the most volatile market since it has the highest standard deviation and SP (1.53%) was the least volatile market. The values of skewness[1] show that the SC, HS, KLSE, NIK, ST, TW and TA were negatively skewed, indicating greater probability of large decrease in returns, whereas NSE,

Table 4.1: Descriptive Statistics (Total Period)												
	NSE_R	KSE_R	SC_R	HS_R	JC_R	KLSE_R	NIK_R	ST_R	KSP_R	TW_R	TA_R	SP_R
Mean	0.0058	0.0052	0.0024	0.0023	**0.0079**	0.0026	**-8.47E-05**	0.0021	0.0037	0.0014	0.0036	1.92E-05
Std. Dev.	0.0654	**0.1665**	0.0419	0.0218	0.0570	0.0193	0.0252	0.0174	0.0265	0.0250	0.0447	**0.0153**
Skewness	1.36	0.76	-0.71	-0.26	0.47	-0.52	-0.28	-0.76	0.02	-0.01	-0.12	0.02
Kurtosis	365.98	123.22	150.11	15.72	210.99	41.93	21.14	29.96	28.76	25.26	8.59	13.43
Jarque-Bera	16365474	1795362	2688357	20120.98	5373517	188412.1	40906.89	90577.77	82432.92	61566.27	3885.354	13513.44
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.1A: Descriptive Statistics (Period 1)												
	NSE_R1	KSE_R1	SC_R1	HS_R1	JC_R1	KLSE_R1	NIK_R1	ST_R1	KSP_R1	TW_R1	TA_R1	SP_R1
Mean	0.0023	-0.0092	0.0021	-3.73E-05	**0.0021**	1.30E-05	-0.0013	-7.18E-05	-0.0011	**-8.43E-05**	8.40E-05	-4.52E-05
Std. Dev.	0.0183	**0.3105**	0.0724	0.0277	0.1063	0.0278	0.0223	0.0221	0.0344	0.0338	0.0596	**0.0146**
Skewness	-0.13	0.52	-0.15	-0.40	0.30	-0.66	0.03	-1.08	-0.71	0.04	-0.15	0.18
Kurtosis	4.98	39.46	63.24	12.51	69.08	24.59	13.95	33.17	15.54	16.53	6.79	6.68
Jarque-Bera	124.95	41457.93	113415.5	2844.21	136484.7	14620.69	3748.5	28594.89	4977.51	5724.78	450.67	425.98
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.1B: Descriptive Statistics (Period 2)												
	NSE_R2	KSE_R2	SC_R2	HS_R2	JC_R2	KLSE_R2	NIK_R2	ST_R2	KSP_R2	TW_R2	TA_R2	SP_R2
Mean	0.0090	**0.0021**	-0.0035	0.0030	0.0012	0.0038	**-3.90E-06**	0.0032	0.0036	0.0012	0.0044	6.46E-05
Std. Dev.	0.0139	**0.1097**	0.0132	0.0196	0.0275	**0.0128**	0.0283	0.0137	0.0297	0.0202	0.0547	0.0133
Skewness	-1.29	-0.84	0.96	-0.25	-0.05	-0.30	-0.49	0.18	1.08	-0.64	-0.02	0.02
Kurtosis	16.41	76.27	9.04	26.08	34.50	24.85	27.93	20.58	39.51	13.2	4.50	5.78
Jarque-Bera	5823.75	167708.9	1253.14	16631.24	30961.01	14910.12	19423.15	9652.45	41751.47	3305.49	70.32	241.47
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.1C: Descriptive Statistics (Period 3)

	NSE_R3	KSE_R3	SC_R3	HS_R3	JC_R3	KLSE_R3	NIK_R3	ST_R3	KSP_R3	TW_R3	TA_R3	SP_R3
Mean	0.0014	0.0011	**0.0019**	0.0090	0.0014	0.0063	**0.0026**	0.0070	0.0099	0.0044	0.0079	0.0070
Std. Dev.	0.0156	0.0230	0.0171	0.0136	0.0197	**0.0109**	0.0195	0.0130	0.0187	0.0148	0.0189	**0.0432**
Skewness	-0.3649	-0.4929	-0.5353	-0.1335	-0.2404	-0.3994	-0.3464	-0.1181	0.0945	-0.2119	-0.1064	-0.1371
Kurtosis	6.72	16.86	6.48	8.82	37.83	20.11	11.88	13.09	17.17	14.01	11.24	21.80
Jarque-Bera	445.21	5988.84	410.51	1050.69	37610.00	9090.72	2460.04	3154.69	6225.73	3761.48	2105.73	10963.21
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.1D: Descriptive Statistics (Period 4)

	NSE_R4	KSE_R4	SC_R4	HS_R4	JC_R4	KLSE_R4	NIK_R4	ST_R4	KSP_R4	TW_R4	TA_R4	SP_R4
Mean	-0.0030	-0.0014	**-0.0086**	-0.0024	0.0034	5.33E-05	-0.0050	-0.0011	0.0014	0.0010	8.50E-05	**0.0013**
Std. Dev.	**0.1289**	0.0396	0.0362	0.0238	0.0216	0.0208	0.0295	0.0194	**0.0191**	0.0269	0.0326	0.0485
Skewness	0.7477	0.0650	-3.1919	0.0784	-0.0065	0.1126	-0.1651	-0.6038	-0.2131	0.2602	-0.1602	0.0463
Kurtosis	99.00	39.39	64.48	8.34	8.15	40.23	14.85	15.02	12.20	28.43	7.95	24.08
Jarque-Bera	282336.3	40564.19	117015.2	873.30	811.36	42441.95	4300.83	4468.69	2595.28	19811.29	754.71	13602.85
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

KSE, JC, KSP and SP are positively skewed markets. Similarly, the values of kurtosis[2] also show that none of the market falls on the edge of the normal distribution curve since the values of kurtosis for all the markets are greater than 3, ranging from 365.98 for NSE to 8.587476 for TA, indicating leptokurtic distribution. The JB statistic is used to measure the normality of the distribution. The calculated JB statistics and corresponding p-values in table 4.1 are used to test null hypothesis that the daily distribution of all the market's returns are normally distributed. All p-values are smaller than the 0.05, suggesting that the null hypothesis is rejected at the 95 percent level of confidence. Thus, none of the return series followed the normal distribution.

The descriptive statistics for the first, second, third and fourth sub-periods is presented in table 4.1A, table 4.1B, table 4.1C, and table 4.1D respectively, for all the twelve markets. It can be clearly seen from the above-mentioned tables that similar to the results of total period, JC (0.00271) has the highest mean return in period-1 and, also, it is followed by KSE (0.002058) in period-2, SC (0.001914) in period-3 and SP (0.001296) in period-4. But TW (-8.43E-05) has the lowest mean return in period-1, NIK (-3.90E-06 and 0.00260) in both period-2 and period-3 and SC (-0.00857) in period-4.

As far as the volatility of the stock markets is concerned, similar to total period, KSE (31.05% and 10.97%) was again most volatile market during the period-1 and the period-2, while SP (4.32%) was most volatile in period-3 and NSE (12.89%) in period-4. Whereas, SP (1.46%) was the least volatile in period-1, followed by KLSE (1.28% and 1.09%) in period-2 and period-3 and KSP (1.91%) in period-4.

For all the four sub-periods, the values of skewness ($\neq 0$) and kurtosis ($\neq 3$) suggest that the stock returns do not follow a normal distribution, which is also verified with the Jarque-Bera[3] statistic and the probability values (< 0.05).

4.2 TESTS FOR EFFICIENCY

The following section deals with the tests such as runs test, ACF test, unit root test and variance ratio test to check the randomness of the time series.

4.2.1 Runs test

The runs test is well known and widely used to detect the random walk. According to Mollah (2006), the number of runs is computed as a progression of the price changes of the same sign. When likely numbers of runs differ significantly from the observed number of runs, the null hypothesis of randomness is rejected. The runs test also converts the total number of runs into a

Z statistic. For large samples, the *Z* statistics give the probability of difference between the actual and expected number of runs. The *Z* value, greater than ±1.96, rejects the null hypothesis at 5 percent level of significance (Sharma and Kennedy, 1997).

The results of the runs test for returns on selected indices for all the twelve stock markets are reported in table 4.2 for all the five time periods. This table presents the results in a summarized form to save the space. The detailed tables are provided in Appendix A.

Table 4.2: Runs Test

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
Total Period	No	Yes	Yes	No	No	No	No	Yes	Yes	Yes	No	No
Period – 1	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Period – 2	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Period – 3	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No
Period – 4	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No

From the table 4.2, it is observed here that the *Z* values are greater than ±1.96 .It means that the observed or actual numbers of runs are less than the expected number of runs for all markets in total time period except NSE, HS, JC, KLSE, NIK, TA, and SP, thus it can be concluded that these seven return series do not follow random walk during the total time-period of the study. Therefore, all markets are weak form efficient except for the seven markets in the total time period. But the results differ for HS, JC, NIK and SP in period-1. In period-2, all markets followed the same trend as in period-1 except, KLSE and SP; i.e., only these two markets were inefficient in weak form in period-2. Similarly, for period-3, only NIK and ST differ in the random walk as compared to period-2. In other words, only these two markets changed their behaviour from period-2 to period-3 as compared to the other markets. Again, in period-4 also only two markets, NSE and KSE have changed their behaviour in comparison to period-3.

It can be concluded from the table 4.2 that the SC, KSP and TW were weak form efficient and only TA is the one which is inefficient in a total time period as well as for all the four sub-periods. Only JC is an exception in total time periods that do not follow a random walk while SP is an exception in period-2 - the only market that follows a random walk. The NSE and KSE are the markets that have changed their behaviour only in period-4 else these markets were following the same trend in total time period and the first three sub-periods.

4.2.2 Autocorrelation Function (ACF)

Autocorrelation test is used to test the dependence or independence of random variables in a series. The ACF tests whether the correlation coefficients are significantly different from zero. The ACF identify and measure the relationship between the values of a variable at time 't' and in the previous period, 't-1'.

The significance level of ACF at each lag can be tested using the method recommended by Brooks (2002), where the critical value is calculated as (i.e., twice of standard error), where *N* is the number of observations in each time period. The decision rule of test is that the null hypothesis of independence among price changes would be rejected if the autocorrelation coefficient were more than twice of standard error.

Since, it is not easy to evaluate market efficiency from individually statistically significant coefficients, the Q-Statistic test is also performed in order to draw some more generalized findings and evaluate the overall ACF. If p-value of the Q-Statistic is less than 0.05, the null hypothesis of all autocorrelation coefficients jointly equal to zero, it can be rejected at 5 percent level of significance. It can, hence, be concluded that the past returns be used to predict the future returns making the weak form efficiency not valid anymore.

Table 4.3 reports the autocorrelation test results for a total time period of the twelve stock market returns taken for the study. The values show that the autocorrelation of the log differences of stock price indices dies off more quickly than autocorrelation of the stock index series. The results for autocorrelation of stock price series are presented here for lag one to ten continuously and individually at a distance of five lags, up to lag 30. This result indicates that the differences in the rate of stock returns are likely to be a stationary process.

The ACF of all the twelve markets along with their Q-statistic is presented in table 4.3 for the total time period. It is evident from table 4.3 that the ACFs are significant at various lags starting from the very first lag for all the stock markets. The TA is the highly autocorrelated market because it has maximum significant autocorrelation coefficients at various lags shown here. The TA is followed by NSE, SC and SP. The KSE, ST and TW follow the same level of autocorrelation as their numbers of autocorrelation coefficients are equal. Similarly, after KSE, ST and TW, the HS, JC and KLSE have a similar degree of autocorrelation and NIK and KSP also has the same level of autocorrelation but less than HS, JC and KLSE.

The presence of non-zero autocorrelation coefficients in the log of market return series clearly indicate that there is a serial dependence between the values and the significant autocorrelation of daily market returns for the sample period. The non-zero autocorrelation of the series associated with Ljung-Box Q-Statistics that are jointly significant at 1 percent level at 30 degrees of freedom (lags) suggest that the return series of all the twelve markets does not follow the random walk model and, thus, past returns could be used to predict the future returns for a total time period considered for the present study.

Table 4.3A, table 4.3B, table 4.3C and table 4.3D represents the results of autocorrelation with the Q-statistic for the period-1, period-2, period-3 and period-4 respectively. It can be seen from the tables that for the period-1, the NSE does not have any significant autocorrelation coefficient whereas the rest of the markets have a significant autocorrelation coefficient at one or the other lags. For period-2, SC is the only market that does not have any significant autocorrelation coefficient but all other markets do. Similar to period-1, in period-3 also, all other markets have a significant autocorrelation coefficient except NSE whereas, in period-4 JC and SC are the two markets that do not have the significant autocorrelation coefficient while other ten markets do have.

The Ljung-Box Q-Statistics also give the same results for all the markets in all the four sub-periods that the Q test rejects the joint null hypothesis of zero autocorrelations at 1 percent level. It can be concluded that, as in the case of the total time period, all the twelve markets are inefficient markets during the four sub-periods of the study.

Table 4.3: Autocorrelation Function and Ljung Box Q-Statistics (Total Period)

	NSE		KSE		SC		HS		JC		KLSE	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	**-0.387**	446.91	**-0.425**	537.80	**-0.283**	238.51	**-0.144**	61.451	**-0.493**	725.78	**-0.247**	181.36
2	**-0.039**	451.54	**-0.054**	546.45	**-0.049**	245.75	**-0.045**	67.494	**0.209**	856.52	**-0.059**	191.79
3	**0.041**	456.63	0.022	547.84	-0.005	245.83	**-0.046**	73.938	**-0.108**	891.41	0.015	192.45
4	**-0.059**	467.12	**-0.072**	563.49	-0.013	246.36	0.003	73.964	**-0.039**	895.89	-0.024	194.10
5	**0.078**	485.32	**0.104**	595.66	**-0.073**	262.20	-0.029	76.432	-0.008	896.09	**0.074**	210.57
6	**-0.182**	584.26	**-0.066**	608.66	**0.054**	270.81	-0.023	78.025	-0.011	896.48	-0.029	213.03
7	**0.086**	606.22	0.008	608.84	**-0.057**	280.50	0.028	80.319	-0.005	896.56	0.007	213.18
8	**-0.074**	622.65	-0.011	609.21	0.016	281.26	0.030	82.937	-0.002	896.57	-0.001	213.19
9	**0.042**	627.88	0.022	610.68	**0.127**	329.64	-0.003	82.973	-0.019	897.65	-0.009	213.41
10	**0.110**	664.25	0.017	611.57	**-0.067**	342.92	-0.034	86.368	-0.00	897.65	-0.030	216.05
15	**0.148**	865.86	-0.010	621.52	**-0.074**	375.52	0.002	92.511	-0.004	900.83	-0.016	232.60
20	0.019	943.89	-0.009	629.61	0.012	397.96	-0.006	99.412	0.006	901.95	0.010	252.81
25	-0.009	990.01	0.004	634.25	0.044	475.99	**0.046**	108.60	0.006	903.33	0.011	258.89
30	-0.020	1028.7	-0.012	636.81	0.005	486.81	-0.007	123.17	0.001	904.24	**-0.058**	270.47
N	2970		2871		2922		2898		2832		2884	
2S.E	0.0367		0.0373		0.0370		0.0371		0.0376		0.0372	

Note: The figures in bold are significant at 2 standard error.

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Table 4.3: Autocorrelation Function and Ljung Box Q-Statistics (Total Period)

	NIK		ST		KSP		TW		TA		SP	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	**-0.261**	203.67	**-0.129**	49.723	**-0.138**	56.912	**-0.179**	95.206	**-0.421**	527.83	**-0.166**	82.526
2	**-0.044**	209.48	**-0.057**	59.347	**-0.073**	72.815	-0.021	96.490	**-0.046**	534.25	**-0.039**	86.955
3	**-0.037**	213.61	0.040	64.179	**-0.094**	99.217	0.022	97.877	-0.018	535.27	0.010	87.242
4	-0.016	214.34	-0.015	64.877	0.010	99.494	**-0.062**	109.18	**-0.191**	643.75	-0.012	87.670
5	-0.011	214.67	-0.00	64.877	0.027	101.67	-0.004	109.22	**0.470**	1302.4	-0.020	88.840
6	0.014	215.24	-0.006	64.975	-0.030	104.38	**-0.069**	123.42	**-0.227**	1456.0	-0.014	89.457
7	0.036	219.21	0.006	65.077	0.017	105.29	0.017	124.25	-0.029	1458.5	0.018	90.460
8	0.00	219.22	0.006	65.187	0.004	105.35	-0.019	125.37	**-0.051**	1466.4	-0.009	90.688
9	-0.028	221.59	-0.013	65.678	-0.012	105.76	0.017	126.28	**-0.083**	1486.9	**-0.038**	94.957
10	-0.014	222.14	-0.018	66.675	0.011	106.10	-0.016	127.04	**0.331**	1815.1	**0.042**	100.13
15	0.007	228.62	0.00	71.856	-0.033	118.52	**0.049**	140.74	**0.214**	2045.2	**0.047**	109.90
20	0.023	239.74	0.008	74.981	-0.020	125.00	**-0.054**	151.11	**0.127**	2150.1	-0.014	122.12
25	-0.033	255.19	0.070	110.88	-0.011	150.39	0.004	155.76	**0.109**	2215.4	**0.040**	141.86
30	-0.015	261.49	-0.049	124.20	-0.011	154.63	0.008	163.11	**0.079**	2253.6	-0.013	146.36
N	2854		2923		2885		2863		2461		2929	
2S.E	0.0374		0.0370		0.0372		0.0374		0.0403		0.0370	

Note: The figures in bold are significant at 2 standard error.

Table 4.3A: Autocorrelation Function and Ljung Box Q-Statistics (Period 1)												
	NSE		KSE		SC		HS		JC		KLSE	
Lags	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat
1	0.066	3.3037	**-0.448**	151.02	**-0.346**	90.037	**-0.149**	16.691	**-0.554**	230.73	**-0.224**	37.707
2	-0.040	4.5342	-0.050	152.89	-0.030	90.696	**-0.083**	21.911	**0.244**	275.79	**-0.089**	43.628
3	-0.013	4.6644	0.062	155.78	-0.031	91.422	-0.051	23.847	**-0.123**	287.15	0.040	44.845
4	0.034	5.5598	**-0.103**	163.79	0.001	91.422	-0.003	23.855	-0.033	287.99	-0.042	46.158
5	0.014	5.7024	**0.116**	173.95	**-0.086**	97.015	-0.025	24.325	-0.002	287.99	**0.110**	55.284
6	-0.057	8.1772	**-0.087**	179.73	0.051	99.018	-0.044	25.822	-0.009	288.05	-0.029	55.941
7	-0.011	8.2717	0.026	180.23	-0.067	102.41	0.040	27.014	-0.004	288.07	0.009	56.002
8	0.006	8.2997	-0.013	180.35	0.018	102.66	0.022	27.366	-0.004	288.08	-0.006	56.031
9	0.046	9.8765	0.024	180.78	**0.173**	125.35	**0.104**	35.618	-0.013	288.21	-0.013	56.153
10	0.070	13.653	0.018	181.03	**-0.090**	131.59	**-0.090**	41.841	-0.001	288.21	-0.049	57.986
15	0.016	17.005	-0.005	184.68	**-0.102**	147.01	-0.012	47.729	-0.001	289.21	-0.021	66.693
20	-0.060	22.457	-0.012	187.49	0.020	156.09	0.046	51.195	0.006	289.82	-0.019	72.149
25	0.006	28.457	0.005	189.01	0.067	192.89	0.038	55.991	0.004	290.21	-0.016	75.693
30	0.015	35.162	-0.008	189.84	-0.015	197.67	-0.036	66.706	0.003	290.58	**-0.088**	82.409
N	729		714		700		724		704		718	
2S.E	0.0740		0.0748		0.0756		0.0744		0.0754		0.0746	

Note: The figures in bold are significant at 2 standard error.

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Table 4.3A: Autocorrelation Function and Ljung Box Q-Statistics (Period 1)												
	NIK		**ST**		**KSP**		**TW**		**TA**		**SP**	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	**-0.245**	45.099	**-0.183**	25.304	-0.058	2.5096	**-0.300**	67.886	**-0.395**	117.69	**-0.098**	7.2067
2	-0.028	45.705	-0.005	25.325	**-0.136**	16.372	0.012	67.995	-0.070	121.36	0.006	7.2382
3	-0.055	47.964	0.006	25.350	**-0.153**	34.123	**0.076**	72.365	-0.055	123.68	**-0.075**	11.516
4	0.024	48.387	-0.002	25.352	0.022	34.482	**-0.127**	84.485	**-0.177**	147.27	-0.013	11.644
5	0.033	49.227	-0.004	25.364	0.043	35.886	0.064	87.591	**0.514**	347.14	-0.048	13.399
6	-0.037	50.256	-0.005	25.379	-0.018	36.129	-0.032	88.353	**-0.248**	393.74	0.010	13.472
7	0.045	51.824	0.043	26.774	0.006	36.154	0.024	88.785	-0.031	394.45	0.009	13.533
8	0.031	52.564	0.009	26.837	0.018	36.390	-0.058	91.346	-0.055	396.76	-0.037	14.567
9	-0.069	56.187	-0.032	27.592	0.016	36.576	**0.085**	96.879	**-0.107**	405.52	-0.029	15.197
10	0.014	56.335	-0.057	30.081	-0.016	36.768	-0.021	97.223	**0.377**	513.66	0.072	19.106
15	0.011	57.369	-0.017	34.835	-0.038	40.645	0.048	101.29	**0.272**	596.94	0.005	22.769
20	-0.017	60.544	-0.002	36.627	-0.019	42.158	**-0.081**	107.91	**0.164**	636.70	-0.039	27.718
25	0.034	63.997	0.048	54.850	-0.032	47.605	-0.024	114.32	**0.143**	663.06	0.052	32.773
30	0.006	66.759	**-0.093**	63.103	-0.059	54.287	0.005	118.80	**0.105**	680.26	0.013	35.937
N	702		718		720		710		651		727	
2S.E	0.0755		0.0746		0.0745		0.0747		0.0784		0.0742	

Note: The figures in bold are significant at 2 standard error.

Table 4.3B: Autocorrelation Function and Ljung Box Q-Statistics (Period 2)												
	NSE		KSE		SC		HS		JC		KLSE	
Lags	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat
1	**0.084**	5.2605	**-0.261**	51.059	0.029	0.6113	**-0.296**	65.821	**-0.085**	5.4240	**-0.152**	17.305
2	**-0.126**	17.247	**-0.092**	57.440	-0.024	1.0632	0.042	67.170	**-0.085**	10.835	**-0.075**	21.588
3	0.070	20.994	**-0.291**	121.09	0.030	1.7397	**-0.119**	77.806	0.048	12.598	-0.072	25.443
4	**0.110**	30.178	**0.154**	138.90	-0.008	1.7826	**0.108**	86.586	**-0.164**	33.014	0.051	27.423
5	-0.032	30.943	0.032	139.69	-0.037	2.8160	**-0.090**	92.716	-0.043	34.384	-0.014	27.568
6	-0.072	34.871	0.091	146.00	-0.021	3.1659	0.018	92.951	-0.021	34.725	-0.009	27.629
7	-0.033	35.714	**-0.130**	158.90	0.015	3.3464	-0.025	93.433	-0.018	34.964	0.010	27.708
8	-0.008	35.764	0.001	158.90	-0.015	3.5231	0.024	93.884	-0.008	35.010	0.034	28.570
9	0.033	36.582	0.011	159.00	-0.003	3.5319	-0.017	94.100	-0.069	38.641	-0.043	29.982
10	0.065	39.835	0.011	159.09	0.043	4.9307	0.005	94.115	0.057	41.072	0.008	30.031
15	-0.055	46.340	-0.058	173.25	0.013	7.5113	-0.033	103.93	-0.068	50.698	-0.011	30.654
20	0.045	52.079	0.004	173.43	0.016	14.186	-0.100	126.69	-0.022	64.644	**-0.093**	37.989
25	-0.012	53.746	0.011	173.69	-0.022	15.554	0.015	130.25	0.010	65.456	0.067	58.821
30	-0.009	62.676	-0.002	173.76	-0.001	18.382	0.005	130.80	-0.012	66.172	0.032	62.475
N	739		723		744		727		720		726	
2S.E	0.0736		0.0744		0.0733		0.0742		0.0745		0.0742	

Note: The figures in bold are significant at 2 standard error.

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Table 4.3B: Autocorrelation Function and Ljung Box Q-Statistics (Period 2)

	NIK		ST		KSP		TW		TA		SP	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	**-0.321**	77.708	**-0.083**	5.2311	**-0.238**	42.762	**-0.081**	4.9263	**-0.485**	177.13	**-0.096**	6.8694
2	-0.007	77.750	**-0.110**	14.350	-0.048	44.512	0.045	6.4602	-0.024	177.57	-0.045	8.3659
3	-0.013	77.884	0.038	15.419	-0.070	48.248	-0.026	6.9564	0.029	178.21	0.011	8.4571
4	-0.020	78.194	-0.011	15.512	-0.004	48.258	-0.057	9.3905	**-0.259**	228.89	-0.003	8.4642
5	-0.001	78.196	0.016	15.712	0.057	50.684	**-0.112**	18.935	**0.543**	451.97	**-0.081**	13.373
6	-0.031	78.944	-0.036	16.692	-0.056	53.050	0.025	19.403	**-0.275**	509.20	0.006	13.403
7	**0.092**	85.316	-0.064	19.803	0.036	54.012	-0.073	23.399	-0.028	509.78	0.005	13.425
8	-0.024	85.745	0.014	19.943	-0.031	54.721	0.017	23.610	-0.063	512.79	-0.009	13.491
9	-0.031	86.469	0.010	20.025	-0.014	54.865	-0.001	23.611	-0.071	516.68	0.012	13.596
10	-0.009	86.534	-0.027	20.562	0.016	55.052	-0.038	24.732	**0.378**	625.16	0.037	14.629
15	-0.028	89.789	-0.021	26.193	-0.071	86.350	0.006	33.509	**0.234**	707.28	-0.030	18.359
20	**0.090**	99.989	0.010	26.779	0.010	89.668	**-0.080**	40.228	**0.143**	743.37	-0.075	25.013
25	-0.030	102.59	0.065	32.514	-0.028	118.26	0.039	46.868	**0.104**	759.75	0.020	25.663
30	-0.041	107.46	-0.017	35.989	-0.024	120.30	0.055	53.883	**0.094**	773.69	0.027	27.729
N	708		730		721		719		667		731	
2S.E	0.0752		0.0740		0.0745		0.0746		0.0774		0.0740	

Note: The figures in bold are significant at 2 standard error.

Table 4.3C: Autocorrelation Function and Ljung Box Q-Statistics (Period 3)

	NSE		KSE		SC		HS		JC		KLSE	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	0.013	0.1270	**-0.202**	30.411	-0.029	0.6406	**-0.138**	14.162	**-0.098**	7.1134	**-0.081**	4.8427
2	-0.055	2.3729	0.032	31.200	-0.023	1.0494	**-0.081**	19.115	0.002	7.1172	**-0.083**	9.9988
3	-0.015	2.5459	-0.019	31.472	**0.082**	6.0857	**0.095**	25.924	**-0.091**	13.383	0.038	11.100
4	0.047	4.2351	0.020	31.765	0.030	6.7758	0.008	25.976	-0.030	14.078	-0.062	13.969
5	0.012	4.3507	**-0.079**	36.404	0.001	6.7773	-0.058	28.511	-0.046	15.682	**-0.088**	19.847
6	-0.059	7.0036	0.028	37.009	-0.072	10.636	-0.007	28.544	-0.067	19.035	-0.012	19.947
7	-0.046	8.6173	0.034	37.897	-0.023	11.040	-0.008	28.588	0.007	19.076	0.025	20.436
8	0.008	8.6698	-0.072	41.761	-0.002	11.043	-0.018	28.820	-0.041	20.362	-0.046	22.017
9	0.024	9.0985	**0.097**	48.811	0.023	11.436	-0.018	29.064	0.033	21.189	0.033	22.833
10	0.060	11.838	0.048	50.555	0.025	11.901	0.056	31.432	-0.019	21.455	**0.074**	26.999
15	0.007	21.290	-0.070	63.960	0.064	32.341	-0.027	37.923	0.014	27.231	-0.044	30.742
20	-0.046	34.771	-0.051	70.546	-0.010	39.652	0.048	41.862	-0.00	29.099	0.003	31.767
25	0.025	37.148	-0.028	74.478	-0.045	44.307	0.023	43.306	0.003	34.658	0.033	35.998
30	-0.053	39.489	-0.009	77.983	0.017	49.869	0.032	54.170	-0.035	38.410	-0.049	42.605
N	749		726		749		727		718		723	
2S.E	0.0731		0.0742		0.0731		0.0742		0.0746		0.0744	

Note: The figures in bold are significant at 2 standard error.

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Table 4.3C: Autocorrelation Function and Ljung Box Q-Statistics (Period 3)												
	NIK		**ST**		**KSP**		**TW**		**TA**		**SP**	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	**-0.271**	54.668	**-0.195**	28.325	**-0.230**	39.410	-0.055	2.2738	**-0.414**	127.91	-0.203	30.676
2	-0.050	56.517	**-0.113**	37.895	-0.046	41.023	**-0.116**	12.384	0.039	129.07	-0.033	31.509
3	-0.022	56.874	**0.085**	43.344	-0.021	41.364	0.038	13.478	-0.071	132.83	0.042	32.841
4	0.051	58.828	-0.007	43.377	0.021	41.682	0.012	13.579	-0.078	137.42	-0.048	34.595
5	-0.042	60.139	-0.045	44.927	-0.073	45.647	-0.008	13.623	**0.283**	197.74	-0.005	34.613
6	0.006	60.168	-0.013	45.050	0.011	45.730	-0.070	17.338	**-0.173**	220.13	-0.044	36.040
7	0.016	60.362	0.050	46.920	-0.005	45.753	-0.034	18.225	0.005	220.15	-0.040	37.217
8	-0.032	61.116	-0.054	49.151	0.006	45.779	-0.051	20.153	-0.075	224.34	0.023	37.607
9	-0.027	61.664	0.002	49.156	-0.001	45.779	0.021	20.474	0.074	228.45	-0.057	40.073
10	-0.026	62.177	0.056	51.521	**0.096**	52.757	-0.022	20.848	0.061	231.26	0.061	42.889
15	-0.002	65.570	0.002	56.034	0.051	60.572	-0.007	25.616	0.007	236.87	-0.046	46.640
20	0.029	66.451	0.048	58.822	-0.030	70.046	0.010	32.134	-0.042	241.56	0.016	61.911
25	**-0.091**	76.882	0.062	63.535	0.004	77.486	-0.029	38.631	-0.058	247.61	-0.010	66.779
30	-0.040	89.119	**-0.076**	73.504	-0.001	81.757	-0.027	42.895	-0.054	251.77	0.042	69.939
N	718		737		725		723		569		736	
2S.E	0.0746		0.0737		0.0743		0.0744		0.0838		0.0737	

Note: The figures in bold are significant at 2 standard error.

Table 4.3D: Autocorrelation Function and Ljung Box Q-Statistics (Period 4)												
	NSE		KSE		SC		HS		JC		KLSE	
Lags	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat	ACF	Q-Stat
1	**-0.408**	122.84	**-0.292**	62.912	**-0.129**	12.304	-0.034	0.8525	-0.010	0.0702	**-0.371**	101.40
2	-0.038	123.92	-0.038	63.963	**-0.142**	27.263	-0.040	2.0459	0.017	0.2943	0.009	101.45
3	0.043	125.27	-0.053	66.063	0.071	31.040	-0.041	3.3079	-0.025	0.7536	-0.004	101.46
4	-0.065	128.39	0.045	67.596	**-0.085**	36.340	-0.064	6.3175	-0.001	0.7547	-0.009	101.52
5	**0.082**	133.33	-0.041	68.817	-0.044	37.809	0.019	6.5727	-0.040	1.9208	**0.088**	107.27
6	**-0.188**	159.51	0.011	68.913	**0.098**	44.953	-0.029	7.2190	-0.009	1.9858	-0.042	108.59
7	**0.091**	165.67	-0.013	69.030	-0.038	46.022	0.060	9.9143	-0.010	2.0561	-0.004	108.61
8	**-0.078**	170.19	0.012	69.130	0.011	46.111	0.063	12.913	0.028	2.6296	0.005	108.63
9	**0.042**	171.51	-0.024	69.555	-0.020	46.398	**-0.144**	28.384	**-0.136**	16.373	0.002	108.63
10	**0.112**	180.94	0.029	70.192	-0.010	46.466	-0.019	28.664	-0.011	16.469	-0.041	109.88
15	**0.155**	236.83	0.062	73.306	-0.002	47.246	0.056	34.158	0.020	34.108	-0.002	112.40
20	0.021	258.36	0.032	79.241	-0.017	48.393	-0.040	42.575	0.050	40.449	**0.102**	152.71
25	-0.010	271.23	-0.014	82.241	-0.024	49.334	**0.078**	50.322	0.052	45.705	0.039	156.00
30	-0.021	281.98	-0.005	85.922	**0.080**	55.173	0.009	57.071	0.014	53.912	-0.035	158.06
N	750		706		727		718		688		715	
2S.E	0.0730		0.0753		0.0742		0.0746		0.0762		0.0748	

Note: The figures in bold are significant at 2 standard error.

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Table 4.3D: Autocorrelation Function and Ljung Box Q-Statistics (Period 4)												
	NIK		**ST**		**KSP**		**TW**		**TA**		**SP**	
Lags	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**	**ACF**	**Q-Stat**
1	**-0.224**	36.937	-0.052	1.9693	-0.017	0.2146	**-0.078**	4.4390	**-0.331**	80.786	**-0.220**	35.632
2	-0.062	39.771	-0.072	5.8340	0.008	0.2649	**-0.081**	9.2957	-0.048	82.483	-0.058	38.143
3	-0.018	39.999	0.063	8.8126	-0.044	1.7091	-0.046	10.869	0.004	82.496	0.042	39.430
4	-0.050	41.878	-0.040	10.010	-0.002	1.7126	0.017	11.090	**-0.127**	94.390	-0.009	39.489
5	-0.025	42.355	0.015	10.180	-0.026	2.2009	-0.045	12.597	**0.197**	123.25	0.014	39.631
6	0.040	43.522	0.010	10.255	-0.003	2.2066	**-0.182**	37.275	-0.034	124.11	-0.027	40.189
7	0.031	44.226	-0.027	10.807	-0.001	2.2072	0.068	40.674	-0.025	124.59	0.037	41.209
8	0.005	44.246	0.026	11.295	0.036	3.1906	0.040	41.860	-0.001	124.59	-0.00	41.209
9	-0.028	44.835	-0.006	11.319	-0.060	5.8955	**-0.083**	47.011	**-0.117**	134.87	-0.056	43.584
10	0.018	45.069	-0.005	11.337	-0.003	5.9013	0.004	47.022	**0.159**	153.85	0.025	44.038
15	0.035	48.352	0.033	16.996	-0.049	17.978	**0.089**	61.188	0.041	161.87	**0.116**	58.689
20	-0.036	53.829	-0.005	20.703	**-0.089**	32.564	-0.016	62.191	0.032	174.67	0.012	68.024
25	-0.040	70.409	0.101	35.740	0.069	42.465	0.026	65.248	0.059	182.88	0.055	80.396
30	0.004	77.542	-0.005	44.755	-0.008	50.101	-0.012	66.449	-0.007	185.61	-0.042	85.736
N	723		736		717		709		572		733	
2S.E	0.0744		0.0737		0.0747		0.0751		0.0836		0.0739	

Note: The figures in bold are significant at 2 standard error.

4.2.3 Unit Root Test

To obtain plausible and robust results for any conventional regression analysis, the data should be stationary (Gujarati, 1995). The unit root test is undertaken to test for non-stationarity as a necessary condition for random walk (Worthington and Higgs, 2003; Rao, 1994). According to the random walk hypothesis, the log price series should have a unit root while the return series should be stationary.

A stochastic process is said to be stationary if joint and the conditional distribution of the process is unchanged over the period of time. Whereas, a non-stationary process has no tendency to return to its long run mean and its variance changes over time. The non-stationary series can be obtained by differencing the original price series. According to Engle and Granger (1987), a series x_t is integrated of order 'd', denoted by $x_t \sim I(d)$, we can achieve stationarity in the process by differencing 'd' times. Specifically, $\Delta x_t = x_t - x_{t-1}$ will be stationary, which is integrated of order one (I(1)). The null hypothesis for ADF test states that the series contains unit root test and hence the series is said to be non-stationary. If after running the test at level, the null hypothesis is accepted; i.e., the series contains a unit root and thus non-stationary, and then same test is executed on the first difference of the series. If after obtaining the results on this, the null hypothesis is rejected, it can be concluded that the series is integrated of order one; i.e., I(1) because it became stationary after the first differencing. But, if the null hypothesis is accepted after running the test on first difference in the series that means the series still contains unit root and is non-stationary. In this case, second differencing of the series needs to be done and stationarity is checked again. The process will be repeated till the null hypothesis is not rejected and a stationary series in obtained.

The ADF approach controls higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression whereas, the PP test is less restrictive as compared to ADF test and it also provides an alternative way for checking the stationarity of a time series. The PP test is a more appropriate test as compared to the ADF (Christiano, 1992; Chu and White; 1992; Perron and Vogelsang, 1992a; Perron and Vogelsang, 1992b; Perron, 1990; Perron, 1989).

If the null hypothesis is rejected, the series is found to be non-stationary; i.e., series contains unit root. The series is fit for running the co-integration test only after confirming that all the series are integrated of the same order. Here, ADF and PP test is used to check the stationarity of the series and to test the degree of integration in variables considered in this research work. The ADF test results are presented in table 4.3A and table 4.3B represents the results of PP test.

Table 4.4A: Unit Root Test (Augmented Dickey Fuller)

Periods	Total Period		Period – 1		Period – 2		Period – 3		Period – 4	
Markets	**Level**	**First Difference**	**Level**	**First Difference**	**Level**	**First Difference**	**Level**	**First Difference**	**Level**	**First Difference**
NSE	-2.627572 (0.0875)	-14.17285 (0.000)	-1.228323 (0.6639)	-25.52444 (0.000)	-1.915292 (0.3253)	-15.05440 (0.000)	0.994377 (0.9966)	-26.18057 (0.000)	-2.072543 (0.2561)	-8.946716 (0.000)
KSE	-1.075925 (0.7274)	-39.77253 (0.000)	-1.119524 (0.73020)	-15.46061 (0.000)	-1.008653 (0.7518)	-18.70122 (0.000)	-1.316647 (0.6235)	-35.05437 (0.000)	-0.786154 (0.8219)	-20.75279 (0.000)
SC	-1.410557 (0.5786)	-48.11784 (0.001)	-0.740268 (0.8343)	-11.38843 (0.000)	-2.575276 (0.0986)	-26.49314 (0.000)	1.113294 (0.9976)	-27.73124 (0.000)	0.624127 (0.9904)	-23.11636 (0.001)
HS	-1.830500 (0.3659)	-43.94409 (0.000)	-1.703388 (0.4292)	-22.85065 (0.000)	-2.001747 (0.2862)	-20.17031 (0.000)	0.343811 (0.9804)	-15.69359 (0.000)	-1.143183 (0.7002)	-29.36216 (0.000)
JC	-2.723209 (0.0702)	-65.62768 (0.001)	-2.414262 (0.1381)	-26.59697 (0.000)	-2.115758 (0.2386)	-16.59854 (0.000)	0.542529 (0.9881)	-28.99244 (0.000)	-1.647447 (0.4577)	-29.34892 (0.001)
KLSE	-2.074676 (0.2552)	-50.11753 (0.001)	-1.539131 (0.5133)	-25.55732 (0.000)	-1.841636 (0.3603)	-19.35117 (0.000)	0.061024 (0.9626)	-29.77278 (0.000)	-1.298902 (0.6318)	-26.42719 (0.001)
NIK	-1.698523 (0.4319)	-39.88759 (0.000)	-1.644916 (0.4590)	-24.51739 (0.000)	-1.783716 (0.3888)	-25.66014 (0.000)	-1.753193 (0.4040)	-25.30637 (0.000)	-0.806808 (0.8162)	-34.37370 (0.000)
ST	-1.621163 (0.4716)	-44.15434 (0.000)	-1.617981 (0.4729)	-31.00863 (0.000)	-1.805085 (0.3782)	-22.70899 (0.000)	-0.554424 (0.8776)	-24.00689 (0.000)	-0.953103 (0.7711)	-29.33697 (0.000)
KSP	-1.897838 (0.3336)	-37.22343 (0.000)	-1.414261 (0.5764)	-20.64876 (0.000)	-2.158238 (0.2221)	-20.56416 (0.000)	-0.980470 (0.7618)	-32.01023 (0.000)	-1.884248 (0.3399)	-28.38736 (0.000)
TW	-2.675001 (0.0785)	-26.40925 (0.000)	-1.433078 (0.5670)	-16.78374 (0.000)	-2.270077 (0.1821)	-29.41414 (0.000)	-1.091762 (0.7208)	-22.57402 (0.000)	-1.651665 (0.4556)	-14.35690 (0.000)
TA	-1.627613 (0.4683)	-18.89644 (0.000)	-1.053183 (0.7355)	-17.13435 (0.000)	-2.053679 (0.2639)	-13.16960 (0.000)	-0.347883 (0.9150)	-13.09390 (0.000)	-1.232618 (0.6620)	-21.74921 (0.000)
SP	-1.994619 (0.2894)	-44.14761 (0.000)	-2.060951 (0.2609)	-30.48137 (0.000)	-1.732673 (0.4143)	-30.66832 (0.000)	-1.111916 (0.7128)	-33.53079 (0.000)	-0.500739 (0.8884)	-23.45153 (0.000)
CV at 5%	-2.8623		-2.8652		-2.8652		-2.8652		-2.8653	

Note: The figure in parenthesis represents the probability values.
Exogenous: Individual Effects
Lag Length: Automatic based on SIC
Deterministic terms: Intercept

Table 4.4B: Unit Root Test (Phillips Perron)

Periods	Total Period		Period – 1		Period – 2		Period – 3		Period – 4	
Markets	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
NSE	-1.666236 (0.5734)	-83.7052 (0.001)	-1.982847 (0.2946)	-25.43048 (0.000)	-1.966070 (0.3021)	-24.58591 (0.000)	-2.583570 (0.0968)	-26.21870 (0.000)	-1.992714 (0.1908)	-47.52365 (0.001)
KSE	-1.496114 (0.5357)	-98.69521 (0.001)	-1.01229 (0.2160)	-34.0823 (0.001)	-1.347643 (0.6088)	-57.68383 (0.001)	-1.003430 (0.7537)	-35.47087 (0.000)	-1.168509 (0.6897)	-41.81571 (0.001)
SC	-1.620520 (0.4719)	-70.31726 (0.001)	-2.544780 (0.1053)	-67.98239 (0.001)	-2.649531 (0.0836)	-26.48202 (0.000)	-2.178124 (0.2146)	-27.71818 (0.000)	0.210575 (0.9732)	-30.90886 (0.000)
HS	-1.875032 (0.3444)	-62.78001 (0.001)	-1.834677 (0.3637)	-34.21271 (0.000)	-2.044755 (0.2677)	-39.92483 (0.000)	-2.102297 (0.2439)	-30.27375 (0.000)	-0.850538 (0.8035)	-29.66562 (0.000)
JC	-2.476096 (0.1215)	-66.32067 (0.001)	-1.387141 (0.3117)	-32.87613 (0.001)	-1.774966 (0.3931)	-33.98431 (0.000)	-2.440047 (0.1311)	-29.91786 (0.000)	-1.627087 (0.4682)	-29.47035 (0.000)
KLSE	-2.067868 (0.2580)	-76.16148 (0.001)	-1.831415 (0.3653)	-37.62384 (0.000)	-1.747996 (0.4066)	-33.53757 (0.000)	-1.957684 (0.3058)	-30.76882 (0.000)	-1.294090 (0.6340)	-42.07926 (0.001)
NIK	-1.782165 (0.3898)	-77.33918 (0.001)	-0.996998 (0.7560)	-35.72464 (0.000)	-2.799283 (0.0588)	-43.97879 (0.001)	-0.926462 (0.7799)	-39.26443 (0.000)	-0.569275 (0.8745)	-36.34502 (0.000)
ST	-1.689224 (0.4367)	-61.47243 (0.001)	-1.545309 (0.5101)	-33.73172 (0.000)	-1.815380 (0.3731)	-30.63175 (0.000)	-0.894188 (0.7902)	-32.49716 (0.000)	-0.953103 (0.7711)	-29.34524 (0.000)
KSP	-1.970842 (0.3000)	-63.87037 (0.001)	-1.583714 (0.4904)	-30.63543 (0.000)	-2.750014 (0.0662)	-41.13660 (0.001)	-0.798365 (0.8186)	-34.17620 (0.000)	-1.842530 (0.3599)	-28.40771 (0.000)
TW	-2.732815 (0.0686)	-68.85775 (0.001)	-1.302972 (0.6299)	-39.19865 (0.000)	-1.946399 (0.3110)	-30.46134 (0.000)	-1.300380 (0.6311)	-29.54449 (0.000)	-1.813895 (0.3738)	-29.85022 (0.000)
TA	-2.156951 (0.2225)	-99.00466 (0.001)	-2.453574 (0.2103)	-31.40133 (0.001)	-2.433965 (0.1327)	-81.29252 (0.001)	-1.104063 (0.7160)	-46.39101 (0.001)	-2.029541 (0.2742)	-46.83482 (0.001)
SP	-1.994032 (0.2897)	-66.19338 (0.001)	-1.730705 (0.4153)	-31.44248 (0.000)	-1.656670 (0.4530)	-31.18406 (0.000)	-1.089224 (0.7218)	-35.38836 (0.000)	-0.633452 (0.8604)	-34.71943 (0.000)
CV at 5%	-2.8623		-2.8652		-2.8652		-2.8652		-2.8653	

Note: The figure in parenthesis represents the probability values.
MacKinnon (1996) one-sided p-values
Exogenous: Individual Effects
Bandwidth: Newey-West using Bartlett kernel
Deterministic Terms: Intercept

The results for ADF test for all the time periods understudy are presented in table 4.3A. The table shows that all the stock indices taken contain a unit root at level in all sub-periods of time. Since the indices are found to be non-stationary at levels, as a standard procedure the first differences for all the stock market prices are taken. The same test is applied again to the first difference of the price series. The results obtained are indicative of that all the twelve indices become stationary after differencing for one time.

Hence, for the first differences of all the variables the null hypothesis of a unit root is strongly rejected and no existence of unit root (stationarity) is found in the indices considered in the present study. The results signify that all index levels are integrated of the order one, I(1).

Hence, it can be said that all the variables contain a unit root, that is, non-stationary in their level forms, but stationary in their first differenced form in all the five time periods, which makes it clear that the recent financial crisis does not have any impact on the efficiency of stock markets under the present study. It shows that the extent of stock market efficiency does not vary with the financial disorders in the stock markets. Thus, the null hypothesis, first differences in these stock indices are non-stationary, is strongly rejected. Now the stock indices are I(1) process and the series can be modelled by co-integration analysis.

The PP test is less restrictive and provides an alternative way for checking the stationarity of a time series. From table 4.3B, same conclusion, as in case of the ADF test, has drawn. As concluded in ADF test, for the first differences of all the variables the null hypothesis of a unit root is strongly rejected in all the five time periods. It is again verified that all the variables contain a unit root. The results of PP test also signify that all index levels are integrated of order one, I(1). Therefore, the market returns are non-random and are not efficient in weak form.

The optimum number of lags chosen for the ADF test is chosen by minimizing the Akaike information criteria (AIC), but the unit root findings are really invariant to the number of lags chosen.

It is known that the unit root tests have very poor power properties, so a preferred alternative is a variance ratio test.

4.2.4 Variance Ratio (VR) Test

The VR test examines the predictability of return series by comparing variances of differences of the data (returns) calculated over different intervals. The variances of the increments in a random walk is linear in sampling interval such that if a series follow random walk model, the variance of its q-differences would be q times the variance of its first differences. Thus, the null hypothesis for random walk can be stated as VR (q,1) = 1 and the alternative hypothesis that considered series do not follow random walk can given a form of equation as VR (q,1) ≠ 1. In simpler terms, for a random series, the variance computed at each individual lag interval q should be equal to unity. If variance ratio is less than one than the series is said to be mean reverting and if variance ratio is greater than one than the series is said to be persistent. The variance ratio test is heteroskedastic robust multiple comparison test. The results (Z-statistic) of the variance ratio test are presented in table 4.5 here below.

Table 4.5: Variance Ratio Test

	Total Period	Period-1	Period-2	Period-3	Period-4
NSE	2.7534 [0.0849]*	6.7771 [0.0000]	6.2581 [0.0000]	6.7389 [0.0000]	2.3241 [0.2628]*
KSE	4.4681 [0.0001]	4.0404 [0.008]	2.7968 [0.0747]*	5.1498 [0.0000]	3.619 [0.0044]
SC	3.7655 [0.0025]	3.1589 [0.0235]	7.5987 [0.0000]	7.8208 [0.0000]	2.5788 [0.1388]*
HS	3.9891 [0.001]	6.5863 [0.0000]	4.4822 [0.0001]	6.1678 [0.0000]	6.5777 [0.0000]
JC	3.4154 [0.0095]	2.6568 [0.112]*	4.4977 [0.0001]	3.8889 [0.0015]	6.8302 [0.0000]
KLSE	3.557 [0.0056]	4.3265 [0.0002]	3.7102 [0.0031]	4.1845 [0.0004]	3.7006 [0.0032]
NIK	9.3716 [0.0000]	5.6839 [0.0000]	4.3885 [0.0002]	6.2087 [0.0000]	5.5991 [0.0000]
ST	6.9252 [0.0000]	3.5406 [0.006]	4.6747 [0.0000]	5.3894 [0.0000]	4.7232 [0.0000]
KSP	7.8595 [0.0000]	5.2981 [0.0000]	3.662 [0.0037]	4.7828 [0.0000]	6.0901 [0.0000]
TW	7.806 [0.0000]	4.9688 [0.0000]	6.4864 [0.0000]	5.818 [0.0000]	4.0268 [0.0008]
TA	17.4908 [0.0000]	10.0182 [0.0000]	11.6879 [0.0000]	7.6853 [0.0000]	8.6954 [0.0000]
SP	10.5116 [0.0000]	6.3153 [0.0000]	8.4688 [0.0000]	8.2544 [0.0000]	6.1324 [0.0000]

* shows the acceptance of null hypothesis at 5 percent level of significance.
*The figures in parenthesis show the probability values.

It can be clearly seen from table 4.5 shows that at 5 percent level of significance, the null hypothesis is rejected for NSE in total period and period-4, JC in period-1, KSE in period-2. Except NSE, SC is another market that does not follow a random walk in period-4. Hence, all the markets, excluding a few, are weak form inefficient markets for all the time periods.

4.3 CONCLUSION

This chapter provides the results obtained after analyzing the data on the basis of selected econometric techniques. The order of tests was same as mentioned in the previous chapter and the generalized conclusion of these tests are discussed in this section of the chapter. The runs test, ACF, unit root (ADF and PP) test, and variance ratio test were applied to the data.

The results of the runs test give varied results that a limited number of markets follow random walk in one period but not in other sub-periods. So, it was not possible to provide a conclusive argument on the state of efficiency on the basis of only runs test. The data is examined further with two other tests, namely; ACF test and unit root test, which confirm non randomness of time series for all the markets in all the time periods. It is further resolved through variance ratio test that all the markets are inefficient in weak form; exceptions are only a few cases.

End Notes:

1. Skewness is the measure of asymmetry of the distribution of the series around its mean. It is computed as $S = \frac{1}{N}\left(\frac{Y-\bar{Y}}{S}\right)$, where S is an estimator for the standard deviation. Standard value of skewness = 0.
2. Kurtosis measures the peakedness or flatness of the distribution of the series. It is computed as $K = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{Y_i-\bar{Y}}{s}\right]^4$, where s is the standard deviation. The standard value of kurtosis = 3.
3. Jarque Bera is a test statistic for testing whether the series is normally distributed. It is calculated as $JB = \frac{N-K}{6}\left[s^2 + \frac{(k-3)^2}{4}\right]$, where k is the kurtosis coefficient and, s is the skewness coefficient and K is the number of estimated coefficients used to create the series.

CHAPTER - 5

STOCK MARKET INTEGRATION:

AN EMPIRICAL ANALYSIS

After analyzing the efficiency of the twelve stock markets considered in the present study, this chapter presents the empirical results of the study that are obtained after testing equity market integration among eleven Asian and one US stock market. The focus of this chapter is on the second and forth research question of this thesis. The third research question is answered in the last chapter with the support of literature. In order to answer this second research question, a number of econometric tools are used namely, Pearson's correlation test, Johansen's co-integration test, ECM, Granger causality test, IRF and VDC analysis. The last part of this chapter fulfils the forth objective of the study; i.e., to check whether the volatility is time varying by using GARCH (1,1) model. For analysis, these tests are applied to the daily data for past twelve years starting from 01/01/1999 to 31/12/2010, which are divided into four equal sub-periods. The results of the econometric tests applied are presented in the following sections of this chapter.

5.1 TESTS FOR INTEGRATION

5.1.1 Pearson's Correlation Test

To emphasize on the short run relationship amid the movements of the stock markets, the correlation coefficients are calculated and reported in table 5.1 for a total period, table 5.1A for period-1 and period-2, table 5.1B for period-2 and period-3 and table 5.1C for period-3 and period-4.

It is evident from the table 5.1 that the level of correlations among the stock market returns for the total time period varies from low to moderate. The highest correlation is found between ST and HS (43.71%), followed by KSP and ST (41.40%), KLSE and ST (33.63%), and TW and KLSE (32.90%). It must also be pointed out that all the markets have a positive correlation except the KSE that has shown a negative correlation with the SC and TW and the SC has shown a negative correlation with TA. The market pairs that are least correlated includes TA and JC (0.65%), followed by TA and TW (1.16%) and KSE and NSE (1.23%). Thus, it can be interpreted from the given statistics that the stock markets returns are not highly, but positively correlated for total time period.

According to table 5.1A, in period-1, ST and HS are the highly correlated markets with the correlation coefficient of 31.68 percent followed by JC and SC (30.83%) and in period-2, KSP and ST are highly correlated with the correlation coefficient of 40.20 percent followed by KLSE and ST (44.78%). Out of 66 pairs correlation pairs in period-1, eleven are found to be insignificant and in period-2 only six are insignificant and rest all are found to be significantly correlated. Amongst these the least correlated markets are SP and ST (2.66%) followed by SP and KSE (2.95%) in period-1 and in period-2, KLSE and SP (0.03%) are least correlated markets followed by NSE and KSE (0.09%). It can be interpreted from table 5.1A that the degree of correlation has fallen considerably in period-2 as compared to period-1 and there are only 26 pairs which have shown the increased correlation in period-2.

The figures in table 5.1B depict that there is a noticeable increase in period-3 as compared to period-2 because there are 47 pairs of correlations that have shown increase in a later period. The highly correlated market in period-3 is ST. It has the highest correlation with KLSE; i.e., 63.14 percent and with HS; i.e., 39.35 percent while the markets that have least correlation coefficient are SP and KLSE (0.03%); KSE and KSP (2.18%); and KSE and NIK (2.22%). Almost all the markets have shown an evident boost in period-3 with only a few exceptions like TA and SP have shown an increase in correlation with every market. The only exception to TA is KLSE and NIK and to SP is KLSE in period-3 as compared to period-2.

Table 5.1C shows the correlation coefficient for period-3 and period-4 and gives a picture of visible increase in period-4 when weigh against period-3. In all there are 38 correlation pairs out of 66 that have shown improvement in period-4 over period-3. Out of these increased values the highest correlation in period- 4 is between HS and ST (67.38%) followed by ST and KSP (58.84%) and the markets that have lowest correlation are KSE and NIK (0.59%) and NSE and SP (1.61%).

Thus, from the above discussion it can be concluded that the correlation among the markets considered in the present study has fallen in period-2 as compared to period-1, then increased remarkably in period-3 and then again fallen slightly in period-4. The increase in the degree of correlation in the stock markets indicates that there is short-term co-movement among the stock indices. It suggests limited opportunities and benefits of any short-term diversification, or speculative activities (Majid et al., 2008).

Table 5.1: Pearson correlation (Total Period)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	-	0.012268	0.034940	0.095947	0.027444	0.051850	0.051483	0.101859	0.067314	0.042134	0.036777	0.020082
KSE		-	-0.016701	0.073048	-0.075506	0.050136	-0.005540	0.072902	0.082839	-0.059124	0.144589	0.025105
SC			-	0.221539	0.272839	0.128462	0.014484	0.151367	0.118604	0.092219	-0.025694	0.031735
HS				-	0.152666	0.224564	0.237926	0.437089	0.294932	0.207375	0.179381	0.175715
JC					-	0.109924	0.083298	0.044972	0.106143	0.230131	0.006452	0.059280
KLSE						-	0.071558	0.336364	0.221889	0.328972	0.171604	0.022762
NIK							-	0.270890	0.261042	0.190871	0.111505	0.116990
ST								-	0.414080	0.236954	0.181693	0.176652
KSP									-	0.291808	0.114380	0.106049
TW										-	0.011620	0.087466
TA											-	0.098665
SP												-

Table 5.1A: Pearson correlation (Period 1 and 2)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	-	0.000900	0.043954	*0.194678*	*0.103324*	*0.129299*	0.129618	*0.288593*	0.167798	*0.222302*	0.055573	*0.048345*
KSE	0.071175	-	*0.025387*	0.012018	*0.025456*	-0.017711	0.006959	*0.017757*	0.024748	*-0.004016*	0.009882	*0.042931*
SC	0.054203	-0.019839	-	0.037201	0.023082	0.044740	-0.007891	0.034142	0.033894	-0.042286	-0.016131	0.003711
HS	0.141577	0.119452	0.228160	-	0.087330	0.088962	*0.129306*	0.232673	-0.003363	*0.136143*	0.121310	0.046381
JC	-0.013684	-0.086454	0.308260	0.103251	-	*0.190604*	0.035353	*0.102135*	*0.079506*	0.129309	*0.057924*	0.013194
KLSE	0.077301	0.073424	0.141595	0.226035	0.068164	-	*0.063391*	*0.447764*	0.158720	0.193046	0.096090	0.000270
NIK	0.150743	-0.019535	-0.052162	0.093726	0.066682	0.040769	-	0.172964	0.185895	*0.158200*	*0.116136*	0.066192
ST	0.131791	0.109869	0.166952	0.316797	-0.078921	0.302017	0.182642	-	0.393514	*0.343779*	0.117184	*0.130241*
KSP	0.190320	0.127561	0.128447	0.307706	0.078461	0.259448	0.223251	0.401990	-	*0.352887*	0.027710	0.048484
TW	0.048896	-0.087550	0.112288	0.075253	0.252286	0.307883	0.073241	0.049007	0.185761	-	*0.043221*	0.066995
TA	0.066697	0.222371	-0.055955	0.172698	-0.042845	0.238129	0.042775	0.193137	0.118114	-0.075477	-	0.029437
SP	0.038234	0.029492	0.051952	0.114545	0.048025	-0.047881	0.102739	0.026614	0.069516	0.082391	0.095987	-

Note: The bottom diagonal provides correlation coefficient for period-1, while the top diagonal provides correlation coefficient for period-2. The figures in the top diagonal indicate the cases of increased correlation.

Table 5.1B: Pearson correlation (Period 2 and 3)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	-	0.043089	0.101089	0.419484	0.348856	0.224472	0.221603	0.329880	0.248222	0.263004	0.162726	0.122997
KSE	0.000900	-	0.005442	0.084560	-0.037361	0.154176	0.022221	0.116150	0.021754	0.048208	0.057453	0.051003
SC	0.043954	0.025387	-	0.221364	0.120981	0.133391	0.097300	0.177687	0.112083	0.138439	0.016193	0.072426
HS	0.194678	0.012018	0.037201	-	0.366851	0.418905	0.3300542	0.567716	0.393226	0.366616	0.172868	0.154058
JC	0.103324	0.025456	0.023082	0.087330	-	0.405042	0.199924	0.499144	0.225912	0.260559	0.130259	0.125236
KLSE	0.129299	-0.017711	0.044740	0.088962	0.190604	-	0.204704	0.631383	0.238984	0.372028	0.120872	0.122929
NIK	0.129618	0.006959	-0.007891	0.129306	0.035353	0.063391	-	0.379561	0.290876	0.312004	0.083629	0.113599
ST	0.288593	0.017757	0.034142	0.232673	0.102135	0.447764	0.172964	-	0.345285	0.446019	0.165232	0.180972
KSP	0.167798	0.024748	0.033894	-0.003363	0.079506	0.158720	0.185895	0.393514	-	0.418228	0.189682	0.101577
TW	0.222302	-0.004016	-0.042286	0.136143	0.129309	0.193046	0.158200	0.343779	0.352887	-	-0.006888	0.088802
TA	0.055573	0.009882	-0.016131	0.121310	0.057924	0.096090	0.116136	0.117184	0.027710	0.043221	-	0.107648
SP	0.048345	0.042931	0.003711	0.046381	0.013194	0.000270	0.066192	0.130241	0.048484	0.066995	0.029437	-

Note: The bottom diagonal provides correlation coefficient for period-2, while the top diagonal provides correlation coefficient for period-3. The figures in the top diagonal indicate the cases of increased correlation.

Table 5.1C: Pearson correlation (Period 3 and 4)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	-	0.021754	0.059639	0.110009	0.101379	0.060607	0.042550	0.117378	0.084764	0.035567	0.064245	0.016055
KSE	0.043089	-	-0.041323	-0.026458	-0.002251	-0.009373	0.005946	0.036903	-0.003482	-0.066603	0.062499	0.055827
SC	0.101089	0.005442	-	0.338795	0.149970	0.128103	0.109573	0.184967	0.228929	0.089175	0.047918	0.018190
HS	0.419484	0.084560	0.221364	-	0.543322	0.238907	0.454220	0.673766	0.648540	0.399228	0.310216	0.308401
JC	0.348856	-0.037361	0.120981	0.366851	-	0.311980	0.311641	0.474679	0.467888	0.374068	0.251443	0.220345
KLSE	0.224472	0.154176	0.133391	0.418905	0.405042	-	0.080523	0.247875	0.248249	0.420151	0.148584	0.075633
NIK	0.221603	0.022221	0.097300	0.300542	0.199924	0.204704	-	0.395835	0.453948	0.312544	0.244414	0.162497
ST	0.329880	0.116150	0.177687	0.567716	0.499144	0.631383	0.379561	-	0.588406	0.378071	0.290599	0.325445
KSP	0.248222	0.021754	0.112083	0.393226	0.225912	0.238984	0.290876	0.345285	-	0.444765	0.292982	0.241542
TW	0.263004	0.048208	0.138439	0.366616	0.260559	0.372028	0.312004	0.446019	0.418228	-	0.182076	0.108230
TA	0.162726	0.057453	0.016193	0.172868	0.130259	0.120872	0.083629	0.165232	0.189682	-0.006888	-	0.208921
SP	0.122997	0.051003	0.072426	0.154058	0.125236	0.122929	0.113599	0.180972	0.101577	0.088802	0.107648	-

Note: The bottom diagonal provides correlation coefficient for period-3, while the top diagonal provides correlation coefficient for period-4. The figures in the top diagonal indicate the cases of increased correlation.

The long-term integration among the stock market can be captured by using the Johansen's co-integration test. So, the next step is to conduct the co-integration test. But the co-integration test is sensitive to lags. Thus, before conducting co-integration test, one has to select appropriate lag for carrying out co-integration and further tests. Therefore, the next section of this chapter presents the lag selection criteria using Lag Exclusion Wald Test.

5.1.2 Optimum Lag Selection – using Vector Autoregression (VAR)

The VAR is the multiple time series generalization of the Autoregressive model. So, the estimated results of VAR model are easier to interpret in the moving representation, from which the VDC and IRF are derived. The number of lags in the VAR is used to approximate the co-integrating relationship between the stock market prices. It is a vital issue as the number of lags has been taken into account to affect the number of co-integrating vectors detected (Richards, 1995). The VAR system consists of a set of regression equations in which all the variables are considered to be endogenous.

Eun and Shim (1989) found that the price changes in one market are transmitted to the other markets within 48 hours and in the light of this, VAR with two lags can be used for analysis. Contradictory to this, to deal with the problem of the lag selection, Hsio (1981) had developed a systematic autoregressive method for choosing the appropriate lag length. Therefore, the appropriate lag length is one where Akaike's Final Prediction Error (FPE) is the lowest. Apart from this, Akaike's Information Criteria (AIC), Schwarz Information Criterion (SIC), Likelihood Ratio (LR) criterion and Hannan-Quinn (HQ) Information Criterion are also useful for choosing the lag length.

There were mixed views given by various researchers in selecting the appropriate lag length. The AIC, SC and LR are the most frequently used criteria for selecting the appropriate lag length. Thus, in order to rule out this confusion that which is best, the Lag Exclusion Wald test is used for choosing the appropriate lag for further analysis for the present study. The Lag Exclusion Wald test takes the affect of all the six lag selection criteria and gives the appropriate lag as the joint result taking all the six criteria into account.

The steps involved in lag selection using VAR are as follows:

For selecting the appropriate lag, the very first step is to run the unrestricted VAR model using the random lag length; here 12 lags were taken for further analysis. Then the next step is to go for the Lag length criteria to select the lag based on any of the six criteria, namely Log

Likelihood Value (Log L), Sequential Modified Likelihood Ratio (LR) test statistic, Akaike Final Prediction Error (FPE), Akaike's Information Criteria (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn (HQ) Information Criterion. The results received are contradictory as different criteria required different lags to be selected. In practice, it may not be possible that all the criteria will suggest one lag length as optimal. So, in order to avoid such perplexity, the next step is to go for Lag Exclusion Wald Test. The results of the Lag Exclusion Wald Test are reported in Table 5.2 below.

Table 5.2: Lag Exclusion Wald Test

	Total Period	Period-1	Period-2	Period-3	Period-4
Lag 1	14766.86 [0.000000]	3326.089 [0.000000]	4064.796 [0.000000]	4000.460 [0.000000]	3235.154 [0.000000]
Lag 2	815.5027 [0.000000]	321.7296 [1.35e-11]	244.7056 [3.31e-07]	327.9906 [2.22e-16]	304.6366 [1.46e-13]
Lag 3	454.3986 [0.000000]	216.6452 [0.007823]	223.7943 [2.30e-05]	239.8936 [9.20e-07]	229.8886* [7.06e-06]
Lag 4	271.0185 [8.03e-10]	261.9204 [5.95e-06]	262.8969 [5.55e-09]	179.6325 [0.023495]	**162.4282 [0.139705]**
Lag 5	845.4853 [0.000000]	451.0507 [0.000000]	349.1754 [0.000000]	200.6157* [0.001280]	260.4369 [9.84e-09]
Lag 6	404.3507 [0.000000]	201.6534* [0.043742]	209.7533 [0.000288]	**163.6022 [0.126036]**	202.7720 [0.000911]
Lag 7	261.1356* [8.37e-09]	**175.6075 [0.347907]**	201.1859 [0.001171]	118.6278 [0.939821]	144.6674 [0.468697]
Lag 8	**165.6253 [0.104851]**	176.9825 [0.321443]	174.6827 [0.041624]	146.8349 [0.418709]	120.4124 [0.924233]
Lag 9	320.7885 [1.67e-15]	255.9572 [1.78e-05]	205.1583 [0.000620]	176.1672 [0.035234]	169.7995 [0.069885]
Lag 10	260.4375 [9.84e-09]	230.5017 [0.001168]	175.4332 [0.038280]	123.2392 [0.893956]	139.9177 [0.580618]
Lag 11	270.1115 [9.99e-10]	217.2564 [0.007237]	192.5842* [0.004261]	147.5443 [0.402695]	146.6270 [0.423439]
Lag 12	206.9826 [0.000459]	204.7795 [0.031493]	**157.5369 [0.208120]**	183.2605 [0.015009]	146.9155 [0.416880]

Chi-squared test statistics for lag exclusion
Numbers in [ ] are p-values
* shows the lag length selected
The figures in bold shows the lag length at which the p becomes insignificant at 5 percent level of significance.

From table 5.2, it can be seen that the optimum lag length is based on the p-values. According to Lutkepohl and Breitung (1996), the testing sequence terminates when the null hypothesis is rejected for the first time. The order specified by the values that preceded the values that reject the null-hypothesis is then chosen as an estimate of p. For the total time period, it is clear that right at lag 8 the p-value becomes insignificant. So, lag 7 is selected as the optimum lag because till lag 7 the p-values are significant. Similarly, for period-1, lag 6 is the appropriate lag and for the period-2, lag 11 is perfect. Lag 5 is appropriate for the period-3 and lag 3 is best fit for period-4. The further analysis for integration testing would be based on these lag lengths.

After setting the lag length, estimation of the model is possible but the coefficients generated from the estimated VAR model cannot be interpreted directly. To overcome this issue, Litterman (1979) has suggested the use of innovations accounting techniques, which consist of both IRF and VDC analysis.

After selecting appropriate lags for each time period, the next step is to conduct Johansen's co-integration test. Thus, the next part of this chapter explains the results of co-integration test.

5.1.3 Johansen's Co-integraion Test

The series are said to be co-integrated, if they are non-stationary, but a linear combination of them is stationary. The null hypothesis of, no co-integrating equations, is put to test. Prior to applying co-integration test, ADF and PP test of unit root is used. It was found that the index series were integrated of the same order; i.e., I (1). So, after identifying that all stock indices are stationary at first difference, it is now possible to proceed to test for co-integration, aiming at investigating whether there exist a long run relationship amongst the stock markets. The Johansen's co-integration test is sensitive to the lag length (Enders, 2004). Thus, before conducting the co-integration test, lag exclusion Wald test was employed to select the appropriate lag length to include in the analysis. The results of co-integration analysis are presented in table 5.3 and table 5.3A.

First part of the co-integration test, the trace test for all the five time periods, indicates that there exists co-integration in all the five time periods. Keeping in view the null hypothesis of no co-integration ($r = 0$) among the variables, the trace test statistic is 561.65. It is well above the 5 percent critical value of 334.98. So, the null hypothesis is rejected. It is evident from the table 5.5 that the other hypotheses ($r \geq 1$, $r \geq 2$ and $r \geq 3$) are also rejected at 5 percent level of significance for the same reason.

Therefore, it can be concluded that the long run relationship exists between the twelve stock markets which are considered for this study and four co-integration equations are likely in total time period of the present study.

In the same way, one co-integration equation is possible in period-1, three in period-2, eleven in period-4 and three in period-4. Just as in the trace test the hypotheses were evaluated, in the second part of co-integration test, the Maximum Eigenvalue test for all the five time periods, also indicates the same results that co-integration exists in all the markets in all the five time periods. According to this test, two co-integration equations are possible for the total time period. One co-integration equation is possible in period-1 and period-2; two equations are possible in period-3 and one in period-4.

Both tests indicate co-integrating equations at 5 percent level for all the time periods. The time series are co-integrated for the total time period as well as for sub-periods. There exists a long-term relationship between the series for the overall time period and for sub-periods. Both tests are showing same results, it is further indicated that co-integration is strong for the period of study.

If the stock markets are found to be co-integrated, the next step is to evaluate the speed of adjustment of the markets. This is required to test the short run equilibrium in the markets and can be done using VECM. Hence, the next part of this chapter shows the results of the VECM.

Table 5.3: Johansen's Co-integration Test

H_o	Total Period				Period – 1				Period – 2				Period – 3				Period – 4			
	λ_{trace}	5%CV	λ_{Max}	5%CV	λ_{trace}	5%CV	λ_{Max}	5%CV	λ_{trace}	5%CV	λ_{Max}	5%CV	λ_{trace}	5%CV	λ_{Max}	5%CV	λ_{trace}	5%CV	λ_{Max}	5%CV
r = 0	*561.65*	*334.98*	*227.02*	*76.58*	*363.15*	*334.98*	*83.49*	*76.58*	*379.67*	*334.98*	*80.93*	*76.58*	*446.87*	*334.98*	*81.49*	*76.58*	*430.19*	*334.98*	*117.90*	*76.58*
r ≤ 1	*334.63*	*285.14*	*73.29*	*70.54*	279.67	285.14	64.04	70.54	*298.74*	*285.14*	57.89	70.54	*365.38*	*285.14*	*74.40*	*70.54*	*312.30*	*285.14*	62.94	70.53
r ≤ 2	*261.35*	*239.24*	52.07	64.50	215.63	239.24	48.72	64.50	*240.85*	*239.24*	50.09	64.50	*290.97*	*239.24*	61.91	64.50	*249.35*	*239.24*	54.41	64.50
r ≤ 3	*209.28*	*197.37*	51.63	58.43	166.91	197.37	39.80	58.43	190.76	197.37	45.42	58.43	*229.06*	*197.37*	47.72	58.43	194.94	197.37	50.43	58.43
r ≤ 4	157.64	159.53	41.26	52.36	127.12	159.53	32.18	52.36	145.35	159.53	35.82	52.36	*181.34*	*159.53*	43.80	52.36	144.52	159.5	38.02	52.36
r ≤ 5	116.38	125.62	33.77	46.23	94.94	125.62	24.05	46.23	109.53	125.62	31.23	46.23	*137.54*	*125.62*	32.95	46.23	106.50	125.62	28.56	46.23
r ≤ 6	82.61	95.75	23.71	40.08	70.89	95.75	22.01	40.08	78.30	95.75	25.59	40.08	*104.59*	*95.75*	30.00	40.08	77.93	95.75	28.03	40.08
r ≤ 7	58.90	69.82	19.68	33.88	48.88	69.82	15.62	33.88	52.70	69.82	22.65	33.88	*74.59*	*69.82*	22.46	33.88	49.90	69.82	17.04	33.88
r ≤ 8	39.21	47.86	18.62	27.58	33.26	47.86	12.04	27.58	30.06	47.86	15.85	27.58	*52.13*	*47.86*	20.60	27.58	32.86	47.86	15.12	27.58
r ≤ 9	20.60	29.80	13.40	21.13	21.21	29.80	11.24	21.13	14.21	29.80	9.87	21.13	*31.53*	*29.80*	15.83	21.13	17.74	29.80	12.46	21.13
r ≤ 10	7.20	15.49	5.67	14.26	9.97	15.49	6.20	14.26	4.34	15.49	3.95	14.26	*15.67*	*15.49*	13.15	14.26	5.28	15.49	4.91	14.26
r ≤ 11	1.52	3.84	1.52	3.84	3.77	3.84	3.77	3.84	0.39	3.84	0.39	3.84	2.55	3.84	2.55	3.84	0.38	3.84	0.38	3.84

Figures in italics denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5.3A: No. of Co-integration Equations

Time Periods	Unrestricted Co-integration Rank Test (Trace)	Unrestricted Co-integration Rank Test (Maximum Eigenvalue)
Total Period	4	2
Period – 1	1	1
Period – 2	3	1
Period – 3	11	2
Period – 4	3	1

5.1.4 Vector Error Correction Mechanism (VECM)

Since the stock markets considered in the present study are found to be co-integrated, it is now required to test the short run equilibrium or the speed of adjustment of the stock markets by using the VECM. The VECM (based on VAR) is used to examine the short run equilibrium dynamics of the stock indices. The rationale that works behind the VECM is that if two non-stationary variables are co-integrated then there exists a long run relationship between them. The ECM can be treated as the regression of these two variables as 'equilibrium error' and by incorporating it in the model. The speed of adjustment of the system, with which two variables adjust, toward long run equilibrium after an initial shock can be calculated using ECM (Dhawan and Rajib, 2007). The error correction parameters are also called the speed of adjustment and it indicates how quickly the variables moves back to the long run equilibrium after a shock. Table 5.4 summarizes the F-statistics, coefficient of lagged values of the ECT and the t-value between the pairs of stock market indices.

From table 5.4, a number of significant slope coefficients are found, which shows that in long run changes in one country's stock market prices influences another country's stock market price. The positive values of coefficient of co-integration relation; i.e., ECM(-1) indicate that the returns of the underlying stock market go up when the co-integration equation shows positive values. The negative values of coefficients of co-integration relation signify that the returns of the stock market go down when the co-integration equations show positive values. Therefore, the speed of adjustment of the markets with the positive coefficients is marginally higher than the rest of the stock markets and these markets would go back to equilibrium faster as compared to other markets.

From the above mentioned rule, it can be said that in total period, HS (0.044638) has the greatest impact on other equity markets (since it has the highest ECT) followed by NIK (0.003912), JC (0.001376) and SP (0.000506) and NSE (-0.327956) would have the greatest negative impact followed by KSE (-0.035929), TW (-0.025070), SC (-0.005184), TA (-0.003912), KLSE (-0.002539), ST (-0.001360) and KSP (-0.000232). The results suggest that the ECT or the adjustment coefficients are statistically significant only for NSE (-0.327956) and TA (-0.003912). (see Table 5.4)

Similar to the total time period, in period-1, all stock market indices have a significant coefficient of error correction except KSE (0.120143), HS (-0.051259), JC (0.004860), and NIK (-0.046730). In period-2, KSE (0.065142), SC (0.006779), HS (0.106921), TW (0.044399) and TA (-0.006695) have an insignificant ECT coefficient. NSE (0.066687), HS

(0.520898), JC (0.041652), KLSE (0.007237) and TA (0.015453) have an insignificant coefficient for ECT in period-3 and in period-4, NSE (-0.473009) is the only market that does not have a significant coefficient for error correction.

In period-1, the markets that have tendency to move back to equilibrium are KSE (0.120143), TW (0.021523), SC (0.007916), JC (0.004860), SP (0.001472), KSP (0.000923), KLSE (0.000530) and TA (1.27E-05) and the markets for which returns fall when positive values are shown by co-integrating equations are HS (-0.051259), NIK (-0.046730) NSE (-0.001150) and ST (-0.000689). In period-2, HS (0.106921), KSE (0.065142), TW (0.044399), NIK (0.007490), SC (0.006779), ST (0.005343), KSP (0.003153), SP (0.002278) and KLSE (0.001633) are the markets whose return would move toward positive side when co-integrating equations have positive values but the markets that would earn negative returns are a TA (-0.006695), NSE (-0.003074) and JC (-0.002155).

However, in period-3, all other markets have positive ECT except SP (-0.005762) that has the negative ECT. The market that has the highest tendency to move back to equilibrium is HS (0.520898). In line with the results of the period-3, HS (0.020527) also hold the highest ECT in period-4 followed by ST (0.002611), JC (0.002401) and SP (0.000983) also NSE (-0.473009) has the highest negative ECT followed by KSE (-0.021511), NIK (-0.010255), TA (-0.003611), SC (-0.003491), KSP (-0.001437), TW (-0.001346) and KLSE (-0.000553).

After analysing the speed of adjustment of the integrated stock markets, the next step is to see the direction of causality of the markets. The causality in the stock markets can be studied using the Granger causality test. The results of Granger causality test are presented in the next section of this chapter.

Table 5.4: Vector Error Correction Model

	Variables	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
Total Period	**ECT (α)**	-0.327956 [-14.1753]*	-0.035929 [-1.40477]	-0.005184 [-0.86284]	0.044638 [1.62596]	0.001376 [0.50150]	-0.002539 [-1.79470]	0.003912 [0.16084]	-0.001360 [-0.45448]	-0.000232 [-0.11486]	-0.025070 [-1.87506]	-0.003912 [-2.43813]*	0.000506 [0.40235]
	F-statistics	17.65155	10.74053	4.880521	4.149077	3.443035	6.444000	5.826594	3.876687	3.075478	3.875472	25.55851	11.32705
Period-1	**ECT (α)**	-0.001150 [-0.86719]	0.120143 [5.90196]*	0.007916 [1.71228]	-0.051259 [-2.55524]*	0.004860 [2.81551]*	0.000530 [0.46188]	-0.046730 [-2.69747]*	-0.000689 [-0.31640]	0.000923 [0.69327]	0.021523 [1.76913]	1.27E-05 [0.01205]	0.001472 [1.51399]
	F-statistics	1.286917	8.479652	6.099724	2.357696	4.733836	2.446598	1.636831	1.405195	1.661524	3.017050	13.15976	3.779012
Period-2	**ECT (α)**	-0.003074 [-1.07691]	0.065142 [2.42562]*	0.006779 [2.53586]*	0.106921 [3.98393]*	-0.002155 [-0.98157]	0.001633 [1.21122]	0.007490 [0.19682]	0.005343 [1.81491]	0.003153 [1.09594]	0.044399 [3.05227]*	-0.006695 [-3.38365]*	0.002278 [1.35067]
	F-statistics	1.188099	3.375213	1.565969	2.415149	1.207337	1.134655	2.580813	1.762819	2.123911	1.692619	10.29546	2.080420
Period-3	**ECT (α)**	0.066687 [3.94556]*	0.089752 [1.29028]	0.011161 [0.67310]	0.520898 [6.42113]*	0.041652 [4.92863]*	0.007237 [1.96950]*	0.023386 [0.27374]	0.018983 [1.80782]	0.013258 [1.85268]	0.030601 [0.94612]	0.015453 [3.78523]*	-0.005762 [-1.88137]
	F-statistics	1.973689	2.096543	1.538743	3.335988	2.968946	2.089787	2.643417	3.073044	3.120119	2.856315	5.931110	6.558333
Period-4	**ECT (α)**	-0.473009 [-10.4441]*	-0.021511 [-0.79604]	-0.003491 [-0.46432]	0.020527 [0.60147]	0.002401 [0.65610]	-0.000553 [-0.31759]	-0.010255 [-0.47393]	0.002611 [0.74007]	-0.001437 [-0.68904]	-0.001346 [-0.10010]	-0.003611 [-1.66931]	0.000983 [0.69992]
	F-statistics	8.994085	6.159023	2.127410	2.222386	1.531509	6.242335	3.624434	2.358816	1.222085	2.299671	6.758481	11.42543

Note: the values in parenthesis are t-statistics.
*implies that the null hypothesis of zero coefficient is significant at 5% level of significance.

5.1.5 Granger Causality Test

The Granger causality test is conducted to examine whether one stock market causes other stock markets in short run. The short run causality is revealed by the Granger causality test. The null hypothesis of the test states that there is no granger causality among markets. The final outcome of the test for a total time period are summarized in Table 5.5 and for sub-periods are given in table 5.5A, table 5.5B and table 5.5C. (Refer Annexure A for detail results)

It can be concluded from table 5.5 that US stock market holds a very dominant place since it has unidirectional causality with all other markets except ST and only SP is causing all other markets for a total time-period. TA and TW also have bidirectional causality with all the markets except SC and HS in case of TA as it is causing SC and caused by HS; and NSE, KSE and SC in case of TW as it is causing both NSE and SC but having no causal relation with KSE. KSP has the mixed relation to other markets as it has bidirectional causation with HS, NIK, TW and causing TA, NSE, JC and KLSE and caused by ST and SP. Similar to TA and TW, ST and NIK also have bidirectional causality with the majority of markets except NSE, KSE, NIK and KSP for ST and JC, ST and SP for NIK. KLSE and JC have the mixed relations with other markets. HS is causing NSE, JC, KLSE and TA and caused by only SP and with all other markets it has the bidirectional causality. Similar to TA, TW, ST and NIK; SC also have either bidirectional causality or caused by JC, TW, TA and SP and no relation with NSE, NIK and KSP. KSE is the most insignificant market in the group as it does not have relation to most of the markets except SC, JC and TA with which it has bidirectional causality and the ST which is causing KSE. NSE also either has bidirectional causality or caused by HS, ST, KSP, TW and SP and having no relation with KSE, SC, JC and KLSE.

In period-1, majority of markets is showing no relation with other markets; i.e., these are neither causing any market nor caused by other markets. The two way causality is also found only in four pairs that are HS and KSP, HS and ST, SC and JC, and SC and HS. The SP is playing a dominant role in period-1 also, since it is caused only by SC and TA which is caused only by NSE and SP. TW is the most insignificant market because it is caused by all other markets. NSE, KSP and ST have mixed relation to other markets. NIK is causing only TW otherwise it is either caused by other markets or having no relation to other markets. KLSE is the only market in this period that does not have any relation to other markets but only caused by SP. JC is also caused by NSE, KSE and TA and causing the only TW. HS is caused by only SP. SC is caused by only TA and causing only ST and SP. In the same way, KSE is caused by only TA and causing only JC and ST.

Table 5.5: Granger Causality Test (Total Time Period)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	---											
KSE	X	---										
SC	X	↔	---									
HS	↑	X	↔	---								
JC	X	↔	↑	↲	---							
KLSE	X	X	↔	↲	↑	---						
NIK	↔	X	X	↔	↑	↔	---					
ST	↑	↑	↔	↔	↔	↔	↑	---				
KSP	↑	X	X	↔	↑	↑	↔	↲	---			
TW	↑	X	↑	↔	↔	↔	↔	↔	↔	---		
TA	↔	↔	↑	↲	↔	↔	↔	↔	↔	↔	---	
SP	↑	X	↑	↑	↑	↑	↑	↔	↑	↑	↑	---

Note:
1. The bottom diagonal provides causality coefficient for total period.
2. ↔ indicates a bidirectional Granger causality between stock markets.
3. ↲ or ↑ indicate a unidirectional Granger causality from one market to another.
4. X indicates no Granger causality between the stock markets.

Table 5.5A: Granger Causality Test (Period – 1 and Period – 2)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	---	X	X	⇧	X	X	⇧	X	⇧	X	X	↲
KSE	X	---	X	X	X	⇧	X	↲	⇦⇧	X	↲	X
SC	X	X	---	X	X	⇧	↲	⇧	X	⇧	X	X
HS	⇧	X	⇦⇧	---	X	⇧	⇦⇧	⇧	⇧	⇧	⇧	↲
JC	↲	↲	⇦⇧	X	---	↲	X	↲	X	X	X	↲
KLSE	X	X	X	X	X	---	↲	↲	X	↲	↲	↲
NIK	↲	X	X	↲	X	X	---	↲	⇧	X	X	⇦⇧
ST	⇦⇧	↲	↲	⇦⇧	X	X	⇧	---	⇧	⇦⇧	⇧	↲
KSP	X	X	X	⇦⇧	X	X	X	↲	---	↲	↲	↲
TW	↲	X	X	↲	↲	X	↲	↲	↲	---	X	↲
TA	↲	⇧	⇧	X	⇧	X	X	X	X	⇧	---	↲
SP	⇧	X	↲	⇧	X	⇧	⇧	⇧	⇧	⇧	⇧	---

Note:
1. The bottom diagonal provides causality coefficient for period-1, while the top diagonal provides causality coefficient for period-2.
2. ⇦⇧ indicates a bidirectional Granger causality between stock markets.
3. ↲ or ⇧ indicate a unidirectional Granger causality from one market to another.
4. X indicates no Granger causality between the stock markets.

Table 5.5B: Granger Causality Test (Period – 3 and Period – 4)

	NSE	KSE	SC	HS	JC	KLSE	NIK	ST	KSP	TW	TA	SP
NSE	---	X	X	X	↲	X	↲	X	X	X	X	X
KSE	↲	---	X	X	⬏	X	X	⬏	X	X	X	X
SC	⬏	X	---	⬏	↲	⬏	X	X	X	X	⇦⇧	↲
HS	↲	X	⬏	---	⬏	⬏	⬏	⇦⇧	⇦⇧	⬏	⇦⇧	⇦⇧
JC	X	↲	↲	↲	---	⬏	⬏	↲	⇦⇧	⬏	⇦⇧	↲
KLSE	↲	↲	X	↲	⬏	---	⇦⇧	↲	↲	X	⇦⇧	↲
NIK	↲	X	X	↲	X	X	---	⇦⇧	↲	↲	⇦⇧	↲
ST	⇦⇧	X	X	⬏	↲	↲	⇦⇧	---	⇦⇧	⬏	⬏	↲
KSP	⇦⇧	X	X	↲	⇦⇧	↲	⬏	⇦⇧	---	⇦⇧	⬏	⇦⇧
TW	↲	⬏	⬏	⇦⇧	⬏	⬏	⬏	⬏	⇦⇧	---	⬏	↲
TA	↲	X	↲	↲	⇦⇧	⇦⇧	⇦⇧	⇦⇧	⇦⇧	⇦⇧	---	⬏
SP	⇦⇧	X	⬏	⬏	⇦⇧	⇦⇧	⬏	⇦⇧	⇦⇧	⬏	⬏	---

Note:
1. The bottom diagonal provides causality coefficient for period-3, while the top diagonal provides causality coefficient for period-4.
2. ⇦⇧ indicates a bidirectional Granger causality between stock markets.
3. ↲ or ⬏ indicate a unidirectional Granger causality from one market to another.
4. X indicates no Granger causality between the stock markets.

In period-2, similar to period-1, there are only four pairs that have bidirectional causality and the pairs are KSE and KSP, HS and NIK, NIK and SP, and ST and TW. Out of 66 pairs of causality, 27 pairs do not have any relation between them and thus, the majority of markets have unidirectional causality. SP is again found to be the dominant market as it is causing all other markets, followed by HS which is only caused by NSE and SP. NIK, ST, TA and TW have somehow mixed relations with other markets. KSP and JC are again found to be insignificant market as it is not causing any other market followed by KLSE with is causing only JC. SC is only caused by NIK but causing KLSE, ST and TW and having no relation to all other markets. KSE also do not have any relation to most of the markets except ST and TA, which causes KSE and KLSE, which is caused by KSE. Similar to KSE, NSE was also caused by only SP and cause HS, NIK and KSP.

In period-3, the bidirectional causality increased in the markets. In this period there are 17 causality pairs that have two-way causality. The situation of no relation is also reduced in the period-3 as there are only fourteen pairs that do not have any relation among them. SP, similar to previous periods, is not caused by any market and NIK and TA is caused by all other markets. JC, ST and KSP are caused by all other markets except ST, HS and NIK respectively and KLSE is caused by all markets except JC and ST. NSE is caused by only SC and causes TW and KSE that are also caused by only SP and TW respectively. HS is caused by NSE, ST and SP and SC are caused by HS, TW and SP.

In period-4 also, there are fourteen two-way causality pairs existing slightly less than previous period and 22 pairs do not have any relation to other markets. HS and ST are caused by only one market that is SC and KSE respectively. NIK is causing only NSE whereas, TA is causing only SP. NSE is caused by two markets that are JC and NIK while KSE is causing two markets that are JC and ST. SC is the market that has bidirectional relation with only TA and unidirectional causality with only four markets wherein it is caused by the JC and SP and causing HS and KLSE with other markets it has no relation. JC has the mixed relations with other markets. KLSE is the most dominant market as it is caused by all markets and causing none. KSP is the one that is caused by none of the market unidirectionally.

The further section of this chapter deals with the Innovative Accounting techniques, the IRF and the VDC. The IRF shows the reaction of all the markets in the system when a shock of one variance is given to any one market. The VDC studies the causal relation among the markets in the system.

5.1.6 Impulse Response Function (IRF)

The IRF is the dynamic analysis evaluating multiplier effect among different variables in the VAR system. It measures how one shock to a variable is transmitted to others over time in a system. It is particularly useful for this system as a way for examining short run dynamism among different variables in the system. It can further be related to causality, as zero impulse response between two variables implies no dynamic causality between the two variables (or indices) (Lutkepohl, 1991).

There are several methods for calculating the IRF. The Cholesky decomposition is used for the present study. The Cholesky decomposition is sensitive to the ordering of variables. So, it is essential that the variables in the system are ordered systematically. Here the ordering of the variables is done according to the sequence of market trading timings. The market that opens earliest is kept first and the market that opens at the last is taken as the last market for the IRF. The ordering of the stock price indices is NIK, KSP, TW, KLSE, ST, SC, HS, JC, NSE, KSE, TA and SP. (Refer Annexure A)

Figure 5.1, figure 5.1A, figure 5.1B, figure 5.1C and figure 5.1D plots the time path of impulse responses of each foreign stock index to one standard deviation shock for a total time period, period-1, period-2, period-3 and period-4 respectively for up to ten lags. (Refer Annexure B for figures)

From the figure 5.1, it can be seen that if a shock of one standard deviation is given to the one market, how this particular market will be reacting to other markets in first time period; i.e., the total time period. It can be interpreted from the figure 5.1 that all of the markets strongly reacted to their own shocks. In other words, when the shock is given within one market it takes time for that market to come back to equilibrium levels. All the markets generally come back to the equilibrium level right at second day after the shock is introduced to the market on day zero. Only two markets have shown the fluctuating trend during the total time period, that are SC and TW, when shock was given by JC to both the markets but these markets also come down to equilibrium level after a fifth day.

Like total time period, in period-1 also all the markets are reacting mainly to its own shocks. When shocks are introduced by other markets then the market considered comes back to equilibrium maximum in 2-3 days. Most of the markets take longer time to come back to normal when the shock was introduced by JC; and JC itself shows fluctuating trend when shocks are introduced by SC and TW.

The results for the period-2 differ from the previous time periods because in this period the markets take longer time to come back to its normal level. In period-2, no doubt the markets are largely impacted from its own shocks that were introduced on day zero but also the markets takes about 5-8 days to come back to the equilibrium level. Except own self, the market in this period are effected by other markets also. For example, KSE if affected by the SC, KLSE, TW and TA and it takes around 5-6 days to come back to stable situation. SC is impacted by the shocks introduced by the HS, SC and NIK and takes around 8-9 days to come back to its original state. Similarly, HS is effected by NIK and SP; and JC is effected by NSE and SP. ST is moved by most of the markets like SC, HS, KLSE, TW and SP whereas KSP is effected by only HS; and TW is affected by SC and SP.

In the period-3 also mostly markets react to the shocks given by itself on day zero and not effected much by other markets except ST which is effected by all the markets except NSE and KSE. KSE, TA and SP are the one which came back to its equilibrium in 2-3 days after the shocks are introduced to these markets by other markets. NSE, SC and KSP are the markets that are moved only by SP, HS and JC respectively. HS, JC and KLSE come back to its equilibrium very soon except in the case of two markets for which it takes around 6-7 days to come back to the normal situation. These two markets are JC and SP in case of HS, SC and KLSE for JC; and HS and ST for KLSE. NIK takes longer time to come back to its equilibrium when shock was introduced by ST, KSP and SP.

Contradictory to all the time periods mentioned earlier, in the period-4, none of the market is moved by the shocks given by the other markets in this period but the markets have largely been moved only by the shocks introduced by it.

5.1.7 Variance Decomposition (VDC) Analysis

The VDC is used to identify the causal relations among the variables. It explains the degree and extent at which the movement of a particular variable is described by the shocks among all the variables in the system. The forecast error variance decomposition explains the condition of the movements in a progression due to its own shocks versus shocks to the other variables. Table 5.6, table 5.6A, table 5.6B, table 5.6C and table 5.6D represents the values of VDC for a total time period, period-1, period-2, period-3 and period-4 respectively. The following discussion would be based on the above mentioned tables and in each case comment would be made on the decomposed variance on the last; i.e., tenth day, when the transmission is almost complete.

Table 5.6 reports the decomposition of forecast error variance of each country for a total time period. In this table, the decomposition of 1, 3, 5 and 10 days forecast error-variance of stock indices into fractions that are attributable to innovations in each of the twelve markets. At day 10 horizon, the proportion of domestic stock index variance that can be collectively attributed to other stock markets, the market innovation ranges from 2.70 percent for NSE to 32.64 percent for ST. The proportion is 12.78 percent for NIK, 14.90 percent for KSP, 16.58 percent for TW, 15.36 percent for KLSE, 10.92 percent for SC, 31.95 percent for HS, 11.26 percent for JC, 6.59 percent for KSE, 9.81 percent for TA and 13.90 percent for SP.

Similar to the total time period, ST has the highest forecast error variance for period-1 (30.13%), period-2 (45.32%) and period-3 (57.69%) while KSE (7.03%), SC (10.84%) and KSE (10.26%) has the lowest variance in period-1, period-2 and period-3 respectively. Other than these, in period-4 HS (65.34%) has the maximum forecast error variance but the minimum is for NSE (4.37%).

These results show that in almost all the markets, a large fraction of domestic stock index variance is attributable to shocks originated from foreign index and the contribution of NSE is least in total period and period-4, KSE has the least input in Period-2 and period-4 and SC has the least contributor in period-3.

Table 5.6: Variance Decomposition Test (Total Period)														
	Lags	**NIK**	**KSP**	**TW**	**KLSE**	**ST**	**SC**	**HS**	**JC**	**NSE**	**KSE**	**TA**	**SP**	**FOREIGN**
NIK	1	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	88.59	0.58	0.25	0.06	1.34	0.07	0.76	0.03	0.13	0.09	0.05	8.04	11.41
	5	88.32	0.62	0.26	0.13	1.34	0.08	0.76	0.03	0.15	0.14	0.12	8.05	11.68
	10	87.22	0.67	0.44	0.19	1.37	0.10	0.84	0.22	0.26	0.28	0.18	8.23	12.78
KSP	1	5.76	94.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.76
	3	5.12	87.37	0.03	0.36	0.99	0.18	1.03	0.07	0.03	0.01	0.12	4.69	12.63
	5	5.27	86.88	0.07	0.36	1.08	0.19	1.03	0.10	0.05	0.01	0.13	4.84	13.12
	10	5.33	85.10	0.27	0.76	1.27	0.30	1.03	0.28	0.06	0.20	0.47	4.94	14.90
TW	1	2.71	5.59	91.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.30
	3	2.39	4.93	85.38	0.10	1.54	0.06	0.71	1.10	0.08	0.04	0.21	3.45	14.62
	5	2.44	5.03	84.53	0.18	1.71	0.06	0.74	1.47	0.08	0.07	0.21	3.49	15.47
	10	2.46	5.02	83.42	0.64	1.75	0.24	0.92	1.52	0.11	0.15	0.22	3.56	16.58
KLSE	1	0.21	2.64	7.21	89.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.05
	3	0.31	2.36	6.82	87.04	0.76	0.12	0.42	0.03	0.03	0.14	0.04	1.95	12.96
	5	0.31	2.38	6.96	86.25	0.79	0.50	0.45	0.06	0.06	0.18	0.07	2.01	13.75
	10	0.35	2.71	7.23	84.64	0.86	0.76	0.54	0.08	0.06	0.24	0.26	2.26	15.36
ST	1	5.63	11.55	1.20	4.01	77.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.39
	3	4.95	10.15	1.07	4.04	69.38	0.16	1.49	0.28	0.05	0.30	0.04	8.09	30.62
	5	4.91	9.98	1.60	4.20	68.53	0.16	1.55	0.42	0.05	0.35	0.12	8.13	31.47
	10	4.95	9.81	1.60	4.48	67.36	0.59	1.66	0.67	0.07	0.41	0.26	8.14	32.64
SC	1	0.02	0.99	0.15	0.56	0.97	97.30	0.00	0.00	0.00	0.00	0.00	0.00	2.70
	3	0.04	0.84	0.19	0.53	0.90	91.88	0.63	4.21	0.04	0.30	0.36	0.07	8.12
	5	0.06	0.88	0.21	0.54	0.91	90.77	0.64	5.08	0.04	0.40	0.40	0.08	9.23
	10	0.23	1.01	0.36	0.91	1.02	89.08	0.86	4.99	0.09	0.77	0.47	0.19	10.92

Cont...

HS	1	4.14	4.99	0.92	1.39	9.22	2.85	76.50	0.00	0.00	0.00	0.00	0.00	23.50
	3	3.54	4.29	0.87	1.32	8.10	3.10	69.63	0.10	0.04	0.25	0.06	8.68	30.37
	5	3.57	4.28	0.98	1.31	8.11	3.28	69.10	0.13	0.06	0.26	0.19	8.73	30.90
	10	3.73	4.28	1.14	1.33	8.15	3.61	68.05	0.14	0.09	0.51	0.27	8.70	31.95
JC	1	0.69	0.95	2.05	0.84	0.04	2.99	0.48	91.95	0.00	0.00	0.00	0.00	8.05
	3	0.77	0.73	2.24	0.66	0.15	3.18	0.34	90.02	0.05	1.58	0.04	0.22	9.98
	5	0.76	0.75	2.43	0.68	0.20	3.06	0.45	89.51	0.05	1.77	0.07	0.27	10.49
	10	0.82	0.77	2.65	0.70	0.21	3.11	0.52	88.74	0.06	1.94	0.21	0.28	11.26
NSE	1	0.53	0.40	0.12	0.17	0.53	0.02	0.25	0.10	97.89	0.00	0.00	0.00	2.11
	3	0.51	0.34	0.10	0.15	0.43	0.07	0.19	0.12	97.74	0.01	0.01	0.33	2.26
	5	0.58	0.34	0.13	0.15	0.44	0.13	0.23	0.12	97.42	0.02	0.04	0.40	2.58
	10	0.59	0.35	0.15	0.16	0.44	0.14	0.24	0.14	97.30	0.03	0.04	0.41	2.70
KSE	1	0.06	0.89	0.84	0.05	0.00	0.04	0.09	0.11	0.01	97.91	0.00	0.00	2.09
	3	0.06	0.72	0.97	0.46	0.10	0.08	0.33	0.41	0.01	96.41	0.36	0.11	3.59
	5	0.07	0.75	1.07	0.47	0.27	0.96	0.38	0.48	0.01	95.03	0.40	0.14	4.97
	10	0.10	0.77	1.29	0.52	0.63	1.10	0.62	0.50	0.01	93.41	0.77	0.30	6.59
TA	1	0.53	0.40	0.12	0.17	0.53	0.02	0.25	0.10	97.89	0.00	0.00	0.00	2.11
	3	0.51	0.34	0.10	0.15	0.43	0.07	0.19	0.12	97.74	0.01	0.01	0.33	2.26
	5	0.58	0.34	0.13	0.15	0.44	0.13	0.23	0.12	97.42	0.02	0.04	0.40	2.58
	10	0.59	0.35	0.15	0.16	0.44	0.14	0.24	0.14	97.30	0.03	0.04	0.41	2.70
SP	1	0.06	0.89	0.84	0.05	0.00	0.04	0.09	0.11	0.01	97.91	0.00	0.00	2.09
	3	0.06	0.72	0.97	0.46	0.10	0.08	0.33	0.41	0.01	96.41	0.36	0.11	3.59
	5	0.07	0.75	1.07	0.47	0.27	0.96	0.38	0.48	0.01	95.03	0.40	0.14	4.97
	10	0.10	0.77	1.29	0.52	0.63	1.10	0.62	0.50	0.01	93.41	0.77	0.30	6.59

Table 5.6A: Variance Decomposition Test (Period 1)

	Lags	NIK	KSP	TW	KLSE	ST	SC	HS	JC	NSE	KSE	TA	SP	FOREIGN
NIK	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	91.99	0.38	0.39	0.16	0.68	0.48	0.74	0.35	0.45	0.25	0.10	4.01	8.01
	5	91.10	0.40	0.45	0.17	0.71	0.50	0.76	0.72	0.45	0.40	0.21	4.11	8.90
	10	90.97	0.40	0.47	0.17	0.71	0.51	0.76	0.80	0.45	0.42	0.22	4.11	9.03
KSP	1	3.54	96.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.54
	3	3.16	86.97	0.07	0.55	1.06	1.19	0.92	0.46	0.00	0.12	0.77	4.73	13.03
	5	3.13	86.15	0.08	0.60	1.28	1.29	0.95	0.65	0.06	0.18	0.93	4.71	13.85
	10	3.13	86.02	0.08	0.61	1.28	1.29	0.95	0.74	0.06	0.19	0.93	4.70	13.98
TW	1	0.71	2.48	96.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19
	3	1.19	2.14	89.06	0.12	0.54	0.03	0.49	4.87	0.72	0.06	0.45	0.33	10.94
	5	1.17	2.07	84.67	0.13	0.68	0.26	0.64	8.38	0.69	0.12	0.85	0.34	15.33
	10	1.17	2.04	83.57	0.16	0.69	0.35	0.64	9.34	0.69	0.14	0.86	0.34	16.43
KLSE	1	0.01	3.16	7.63	89.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.80
	3	0.12	3.25	7.50	85.75	0.14	0.22	0.71	0.25	0.51	0.38	0.09	1.09	14.25
	5	0.14	3.26	7.47	85.56	0.18	0.27	0.74	0.25	0.51	0.40	0.12	1.12	14.44
	10	0.14	3.26	7.46	85.53	0.18	0.27	0.74	0.25	0.51	0.42	0.12	1.12	14.47
ST	1	1.95	10.27	0.02	1.87	85.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.12
	3	1.62	8.25	0.24	2.34	72.59	1.85	4.21	1.06	0.62	0.89	0.04	6.30	27.41
	5	1.61	8.02	0.25	2.28	70.61	2.45	4.13	2.86	0.61	1.00	0.05	6.14	29.39
	10	1.61	7.93	0.27	2.27	69.87	2.51	4.09	3.72	0.61	1.00	0.05	6.07	30.13
SC	1	0.20	1.68	0.02	0.82	3.03	94.25	0.00	0.00	0.00	0.00	0.00	0.00	5.75
	3	0.33	1.26	0.06	0.67	2.41	82.96	1.23	9.12	0.66	0.48	0.77	0.05	17.04
	5	0.43	1.22	0.11	0.66	2.38	77.18	1.19	14.78	0.63	0.57	0.74	0.12	22.82
	10	0.42	1.20	0.16	0.70	2.39	75.82	1.20	16.03	0.64	0.61	0.73	0.12	24.18

Cont...

HS	1	0.30	7.16	0.02	1.13	4.04	3.38	83.96	0.00	0.00	0.00	0.00	0.00	16.04
	3	0.71	6.98	0.64	1.26	4.53	3.95	77.01	0.42	0.01	0.85	0.03	3.60	22.99
	5	0.83	6.95	0.80	1.29	4.50	3.99	76.62	0.42	0.04	0.90	0.05	3.62	23.38
	10	0.84	6.94	0.80	1.29	4.50	3.99	76.55	0.44	0.05	0.94	0.05	3.62	23.45
JC	1	0.33	0.76	1.15	0.18	0.01	2.50	0.46	94.61	0.00	0.00	0.00	0.00	5.39
	3	0.51	0.46	3.37	0.70	0.23	4.27	0.32	87.14	0.43	2.46	0.00	0.09	12.86
	5	0.48	0.44	3.18	0.76	0.69	4.40	0.36	86.81	0.48	2.30	0.01	0.09	13.19
	10	0.48	0.43	3.14	0.82	0.77	4.59	0.42	86.50	0.49	2.26	0.01	0.09	13.50
NSE	1	1.17	2.51	0.10	0.06	0.13	0.84	0.55	0.00	94.65	0.00	0.00	0.00	5.35
	3	1.26	2.86	0.41	0.61	0.91	0.80	1.46	0.66	87.82	0.25	0.28	2.67	12.18
	5	1.27	2.86	0.41	0.63	0.92	0.84	1.48	1.02	87.23	0.25	0.39	2.72	12.77
	10	1.27	2.85	0.41	0.63	0.92	0.86	1.48	1.10	87.11	0.25	0.41	2.72	12.89
KSE	1	0.21	1.73	1.09	0.18	0.04	0.00	0.08	0.33	0.15	96.19	0.00	0.00	3.81
	3	0.19	1.50	1.28	0.62	0.14	0.14	0.50	0.50	0.41	93.88	0.51	0.34	6.12
	5	0.19	1.51	1.51	0.64	0.15	0.27	0.56	0.56	0.42	93.15	0.68	0.36	6.85
	10	0.19	1.51	1.51	0.67	0.16	0.28	0.56	0.67	0.43	92.97	0.69	0.36	7.03
TA	1	0.10	1.21	0.68	4.20	0.24	0.48	0.79	0.00	0.09	4.26	87.95	0.00	12.05
	3	0.09	1.50	0.53	4.33	0.94	0.51	0.70	0.10	0.51	4.79	85.59	0.40	14.41
	5	0.14	1.69	0.65	4.27	1.31	0.68	0.81	0.71	0.53	4.68	84.11	0.43	15.89
	10	0.15	1.69	0.65	4.26	1.31	0.71	0.80	1.17	0.53	4.66	83.63	0.43	16.37
SP	1	1.84	0.59	0.43	0.39	0.31	0.04	1.51	0.05	0.10	0.18	1.40	93.16	6.84
	3	1.92	0.85	0.42	0.87	0.41	0.43	1.68	0.44	0.28	0.22	1.45	91.03	8.97
	5	1.91	0.87	0.43	0.91	0.41	0.47	1.69	0.69	0.28	0.22	1.47	90.65	9.35
	10	1.91	0.87	0.43	0.91	0.42	0.50	1.69	0.80	0.28	0.22	1.47	90.50	9.50

Table 5.6B: Variance Decomposition Test (Period 2)

	Lags	NIK	KSP	TW	KLSE	ST	SC	HS	JC	NSE	KSE	TA	SP	FOREIGN
NIK	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	93.64	0.12	0.03	0.11	0.72	0.01	0.26	0.51	0.32	0.38	0.04	3.87	6.36
	5	91.09	0.32	0.45	0.47	0.90	0.27	0.78	0.59	0.41	0.74	0.12	3.87	8.91
	10	88.39	0.65	0.74	0.69	1.08	0.54	0.79	1.06	0.61	1.01	0.38	4.05	11.61
KSP	1	4.21	95.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.21
	3	3.68	87.82	0.55	0.67	1.43	0.00	1.86	0.06	0.55	0.55	0.55	2.27	12.18
	5	3.70	82.83	0.90	0.84	1.43	0.18	3.66	0.33	1.38	1.55	0.52	2.69	17.17
	10	3.74	77.82	2.09	1.08	1.47	0.94	4.41	1.14	1.47	2.37	0.72	2.74	22.18
TW	1	2.76	10.76	86.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.52
	3	2.57	9.84	77.55	0.63	1.10	0.13	1.13	0.13	0.29	0.23	1.74	4.67	22.45
	5	2.47	9.57	75.06	0.78	1.76	0.45	1.08	0.26	0.80	0.33	1.78	5.65	24.94
	10	2.51	9.16	72.34	0.98	2.14	1.90	1.11	0.43	1.08	0.41	1.76	6.18	27.66
KLSE	1	0.63	1.49	2.33	95.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.45
	3	0.73	1.39	2.75	90.79	0.13	0.00	0.38	1.17	0.27	1.13	0.28	0.99	9.21
	5	0.74	1.35	2.72	89.17	0.20	0.29	0.63	1.20	0.55	1.28	0.54	1.33	10.83
	10	0.83	1.88	3.17	82.66	1.13	2.51	0.95	1.22	0.68	1.38	1.99	1.60	17.34
ST	1	4.03	11.36	3.85	11.80	68.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.04
	3	3.82	11.15	3.98	11.82	62.44	0.14	0.95	0.70	0.23	0.25	0.11	4.41	37.56
	5	3.60	10.95	5.72	11.77	58.10	0.16	1.00	0.93	0.94	0.31	0.28	6.25	41.90
	10	3.49	10.36	6.64	11.09	54.68	2.11	1.72	0.90	1.03	0.77	0.75	6.46	45.32
SC	1	0.01	0.00	0.25	0.53	0.01	99.19	0.00	0.00	0.00	0.00	0.00	0.00	0.81
	3	0.23	0.17	0.31	0.98	0.04	96.99	0.08	0.26	0.12	0.46	0.35	0.01	3.01
	5	0.78	0.51	0.42	1.04	0.35	93.95	0.48	0.47	0.13	0.75	0.93	0.20	6.05
	10	1.74	0.89	0.78	1.22	0.53	89.16	1.08	0.84	0.29	1.02	1.31	1.13	10.84

Cont...

HS	1	2.06	0.16	1.47	0.57	4.52	0.23	90.99	0.00	0.00	0.00	0.00	0.00	9.01
	3	1.72	0.15	1.22	0.57	3.65	0.41	84.37	0.06	0.44	0.44	0.17	6.81	15.63
	5	2.15	0.15	1.25	0.67	3.64	0.56	82.17	0.16	0.86	0.48	0.82	7.10	17.83
	10	4.41	0.33	1.87	0.69	3.50	1.32	77.13	0.27	1.56	1.12	0.91	6.89	22.87
JC	1	0.27	1.12	0.73	4.18	0.04	0.05	0.42	93.20	0.00	0.00	0.00	0.00	6.80
	3	0.31	1.17	0.83	4.30	0.25	0.33	0.41	90.12	0.83	0.37	0.42	0.67	9.88
	5	0.31	1.36	0.78	5.50	0.76	0.43	0.89	86.67	1.23	0.75	0.40	0.91	13.33
	10	0.42	1.66	1.06	5.45	0.94	0.64	0.98	83.43	1.41	0.79	0.74	2.48	16.57
NSE	1	2.10	2.24	2.08	0.73	2.97	0.45	1.21	0.41	87.81	0.00	0.00	0.00	12.19
	3	2.23	2.85	2.22	0.98	2.85	0.69	1.28	1.01	84.25	0.33	0.12	1.20	15.75
	5	2.12	3.29	2.27	1.37	2.97	1.61	1.49	0.97	81.20	0.80	0.18	1.73	18.80
	10	2.83	3.21	2.62	2.06	3.25	1.74	1.89	1.20	78.27	0.89	0.33	1.70	21.73
KSE	1	0.01	0.87	0.74	0.00	0.38	0.21	0.01	0.01	0.04	97.73	0.00	0.00	2.27
	3	0.07	0.76	0.84	0.12	0.38	0.37	0.22	0.62	0.79	93.50	2.30	0.04	6.50
	5	0.17	0.91	1.19	0.48	0.78	0.67	0.25	0.69	1.10	90.82	2.47	0.49	9.18
	10	0.27	1.45	3.39	1.09	1.49	1.50	1.49	0.64	1.07	83.10	3.70	0.81	16.90
TA	1	1.23	0.09	0.02	0.55	1.25	0.03	0.91	0.02	0.22	0.01	95.68	0.00	4.32
	3	1.19	0.44	0.76	0.52	0.81	0.02	0.55	0.22	0.38	1.42	91.51	2.18	8.49
	5	2.44	0.68	0.93	0.60	1.56	0.04	0.80	0.32	0.69	1.95	87.30	2.70	12.70
	10	2.07	0.67	0.94	0.83	1.49	0.21	0.95	0.67	0.60	2.20	87.04	2.35	12.96
SP	1	1.12	0.70	0.38	0.07	1.50	0.01	1.12	0.00	0.12	0.00	0.23	94.75	6.25
	3	1.27	1.00	0.82	0.46	1.53	0.22	1.79	0.44	0.74	0.12	0.50	91.10	11.90
	5	2.45	1.54	1.13	0.65	1.71	1.27	1.96	0.44	0.75	0.37	0.63	87.09	17.91
	10	3.20	1.76	2.12	0.77	2.12	1.73	2.36	0.76	0.84	0.77	0.73	82.82	27.18

Table 5.6C: Variance Decomposition Test (Period 3)

	Lags	NIK	KSP	TW	KLSE	ST	SC	HS	JC	NSE	KSE	TA	SP	FOREIGN
NIK	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	88.60	0.97	1.29	0.01	0.56	0.03	0.19	0.04	0.88	0.12	0.43	6.88	11.40
	5	85.89	1.32	1.63	0.02	0.99	0.42	0.22	0.49	0.97	0.35	0.50	7.21	14.11
	10	81.86	2.17	2.27	0.49	1.19	0.67	0.93	0.74	1.61	0.58	0.52	6.96	18.14
KSP	1	7.06	92.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.06
	3	5.78	83.12	1.46	0.07	0.54	0.10	0.52	0.14	1.26	0.08	0.25	6.68	16.88
	5	5.64	79.46	1.54	0.58	0.86	0.29	0.68	2.38	1.20	0.51	0.31	6.54	20.54
	10	5.52	77.64	1.54	0.69	0.88	0.64	0.69	2.58	1.22	0.58	1.52	6.48	22.36
TW	1	5.13	13.62	81.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.75
	3	4.68	12.80	70.01	1.13	0.38	0.06	0.52	0.05	1.14	0.01	0.24	8.99	29.99
	5	4.66	13.02	67.70	1.20	0.44	0.78	0.67	0.18	1.20	0.21	1.26	8.68	32.30
	10	4.58	13.07	65.47	1.25	0.53	0.99	1.14	0.28	2.18	0.44	1.62	8.45	34.53
KLSE	1	1.65	2.25	8.32	87.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.21
	3	1.44	2.00	8.36	77.50	0.15	0.46	0.29	0.45	0.32	2.30	0.73	5.99	22.50
	5	1.48	2.19	8.85	75.13	0.24	0.95	0.44	0.57	0.43	2.82	0.97	5.94	24.87
	10	1.75	2.57	8.68	73.31	0.27	1.03	0.59	1.29	0.46	2.81	1.44	5.80	26.69
ST	1	9.24	5.34	7.80	21.99	55.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.37
	3	9.51	4.15	7.02	18.07	47.21	0.17	0.35	0.12	1.45	0.02	0.42	11.52	52.79
	5	9.07	4.51	9.18	17.24	44.30	0.37	0.48	0.49	1.56	0.63	0.80	11.37	55.70
	10	8.88	5.09	8.79	16.93	42.31	0.72	0.52	2.01	1.71	0.69	1.31	11.04	57.69
SC	1	0.24	0.66	0.63	0.36	0.49	97.61	0.00	0.00	0.00	0.00	0.00	0.00	2.39
	3	0.51	0.73	1.82	0.38	0.47	92.81	0.67	0.53	0.45	0.17	0.62	0.83	7.19
	5	0.53	1.17	2.17	0.53	0.77	90.31	1.40	0.52	0.50	0.24	0.61	1.26	9.70
	10	0.60	1.29	2.24	0.63	0.77	89.19	1.74	0.53	0.54	0.32	0.61	1.53	10.81

Cont...

HS	1	4.96	7.88	3.98	5.89	8.49	1.29	67.51	0.00	0.00	0.00	0.00	0.00	32.49
	3	4.77	6.53	4.35	5.01	7.44	1.17	57.62	0.14	1.39	0.02	0.06	11.51	42.38
	5	4.57	6.44	4.52	4.87	7.30	1.58	55.88	0.83	1.42	0.55	0.45	11.59	44.12
	10	4.46	6.57	4.39	5.03	7.48	2.79	53.97	1.04	1.41	0.59	0.98	11.30	46.03
JC	1	2.55	2.92	1.84	8.48	6.09	0.19	0.46	77.46	0.00	0.00	0.00	0.00	22.54
	3	2.63	2.83	1.90	8.03	6.08	0.42	0.51	70.57	0.36	0.69	0.84	5.14	29.43
	5	2.49	2.92	2.31	7.74	5.77	1.40	0.86	68.91	0.34	1.41	0.90	4.95	31.09
	10	2.48	3.05	2.37	8.36	5.60	2.70	0.92	66.50	0.41	1.40	1.35	4.87	33.50
NSE	1	2.28	3.73	1.09	0.51	1.83	0.13	4.69	2.95	82.79	0.00	0.00	0.00	17.21
	3	2.29	3.66	1.10	0.48	1.73	0.84	4.95	2.97	73.28	0.01	0.35	8.34	26.72
	5	2.64	4.55	1.06	0.66	2.13	0.81	5.15	3.10	70.23	0.71	0.38	8.58	29.77
	10	2.62	4.77	1.15	1.36	2.12	1.77	5.34	3.16	68.04	0.71	0.48	8.48	31.96
KSE	1	0.03	0.07	0.01	1.73	0.38	0.09	0.23	1.28	0.03	96.17	0.00	0.00	3.83
	3	0.62	0.31	0.22	2.00	0.53	0.16	0.27	1.39	0.56	93.53	0.28	0.13	6.47
	5	0.77	0.68	0.73	2.31	0.58	0.16	0.42	1.51	0.56	91.73	0.33	0.22	8.27
	10	0.77	0.78	0.78	2.31	0.80	0.27	0.87	1.49	1.38	89.74	0.40	0.42	10.26
TA	1	0.72	1.20	0.62	0.53	1.08	0.00	0.13	0.23	1.08	0.72	93.68	0.00	6.32
	3	0.53	1.25	2.40	0.63	1.02	0.50	0.43	0.23	0.85	0.96	88.83	2.36	11.17
	5	0.52	1.46	2.57	0.72	1.20	0.55	0.43	0.52	1.60	1.60	86.34	2.49	13.66
	10	0.52	1.52	2.39	0.95	1.45	1.24	0.47	0.52	1.78	1.50	85.38	2.27	14.62
SP	1	3.44	1.66	0.80	1.13	1.80	0.17	0.47	0.09	0.93	0.19	1.00	88.31	11.69
	3	3.61	2.01	1.41	1.63	1.95	0.39	0.50	0.65	1.12	0.24	0.96	85.54	14.47
	5	3.43	3.22	1.52	3.04	2.12	0.41	0.51	0.70	1.87	0.72	1.05	81.42	18.58
	10	3.52	3.20	1.53	3.17	2.18	0.63	0.54	0.82	2.34	0.78	1.14	80.16	19.84

Table 5.6D: Variance Decomposition Test (Period 4)

	Lags	NIK	KSP	TW	KLSE	ST	SC	HS	JC	NSE	KSE	TA	SP	FOREIGN
NIK	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	75.32	6.35	0.01	0.24	2.84	0.62	1.05	0.76	0.02	0.58	0.36	11.87	24.68
	5	73.96	7.12	0.07	0.34	2.98	0.63	1.27	0.92	0.03	0.63	0.36	11.68	26.04
	10	73.81	7.11	0.11	0.37	2.99	0.64	1.32	0.92	0.04	0.64	0.37	11.66	26.19
KSP	1	17.04	82.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.04
	3	14.74	71.17	0.38	0.24	2.02	1.33	0.71	0.90	0.09	0.02	0.09	8.32	28.83
	5	14.23	68.43	1.85	0.34	1.98	1.32	2.04	0.87	0.17	0.20	0.25	8.33	31.57
	10	14.24	68.27	1.88	0.35	1.97	1.32	2.05	0.87	0.17	0.22	0.35	8.31	31.73
TW	1	5.46	9.44	85.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.90
	3	4.63	8.44	74.57	0.74	2.79	0.19	0.69	0.47	0.02	0.55	0.03	6.88	25.43
	5	4.65	8.63	72.88	0.90	2.85	0.21	0.91	1.34	0.03	0.64	0.06	6.90	27.12
	10	4.66	8.65	72.74	0.95	2.85	0.21	0.94	1.35	0.04	0.64	0.09	6.88	27.26
KLSE	1	0.06	3.82	9.92	86.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.80
	3	0.80	3.01	9.83	79.84	2.63	0.21	0.43	1.28	0.00	0.04	0.00	1.94	20.16
	5	0.78	3.14	9.85	78.20	2.91	0.22	0.48	1.41	0.12	0.05	0.66	2.18	21.80
	10	0.80	3.14	9.85	78.10	2.92	0.22	0.49	1.45	0.13	0.05	0.67	2.18	21.90
ST	1	13.11	22.83	1.52	0.91	61.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.36
	3	11.39	20.41	2.19	1.12	54.34	0.30	0.40	0.50	0.02	0.50	0.29	8.54	45.66
	5	11.27	19.46	3.43	1.18	53.07	0.29	0.52	0.56	0.02	1.56	0.36	8.27	46.93
	10	11.28	19.41	3.48	1.18	52.88	0.29	0.53	0.58	0.03	1.65	0.38	8.31	47.12
SC	1	0.67	3.91	0.04	0.64	0.38	94.36	0.00	0.00	0.00	0.00	0.00	0.00	5.64
	3	0.69	3.78	0.06	0.67	0.58	91.25	0.81	0.74	0.23	0.36	0.09	0.74	8.75
	5	0.68	3.93	0.09	0.78	0.59	89.99	0.84	0.74	0.32	0.42	0.67	0.96	10.01
	10	0.69	3.93	0.11	0.78	0.61	89.87	0.85	0.75	0.33	0.42	0.69	0.96	10.13

Cont...

HS	1	16.28	25.38	0.98	0.50	11.68	3.65	41.54	0.00	0.00	0.00	0.00	0.00	58.46
	3	13.80	21.35	1.79	0.48	10.22	5.79	35.46	0.51	0.01	0.02	0.04	10.53	64.54
	5	13.42	21.11	2.15	0.64	10.28	5.76	34.69	0.60	0.01	0.04	0.84	10.46	65.31
	10	13.43	21.07	2.18	0.66	10.27	5.76	34.66	0.61	0.01	0.07	0.85	10.44	65.34
JC	1	7.33	12.99	2.34	3.78	5.38	0.05	3.73	64.40	0.00	0.00	0.00	0.00	35.61
	3	6.79	12.07	2.87	3.43	6.04	0.12	3.48	57.48	0.02	1.13	0.18	6.38	42.52
	5	6.75	11.93	2.89	3.43	6.39	0.15	3.59	56.88	0.13	1.19	0.35	6.31	43.12
	10	6.74	11.91	2.92	3.44	6.38	0.16	3.60	56.78	0.13	1.28	0.35	6.30	43.22
NSE	1	0.45	0.62	0.00	0.35	0.49	0.03	0.07	0.20	97.79	0.00	0.00	0.00	2.21
	3	0.79	0.68	0.00	0.31	0.42	0.38	0.08	0.26	96.72	0.06	0.10	0.18	3.28
	5	1.04	0.72	0.06	0.31	0.56	0.72	0.15	0.26	95.81	0.07	0.11	0.18	4.19
	10	1.09	0.75	0.07	0.32	0.59	0.75	0.16	0.26	95.63	0.08	0.11	0.19	4.37
KSE	1	0.18	0.01	1.03	0.02	0.17	0.11	0.59	0.00	0.02	97.86	0.00	0.00	2.14
	3	0.32	0.48	1.33	0.07	0.19	0.30	0.72	0.06	0.24	96.07	0.20	0.03	3.93
	5	0.43	0.68	1.63	0.49	0.33	0.36	1.32	0.15	0.27	93.49	0.80	0.06	6.51
	10	0.43	0.68	1.69	0.50	0.35	0.38	1.35	0.18	0.27	93.29	0.81	0.07	6.71
TA	1	4.16	4.80	0.08	0.48	2.92	0.00	1.24	0.41	0.01	0.51	85.39	0.00	14.61
	3	3.29	4.05	0.18	2.47	2.42	1.13	1.16	0.37	0.07	0.99	80.77	3.10	19.23
	5	3.31	4.33	1.04	2.67	2.74	1.30	1.19	0.49	0.09	1.11	78.71	3.01	21.29
	10	3.30	4.33	1.10	2.73	2.77	1.33	1.20	0.50	0.09	1.14	78.49	3.02	21.51
SP	1	7.11	7.07	0.22	0.27	6.85	0.24	2.21	0.20	0.10	0.39	0.60	74.74	25.26
	3	7.41	7.90	0.21	0.32	6.23	0.28	2.57	0.38	0.15	0.73	0.97	72.86	27.14
	5	7.42	8.03	0.24	0.35	6.20	0.28	2.60	0.68	0.19	0.75	0.97	72.31	27.69
	10	7.42	8.01	0.29	0.35	6.19	0.28	2.63	0.68	0.20	0.75	0.98	72.21	27.79

5.2 TESTS FOR VOLATILITY

5.2.1 GARCH(1,1) Model

GARCH model is used to explain the future variances while taking the past variance into consideration. It is an econometric technique which is used to model the serial dependence of volatility; i.e., this model reflects volatility clustering (Arora et al. (2009)). The results of GARCH (1,1) model, reflected by the variance equation, are presented in table 5.7, table 5.7A, table 5.7B, table 5.7C and table 5.7D for a total time period, period-1, period-2, period-3 and period-4 respectively. The three coefficients; ω, α and β reflect the constant, ARCH term and GARCH term for GARCH (1,1) model.

The significance of α and β, here, indicates that, lagged squared error and lagged conditional variance surely have an impact on the conditional variance and it is true for each market under study that volatility from the previous periods have an impact on current volatility of all the markets. In other words, volatility clustering exists in the markets. But, the persistence of shocks on to volatility depends highly on the sum of the ARCH term (α) and GARCH term (β) parameters. When the sum of the parameters is less than unity, it implies a tendency for the volatility response to decay over time, equal to unity implies indefinite volatility persistence to shocks over time, and greater than unity implies increasing volatility persistence over time. Before looking into the results, it was important to see whether the problem of multi-collinearity arise in the case of testing volatility for twelve stock markets. For the purpose of checking multi-collinearity, the results of Pearson's correlation test was used, which shows that not a single pair of stock market have shown the higher positive correlation among them in any time period. Based on which it can be presumed that the problem of multi-collinearity does not exist in these twelve stock market, and the data for these markets would give fair results when tested for the volatility persistence.

Table 5.7 shows that the three coefficients in the variance equation are statistically significant for a total time period. Since all the coefficients are found to be significant so it can be inferred that volatility clustering exists in the market under present study for total time period. It is also clear that the sum of ARCH term (α) and GARCH term (β) for markets NSE, JC, KSE, SC, TA and TW is more than 1 which implies that volatility persist overtime would increase, while in markets like KLSE and NIK, $\alpha+\beta < 1$, signifying decaying volatility over time. Remaining markets under study (HS, KSP, SP and ST) were added parameters are approximately equal to 1 are expected to reveal indefinite volatility persistence.

Table 5.7: GARCH (1,1) Model (Total Time Period)										
Coefficient	ω	**z-Stat**	**Prob.**	α	**z-Stat**	**Prob.**	β	**z-Stat**	**Prob.**	$\alpha+\beta$
NSE	1.16E-05	11.943	0.00	0.264	60.758	0.00	0.758	139.317	0.00	1.022
HS	6.79E-06	15.504	0.00	0.101	22.526	0.00	0.891	301.744	0.00	0.992
JC	0.002594	55.126	0.00	1.065	17.380	0.00	-0.002	17.380	0.00	1.063
KLSE	8.16E-05	27.821	0.00	0.344	14.745	0.00	0.473	26.858	0.00	0.817
KSE	1.16E-05	11.943	0.00	0.264	60.758	0.00	0.758	139.317	0.00	1.022
KSP	3.83E-06	9.380	0.00	0.072	31.373	0.00	0.928	538.374	0.00	1.000
NIK	0.000113	35.640	0.00	0.221	16.905	0.00	0.597	57.971	0.00	0.818
SC	8.62E-08	0.650	0.51	0.044	92.618	0.00	0.966	7200.354	0.00	1.010
SP	3.18E-06	9.433	0.00	0.109	15.353	0.00	0.882	142.084	0.00	0.991
ST	1.12E-05	25.997	0.00	0.156	23.297	0.00	0.819	150.593	0.00	0.975
TA	1.39E-05	12.932	0.00	0.147	21.271	0.00	0.858	218.108	0.00	1.005
TW	1.59E-05	21.484	0.00	0.231	23.089	0.00	0.798	145.013	0.00	1.029

Table 5.7A: GARCH (1,1) Model (Period-1)										
Coefficient	ω	**z-Stat**	**Prob.**	α	**z-Stat**	**Prob.**	β	**z-Stat**	**Prob.**	$\alpha+\beta$
NSE	2.72E-05	3.972	0.00	0.151	5.851	0.00	0.774	22.892	0.00	0.925
HS	0.000163	10.071	0.00	0.131	5.513	0.00	0.637	19.343	0.00	0.767
JC	0.008051	36.183	0.00	0.338	6.562	0.00	-0.016	-1.885	0.06	0.322
KLSE	0.000255	14.634	0.00	0.302	6.262	0.00	0.338	7.789	0.00	0.639
KSE	0.000247	7.420	0.00	0.221	20.364	0.00	0.833	121.037	0.00	1.054
KSP	0.000268	5.951	0.00	0.183	5.114	0.00	0.583	9.180	0.00	0.766
NIK	0.000163	10.417	0.00	0.235	5.748	0.00	0.235	5.748	0.00	0.470
SC	3.16E-05	24.917	0.00	0.051	22.274	0.00	0.934	1022.438	0.00	0.984
SP	3.42E-05	4.119	0.00	0.192	6.735	0.00	0.650	12.521	0.00	0.842
ST	8.53E-05	8.159	0.00	0.256	4.890	0.00	0.568	10.905	0.00	0.825
TA	0.000119	4.496	0.00	0.148	8.457	0.00	0.821	44.278	0.00	0.969
TW	0.000240	10.202	0.00	0.382	6.988	0.00	0.437	11.588	0.00	0.819

Table 5.7B: GARCH (1,1) Model (Period-2)										
Coefficient	ω	**z-Stat**	**Prob.**	α	**z-Stat**	**Prob.**	β	**z-Stat**	**Prob.**	$\alpha+\beta$
NSE	1.22E-05	3.198	0.00	0.151	6.943	0.00	0.780	20.221	0.00	0.931
HS	0.000113	14.237	0.00	0.203	6.986	0.00	0.449	11.796	0.00	0.652
JC	0.000150	21.909	0.00	0.310	7.878	0.00	0.558	26.324	0.00	0.867
KLSE	4.33E-05	10.496	0.00	0.462	8.584	0.00	0.386	8.402	0.00	0.848
KSE	1.08E-05	-3.374	0.00	0.425	83.052	0.00	0.569	237.888	0.00	0.994
KSP	9.102E-06	7.324	0.00	0.102	16.104	0.00	0.898	261.833	0.00	1.000
NIK	0.000100	16.834	0.00	0.162	10.301	0.00	0.690	43.672	0.00	0.852
SC	2.34E-05	5.746	0.00	0.195	8.370	0.00	0.680	19.043	0.00	0.875
SP	7.33E-06	5.724	0.00	0.003	6.484	0.00	0.847	47.694	0.00	0.850
ST	1.43E-05	6.373	0.00	0.142	7.529	0.00	0.791	35.750	0.00	0.933
TA	5.50E-05	4.107	0.00	0.149	6.819	0.00	0.836	43.679	0.00	0.985
TW	7.61E-05	4.005	0.00	0.081	3.461	0.00	0.734	11.704	0.00	0.816

Table 5.7C: GARCH (1,1) Model (Period-3)										
Coefficient	ω	**z-Stat**	**Prob.**	α	**z-Stat**	**Prob.**	β	**z-Stat**	**Prob.**	$\alpha+\beta$
NSE	1.53E-05	5.371	0.00	0.122	5.537	0.00	0.810	28.855	0.00	0.932
HS	8.00E-06	4.949	0.00	0.116	7.516	0.00	0.848	48.367	0.00	0.964
JC	0.000127	9.528	0.00	0.192	4.504	0.00	0.461	8.034	0.00	0.653
KLSE	1.70E-05	12.068	0.00	0.351	8.474	0.00	0.583	19.330	0.00	0.934
KSE	5.8E-05	9.192	0.00	0.562	11.555	0.00	0.483	15.653	0.00	1.045
KSP	5.70E-05	16.077	0.00	0.142	7.417	0.00	0.688	38.891	0.00	0.830
NIK	0.000160	15.267	0.00	0.352	7.267	0.00	0.228	5.166	0.00	0.579
SC	2.59E-06	2.396	0.01	0.055	5.409	0.00	0.939	90.607	0.00	0.994
SP	2.28E-06	3.997	0.00	0.058	6.683	0.00	0.915	76.719	0.00	0.973
ST	2.28E-05	9.050	0.00	0.153	7.336	0.00	0.708	23.833	0.00	0.861
TA	2.42E-05	5.677	0.00	0.191	5.598	0.00	0.743	20.969	0.00	0.935
TW	2.21E-05	8.591	0.00	0.284	8.747	0.00	0.658	24.886	0.00	0.942

Table 5.7D: GARCH (1,1) Model (Period-4)										
Coefficient	ω	**z-Stat**	**Prob.**	α	**z-Stat**	**Prob.**	β	**z-Stat**	**Prob.**	$\alpha+\beta$
NSE	6.69E	1.988	0.05	0.461	35.559	0.00	0.715	76.106	0.00	1.176
HS	1.43E-05	4.483	0.00	0.126	6.018	0.00	0.846	36.167	0.00	0.971
JC	6.39E-05	6.053	0.00	0.354	8.795	0.00	0.548	13.209	0.00	0.901
KLSE	0.000421	26.873	0.00	0.236	4.799	0.00	-0.045	-3.642	0.00	0.191
KSE	0.000626	28.711	0.00	0.323	8.664	0.00	0.279	11.461	0.00	0.602
KSP	3.76E-06	2.441	0.01	0.097	7.605	0.00	0.893	60.655	0.00	0.990
NIK	0.000157	8.909	0.00	0.249	6.295	0.00	0.570	13.731	0.00	0.819
SC	0.000158	13.603	0.00	0.287	20.010	0.00	0.593	31.347	0.00	0.880
SP	2.54E-06	1.904	0.56	0.195	8.122	0.00	0.837	50.600	0.00	1.032
ST	1.09E-06	1.719	0.85	0.122	9.652	0.00	0.887	103.020	0.00	1.009
TA	3.52E-05	7.509	0.00	0.138	10.587	0.00	0.839	91.696	0.00	0.977
TW	4.30E-06	2.937	0.00	0.329	9.164	0.00	0.780	43.701	0.00	1.110

Table 5.7A, table 5.7B, table 5.7C and table 5.7D reveal that for the period-1, KSE is the most volatile market, whose volatility will persist for longer time because it is the only market that has the sum of ARCH and GARCH terms greater than 1 and this sum for all other markets in period-1 is less than 1. The situation is different in period-2, where KSP has $\alpha+\beta$ = 1and KSE has $\alpha+\beta$ ~ 1, implies that these markets reveal indefinite volatility persistence and all other markets reveal decaying volatility since sum of the volatility parameters for all other markets is less than 1. In period-3 also KSE has $\alpha+\beta$ > 1 and only SC has $\alpha+\beta$ ~ 1, again other markets have shown the sign of decaying volatility. The trend differs for period-4, where NSE, ST, TW and SP have shown increasing volatility persistence over time and KSP has $\alpha+\beta$ ~ 1 and all other markets have $\alpha+\beta$ < 1.

5.3 CONCLUSION

This chapter was an attempt to answer the second and forth research questions of the thesis and reported the results of integration tests and the test for volatility. Pearson's Correlation test, Johansen's co-integration Test, Granger causality test and VAR model were adapted to study the level of integration among twelve Asian and the US stock markets. The results of correlation analysis explained that the level of correlation among these markets increased from period-1 to period-3 but fell in period-4. The results of other tests also followed the same trend; i.e., in case of co-integration test also the integration was found to be highest in case of pre-crisis period; i.e., period-3. The ECM coefficients judge the speed of adjustment of the markets when they are co-integrated and found that the maximum numbers of the positive coefficients were found in period-3, which mean that the markets in period-3 have highest speed of adjustment as compared to the markets in other sub-periods. The Granger causality test also informs that out of the total 66 pairs of markets, the least number of pairs that do not cause each other in any direction are in period-3 and only this pre-crisis period has the highest number of pairs with bidirectional causality. The findings of the IRF also cleared that the markets in period-3 take longer time as compared to markets in other time periods to come back to equilibrium level and in case of VDC analysis also, the highest range of error-forecast variance was in case of period-3 - the pre-crisis period.

The GARCH (1,1) model was adopted to capture the volatility in the twelve stock markets taken up for the study. Volatility clustering was found in these markets but the level or degree of volatility does not vary with the passage of time, more or less it remains same in the first three periods. More specifically, the degree of volatility was highest in period-4 only where more markets have shown increasing volatility persistence as compared to the previous three sub-periods.

CHAPTER - 6

SUMMARY, CONCLUSIONS AND SUGGESTIONS

This chapter summarizes the major findings of the study and draws suggestions and recommendations for the capital markets. It attempts to provide practical implications for the participants of the financial markets. References of the objectives, as mentioned in chapter three, are made at appropriate places with the results and conclusion drawn to ensure that the intented objectives are achieved. The implication and major recommendations emerged from the study are mentioned thereafter. The chapter ends with the discussions on the limitations of the study that serves as potential avenues for extending the study in the future.

6.1 Summary and Conclusion

This section summarizes the key findings of the study and answers the four research questions mentioned in chapter three.

6.1.1 Does the level of informational efficiency vary with time for the markets considered understudy?

The theoretical basis of the EMH in its weak form states that successive stock prices or its returns are independent and identically distributed,which suggest that past stock prices have no predictive content to forecast future stock prices.

Following the literature, it can be said that the empirical studies on the concept of weak form EMH in emerging markets is extensive and it has been an area of focus that is investigated by researchers, especially in recent years. The empirical evidence and results, received from these studies are multifarious and even contradicting. Some studies have accepted the null hypothesis of weak form market efficiency while others have rejected it. Based on the theoretical and empirical literature, the weak form market efficiency for the Asian and the US markets is investigated.

This study tests the weak form market efficiency and examines the random walk for twelve stock markets, eleven from the Asian region and one from the US. It uses daily closing data for the most suitable index (as defined in chapter three) from these markets for the period beginning from January, 1999 and ending in December, 2010. In the era of globalization, stock markets have also undergone tremendous changes. In this continuously changing economic environment, weak form market efficiency is examined for the four sub-periods and also for the total time-period of 12 years. The total time-period is divided into four sub-periods in order to examine whether these stock markets exhibit a change in efficiency over time. Four different econometric techniques, namely runs test, autocorrelation test, unit root (ADF and PP) test and variance ratio test have been employed in this study.

The empirical results indicate that stock returns in the twelve markets are inconsistent with the weak form EMH. The output of the runs test shows the mixed results in the context of market efficiency with the changing course of time. Besides runs test, other tests are also employed for further investigation. The results of an ADF and PP test show the existence of a unit root in all the twelve index series for the total time period as well as for the four sub-periods. The results gleaned from the autocorrelation test also support the outcome obtained from the runs test and the unit root test. The VR test also depicts inefficiency in all the markets except for a few incidences.

The empirical results of this study suggest that the Asian and the US stock markets are not associated with the random walks in all the time periods. Thus, it may be noted hare that the level of efficiency does not vary with time. The results of the present study are not unique but similar to the earlier ones on the Asian and the US stock markets. Overall, the results of this study are also consistent with the general assumption that the Asian and the US markets are not informationally efficient and existence of any financial disturbance like crisis does not effect stock market efficiency. The findings of the present study are similar to those of Frennberg and Hansson (1993), Pant and Bishnoi (2002), Uddin and Khoda (2009), Mahmood et al. (2010) and Sharma and Seth (2011b). At the same time, there are studies that have shown reverse of what this study has concluded. In other words, the studies like Islam et al. (2007), Lim et al. (2008) and Singhania and Seth (2010) have shows the financial crisis has changed state of efficiency in the stock markets.

6.1.2 Does the level of integration vary with time among the markets considered understudy?

As mentioned earlier, this work empirically examines the equity markets in the selected Asian and US stock markets. One of the most important issues in market integration is to clarify and specify how market integration is defined. Two definitions of market integration are commonly adopted in the literature. Theoretically, stock markets are integrated if the expected rate of returns on a stock is equal among markets. Operationally, integration is defined in terms of the price-interdependence between markets.

Within the context of the operational definition, the study establishes the level of integration that exists among stock markets in Asia and in the US. Studies adopting the statistical view of the market integration tend to rely on econometric techniques, such as Pearson's correlation test, Johansen's co-integration test, VAR, Granger causality test, to examine the linkages among the stock markets. The present research also adopts these tests to investigate the relationship between the stock markets in Asia and in the US.

The model that investigates the integration of the markets depends upon the degree of price co-movements. The greater the degree of co-movements, the greater would the stock market integration be. The Pearson's correlation coefficient which measures the linear relationship between two variables, were calculated as a preliminary indication of stock market integration. Testing of stationery needs to be done as a prior step to co-integration. For this purpose, the model of ADF and PP test with intercept was applied, to logarithmic values of each country's stock index for each time period, in chapter four. The definition of co-integration sates that if two time series are I(1), then the residual from the regression of those series would be also I(1), unless they are co-integrated. Johansen (1988) extended the model for any set of n variable based on VAR model. Findings of co-integration test imply that these markets will not vary greatly over the long-term. Once two time series are found to be co-integrated, the next step will be to track the speed of adjustment or restoration of the equilibrium, which takes market back to the normal integrated course. The VECM predicts negative coefficient of adjustment, which supports evidence of co-integration. The Granger causality test measures the causal relationship between two variables. It involves F-tests which test whether lagged information on a variable X provides any statistically significant information about a variable Y in the presence of lagged values. If not, then X does not granger cause Y. After the Granger causality test, IRF and VDC analysis was used to assess the strength and direction of the markets in the present study.

The findings of correlation analysis show that the correlation between the markets is varying from very low to moderate levels. None of the market was found to be highly correlated with others. There were only five insignificant correlation coefficients existing in this period. But, the number of insignificant correlation coefficients was eleven in period-1, which fell to six in period-2 and to two in period-3 but again reached six in period-4. It shows that the correlation improved from period-1 to period-2 and then to period-3 but worsened with a slight fall in period-4. The correlation was found to be highest in the pre-crisis period (period-3) and was least in both, the after-crisis periods and the during crisis period; i.e., period-1 and period-4 respectively. The KSE is only market that has witnessed change (positive to negative) in correlation in all sub-periods.

The results of the ADF and PP tests show that all index levels are I(1) and returns are stationary I(0). Appropriate lag was selected using the Lag Exclusion Wald test for co-integration analysis. Co-integration tests are then applied only to the index levels, but not the index returns and it was again verified although all the twelve stock markets are co-integrated in all the periods but the highest level of co-integration in period-3, the period prior to the financial crisis.

Since, it was already mentioned in chapter five that the speed of adjustment of the markets with the positive coefficients is marginally higher than the rest of the stock markets and these markets would go back to equilibrium faster as compared to the other markets. So, on this basis it was observed that there were only four markets in total time period that have shown positive coefficient of error correction. In line with the results of correlation and co-integration test, the ECM also shows that period-3 has the maximum number of markets with positive coefficients and these numbers were eight in period-1 increased to nine in period-2 then to eleven in period-3 and fell to four in period-4. It is again proved that the markets in pre-crisis period are most robust markets that react to the other markets instantaneously but comes back to the equilibrium with a faster speed.

It was concluded from the Granger causality test that the SP was playing a dominating role in a total time period as well as in other sub-periods as it cause most of the stock markets. There were twelve pairs in total time period that have shown no relation with other markets, at the same time there were 27 pairs that have shown bidirectional causality. Contradictory to total time period, there were only four pairs that have shown bidirectional causality in period-1 and period-2; and the cases of no causality have reduced from 27 to 32 from period-1 to period-2. The pairs of no causality have fallen to fourteen in period-3 but the two way causing pairs have increased to sixteen which again to some extent fallen and reached to thirteen in period-4 in which the cases of no causality have also risen to 22. The results of causality again shown that the period-3 was the most favorable period in context of integration because the maximum degree of integration was found in period-3. This may be due to the highest number of pairs with bidirectional causality and least number of pairs with no causality at all in this period.

As far as the results of IRF are concerned, these are based on the Cholesky decomposition wherein the markets were ordered according to the time of trading. The ordering of the stock price indices is NIK, KSP, TW, KLSE, ST, SC, HS, JC, NSE, KSE, TA and SP. The IRF reports the reaction of market; i.e., when a shock of one standard deviation is given to one stock market to see how this particular stock market reacts to other market. It was noticed from the figures of IRF that all the markets react strongly to its own shocks and takes about 2-3 days on an average to come back to its equilibrium. There was no noticeable movement in period-4, whereas the markets take at the maximum 7-8 days to become stable in period-3 and 5-6 days in period-2, but 2-3 days, both in period-1 and in total time period.

The VDC explains the extent at which a variable is explained by the shocks in all the variables in the system. The decomposition of forecast error variance for the tenth day was noticed in each case and it was observed that the range of innovation in total period was 25.61. Unlike results of the tests mentioned earlier, the results VDC show that the period-4 (the period of global financial crisis) was the most significant period as it has the highest range of innovations; i.e., 60.97, followed by period-3 (47.43), period-2 (34.48) and period-1 (23.10).

Thus, it is now clear from the above discussion that the markets reacted the most in period-3 - the period prior to the recent global financial crisis. It can also be concluded that the integration among the markets improves as an effect of financial crisis. The results of the present study are in line with Choudhry (1996), Masih and Masih (1999), Yang et al. (2003), Ahmed et al. (2005), Yusof and Majid (2006), Ameer (2006), Masih and Masih (2007), Majid et al. (2008), Wang and Moore (2008), Raj and Dhal (2008), Gupta (2011) and Gray (2013).

6.1.3 Is there any relationship that exists between informational efficiency and integration for the markets understudy?

It is not possible to make profits out of arbitrage if the markets are efficient; likewise, when the stock market price series are found to be integrated, international diversification becomes worthless.

The informational efficiency and the integration are inversely related to each other; i.e., if the equity prices are co-integrated, this may indicate the existence of inefficiency in the equity market and if the stock markets are found to efficient, the markets may not follow the same path. The concept was very well defined by Granger (1986), where he has mentioned that if two price series are integrated, one price series can be used to forecast another that violates the EMH. He said that "if x_t, y_t are a pair of prices from a jointly efficient, speculative market, they cannot be co-integrated because if two markets are co-integrated, one can be used to help forecast the other and this would contradict the efficient market assumption." This statement was verified by many other researchers like Cornelius (1993), Campbell and Shiller (1987), Cerchi and Havernner (1988), Diba and Grossman (1988), Kasa (1992), Rappoport and White

(1991), and Taylor and Tonk (1989). They effectively end up by agreeing to what Granger had concluded.

On the basis of the tests conducted, it is concluded that all the twelve stock markets are found to be inefficient in all the time periods except for a few cases that are exceptional. The integration among the markets was examined using the Johansen's co-integration model, Granger causality test and innovation accounting procedure (Sims, 1980). It was observed that the twelve stock markets are integrated in long-term and short-term causality also exists in the markets. When the shock of one standard deviation is given to any one stock market, it majorly reacts to itself and slightly to the other markets too. The markets come to the equilibrium in 2-6 days after of the shock was given..

Thus, the findings of the present study are aligned with the previous researches on the same concept. In other words, the results obtained after testing the efficiency and integration of the markets lead to the conclusion that if the behavior of stock market price series is inefficient or does not follow random walk, the series will be considered to be co-integrated. Hence, the results of the present study responded positively to the last research question posed is : '*YES,* there exists a relationship between the informational efficiency and the integration but the inverse relation; i.e., presence of one, efficiency or integration, eradicates the presence of another'.

Many researchers including Macdonald and Taylor (1988), Hakkio and Rush (1989), Baillie and Bolleslev (1989), Chan et al. (1992), Arshanapalli and Doukas (1993), and Defusco et al (1993), Chan et al. (1997) have also presented the same view as given by the present study. According to the available literature on co-integration and efficiency, if two stock markets are collectively efficient in the long run, then their stock prices cannot be co-integrated (Chan et al., 1997). There were few researchers who have shown disagreement to this view and stated that there was no correspondence between efficient stock markets and co-integrated stock markets like Sephton and Larson (1991), Dwyer and Wallace (1992), Baffes (1994), Crowder (1994, 1996), Engel (1996). Sephton and Larson (1991) asserted that "co-integration tests are panacea they appear to be in the search for a definitive test of market efficiency" and suggested more extensive analysis of co-integration regressions and error correction models before concluding the co-integraion method based results. Dwyer and Wallace (1992) point out that "there is no general equivalence between market efficiency and co-integration" and Engel (1996) declared that "co-integration or lack of co-integration of spot exchange rates has nothing to do with international capital market efficiency." Whereas, different from this school of thought, one that is in favour of the relation between efficiency and integration, there exists another that opposes it. Wilson and Marashdeh (2007) answered the title of their paper ‘Are co-integrated stock prices consistent with the efficient market hypothesis?’ as “‘Yes’ in the long run and ‘No’ in the short run.” and they also said that “market inefficiency in the short run ensures market efficiency in the long run.”

6.1.4 Does the level of volatility vary with time for the markets considered understudy?

Generally, volatility refers to the degree to which stock returns fluctuate. It is witnessed that volatility is not constant, but it tends to cluster, whether high or low. A classical way of modeling volatility may be worked out by using GARCH models. Research in the 1990s showed that discrete time GARCH models give surprisingly good forecasts of volatility when applied to daily financial returns. (Enders, 2004; Choudhary, 1996; Song et al., 1999; Haroutounian and Price, 2001; Siourounis, 2002). Kurma (2006) and Hansen and Lunde (2005) confirmed the superiority of the GARCH (1,1) model and stated that this model outperforms other forecasting models.

The results of this study imply that the financial crisis have not shown much impact on the volatility of the stock markets under the present study but have shown a very modest change in volatility in period-4; i.e., the period of crisis. Otherwise, markets have shown the existence of volatility clustering in all the five time periods. The numbers of stock markets have increased which have shown volatility in period-4. The KSE is the only market that has shown the maximum volatility in all sub-periods except for period-4 and for the total time period taken.

From the above discussion, it has been empirically proven that the stock market efficiency and integration is highly effected in the period of the recent global financial; i.e., sub-period-3. In this sub-period, only a few markets are found to be efficient otherwise in other sub-periods all the stock markets are found to be inefficient. The stock markets taken into consideration in this study are found to be integrated during the whole period of study but the integration is found to be strongest in sub-period-3. In addition to this, the speed of adjustment and the bidirectional causality among these stock markets is highest in this sub-period, the same is concluded by the means of innovation accounting. The volatility in stock markets is not affected much due to financial crisis but it has shown a remarkable increase in during-crisis period; i.e., sub-period-4.

6.2 Implications of the Study and Recommendations

The empirical findings in this research shed light on the effectiveness of stock market efficiency, investment decisions and international diversification. For any stock market, different stakeholders or operators are individual/ institutional investors, portfolio managers, policy makers and agents/brokers. Present research work and its findings may be considered by them to draw meaningful conclusions while operating in the stock markets. They can use this study for quitting or continuing with the existing portfolios.

When managerial implications of the present study are looked upon, it can be suggested that since the markets are not following the random walk, the investors and policy makers may consider the findings of the present study for making time-dependent investment strategies. The returns of such markets provide investors the opportunity to explore the arbitrage profits. The findings can be considered by the market players for price discovery and for further improving the process of price discovery. Economically, these results may be useful in better allocation of available capital so as to have a positive impact on the growth of an economy.

The increase in correlations in returns signifies a reduction in opportunities of diversification of funds among the markets under study. The existence of co-integration and causality further suggests the same. Fostering the international stock market integration has important implication for transforming the international financial system as a whole. Stock market integration allows the nations to use the international stock markets to diversify their capital and, at the same time, to hedge against the atypical adverse shocks like the recent financial crisis, especially when these shocks exist for a short while. The studies like this are helpful for the corporate managers and policy makers in providing them with the information about the effect of international stock market integration and to use this as a base for determining the factors that further determine the stock market prices and returns. Such empirical evidences play a very important role because the managers throughout the world can utilize these results to make decisions about the listing of their firm's stocks; i.e., where and how many exchanges to have their stocks listed. This is for the reason that the share prices are the primary indicators of the shareholders' wealth and the managers' decisions may affect it.

Apart from this, investors, corporate managers and policy makers should continuously look into the changing nature of short-term relation or causality between the markets. They must access the varying short-term relationship of different Asian markets with US markets, to evolve short-term investment strategies. If any crisis takes place in the US markets, there is strong possibility that the crisis has an impact over the Indian and other Asian stock markets due to their integration, but periodically, their nature of causality (unidimensional/ bidimensional) may change, especially during such financial crises. Single investment strategy may not last longer and therefore, short-term strategies are also needed to manage the stock markets of different countries in a well-defined way.

6.3 Limitations of the Study

Although the researcher has tried her best to come out with the present thesis but still like any other research work, this study also has the following limitations:

1. Since the present study is based on the Asian and the US stock markets, the results of the study are indicative, and not conclusive,of the global stock markets in general.

2. While the present study focuses on the effect of the financial crisis on the market integration of the Asian and the US stock markets. There might be several other factors affecting the integration like the nature of industry in the economy, investor's behavior, investment channels and the use of technology etc., which are not studied in this thesis.

3. This study has been done with the limitations of time and resources.

6.4 Recommendations for Future Research

The present research has used the weak form efficiency and integration analysis to study the equity market indices. The results of the study have opened a wide variety of possible areas that warrant further research. There could be several avenues per se for future research and these are presented as follows:

1. With econometric tools, present study has assessed whether the markets react to new information or not. Following the event study methodology given by Fama (1969), this study can be extended further by developing formal speed of adjustment with which the new information is reflected in the prices of individual stocks or portfolios.

2. Inattention of the investor or any problem in the communication channel may also contribute to the delayed reaction to information. So, the future research effort may focus on suitable indicator for investor's inattention.

3. Further researches may also focus on the possibility to explore how stock price informational efficiency effect financial openness and economic growth in general.

4. The study can be extended to include a greater number of stock markets representing various other regions of the world. Empirical studies on the issue can cover broader areas of market integration and use more advanced techniques (like copula) of estimation. Further, these markets can be tested on the basis of weekly, monthly or intra-day (high frequency) data and different indices since the stock markets under this study are tested on the basis of daily stock data.

5. Future studies may allow for risks, such as foreign exchange risk, political risk, etc. which could mark themselves through the time-varying integration.

6. Another possible extension is to make a comparasion between the diversification benefits that investors can achieve while allocating their funds across those Asian and US stock markets.

7. This research work has used equity market indices to test market integration. Though the empirical results indicate that stock markets under study are integrated, it will be interesting to know whether different industries in those countries are integrated.

8. Some markets, such as China and Taiwan, have imposed strict restrictions on foreign direct investments. It might be difficult to directly invest in these markets. Therefore, a follow up study could investigate whether other financial instruments like Global Depository Receipts (GDR)/ American Depository Receipts (ADR) can provide the same diversification benefits as indicated in this research.

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ANNEXURE A

Table A: Runs Test (Total Period)													
	NSE	**KSE**	**SC**	**HS**	**JC**	**KLSE**	**NIK**	**ST**	**KSP**	**TW**	**TA**	**CSE**	**SP**
Test Value[a]	.0012	.0011	.0000	.0004	.0011	.0003	.0001	.0004	.0013	.0003	.0000	.0005	.0005
Cases < Test Value	1490	1490	1490	1490	1490	1490	1490	1490	1490	1490	1464	1489	1490
Cases >= Test Value	1491	1491	1491	1491	1491	1491	1491	1491	1491	1491	1517	1490	1491
Total Cases	2981	2981	2981	2981	2981	2981	2981	2981	2981	2981	2981	2979	2981
Number of Runs	1414	1443	1444	1546	1434	1407	1576	1543	1476	1480	1774	1337	1634
Z[a]	-2.839	-1.777	-1.740	1.997	-2.107	-3.096	3.096	1.887	-.568	-.421	10.371	-5.626	5.221
Asymp. Sig. (2-tailed)[a]	.005	.076	.082	.046	.035	.002	.002	.059	.570	.674	.000	.000	.000

a. Median

Table A1: Runs Test (Period 1)													
	NSE	**KSE**	**SC**	**HS**	**JC**	**KLSE**	**NIK**	**ST**	**KSP**	**TW**	**TA**	**CSE**	**SP**
Test Value[a]	.0006	.0000	.0000	.0000	-.0004	-.0004	-.0008	-.0003	.0009	-.0011	.000000	-.0001	-.0002
Cases < Test Value	375	374	375	375	375	375	375	375	375	375	372	374	375
Cases >= Test Value	375	374	375	375	375	375	375	375	375	375	378	374	375
Total Cases	750	748	750	750	750	750	750	750	750	750	750	748	750
Number of Runs	337	374	352	375	375	346	384	369	357	370	424	327	386
Z[a]	-2.850	-.073	-1.754	-.073	-.073	-2.192	.585	-.512	-1.388	-.438	3.510	-3.512	.731
Asymp. Sig. (2-tailed)[a]	.004	.942	.079	.942	.942	.028	.559	.609	.165	.661	.000	.000	.465

a. Median

Table A1: Runs Test (Period 2)													
	NSE	**KSE**	**SC**	**HS**	**JC**	**KLSE**	**NIK**	**ST**	**KSP**	**TW**	**TA**	**CSE**	**SP**
Test Value[a]	.0016	.0025	.0000	-.0002	.0012	.0005	.0004	.0004	.0013	-.0001	-.0004	.0014	.0005
Cases < Test Value	374	374	362	373	374	374	374	374	374	374	374	374	374
Cases >= Test Value	375	375	387	376	375	375	375	375	375	375	375	375	375
Total Cases	749	749	749	749	749	749	749	749	749	749	749	749	749
Number of Runs	347	367	350	395	351	366	385	387	373	376	441	350	416
Z[a]	-2.084	-.622	-1.836	1.426	-1.792	-.695	.695	.841	-.183	.037	4.790	-1.865	2.962
Asymp. Sig. (2-tailed)[a]	.037	.534	.066	.154	.073	.487	.487	.400	.855	.971	.000	.062	.003

a. Median

Table A1: Runs Test (Period 3)													
	NSE	**KSE**	**SC**	**HS**	**JC**	**KLSE**	**NIK**	**ST**	**KSP**	**TW**	**TA**	**CSE**	**SP**
Test Value[a]	.0015	.0024	.0016	.0011	.0021	.0007	.0005	.0011	.0018	.0008	.0001	.0009	.0008
Cases < Test Value	371	372	372	372	372	372	372	372	372	372	372	372	372
Cases >= Test Value	373	372	372	372	372	372	372	372	372	372	372	372	372
Total Cases	744	744	744	744	744	744	744	744	744	744	744	744	744
Number of Runs	342	376	371	396	361	359	401	410	389	394	476	353	418
Z[a]	-2.274	.220	-.147	1.688	-.880	-1.027	2.054	2.715	1.174	1.541	7.557	-1.467	3.302
Asymp. Sig. (2-tailed)[a]	.023	.826	.883	.091	.379	.304	.040	.007	.240	.123	.000	.142	.001

a. Median

Table A1: Runs Test (Period 4)													
	NSE	**KSE**	**SC**	**HS**	**JC**	**KLSE**	**NIK**	**ST**	**KSP**	**TW**	**TA**	**CSE**	**SP**
Test Value[a]	.0008	.0000	.0007	.0000	.0012	.0001	.0001	.0001	.0009	.0009	.0000	.0004	.0008
Cases < Test Value	367	349	367	360	367	367	367	367	367	367	355	367	367
Cases >= Test Value	368	386	368	375	368	368	368	368	368	368	380	368	368
Total Cases	735	735	735	735	735	735	735	735	735	735	735	735	735
Number of Runs	389	324	369	364	351	351	402	395	368	358	441	324	415
Z[a]	1.513	-3.224	.037	-.321	-1.292	-1.292	2.473	1.956	-.037	-.775	5.390	-3.285	3.433
Asymp. Sig. (2-tailed)[a]	.130	.001	.971	.748	.196	.196	.013	.050	.971	.438	.000	.001	.001

a. Median

Table B: Granger Causality Test (Total Period)			
Null Hypothesis	**Observations**	**F-Statistic**	**Probability**
KSE_R does not Granger Cause NSE_R		0.18536	0.9885
NSE_R does not Granger Cause KSE_R	2974	0.14669	0.9944
SC_R does not Granger Cause NSE_R		1.29611	0.2479
NSE_R does not Granger Cause SC_R	2974	0.46867	0.8578
HS_R does not Granger Cause NSE_R		6.95600	3.E-08*
NSE_R does not Granger Cause HS_R	2974	0.72788	0.6484
JC_R does not Granger Cause NSE_R		1.98858	0.0530
NSE_R does not Granger Cause JC_R	2974	1.53002	0.1523
KLSE_R does not Granger Cause NSE_R		1.92191	0.0622
NSE_R does not Granger Cause KLSE_R	2974	1.28610	0.2529
NIK_R does not Granger Cause NSE_R		7.15672	2.E-08*
NSE_R does not Granger Cause NIK_R	2974	2.55771	0.0126*
ST_R does not Granger Cause NSE_R		6.30025	2.E-07*
NSE_R does not Granger Cause ST_R	2974	0.62036	0.7395
KSP_R does not Granger Cause NSE_R		4.76911	2.E-05*
NSE_R does not Granger Cause KSP_R	2974	1.19976	0.2992
TW_R does not Granger Cause NSE_R		3.39445	0.0013*
NSE_R does not Granger Cause TW_R	2974	1.99880	0.0517
TA_R does not Granger Cause NSE_R		3.23487	0.0020*
NSE_R does not Granger Cause TA_R	2974	2.96397	0.0043*
SP_R does not Granger Cause NSE_R		8.85903	8.E-11*
NSE_R does not Granger Cause SP_R	2974	0.59122	0.7636
SC_R does not Granger Cause KSE_R		3.55343	0.0008*
KSE_R does not Granger Cause SC_R	2974	3.37444	0.0014*
HS_R does not Granger Cause KSE_R		1.27361	0.2592
KSE_R does not Granger Cause HS_R	2974	1.67004	0.1117
JC_R does not Granger Cause KSE_R		3.31812	0.0016*
KSE_R does not Granger Cause JC_R	2974	13.3679	4.E-17*
KLSE_R does not Granger Cause KSE_R		1.89003	0.0671
KSE_R does not Granger Cause KLSE_R	2974	0.65883	0.7072
NIK_R does not Granger Cause KSE_R		0.40845	0.8976
KSE_R does not Granger Cause NIK_R	2974	1.29898	0.2465
ST_R does not Granger Cause KSE_R		2.75215	0.0075*
KSE_R does not Granger Cause ST_R	2974	1.12751	0.3425
KSP_R does not Granger Cause KSE_R		1.14131	0.3339
KSE_R does not Granger Cause KSP_R	2974	0.74812	0.6311
TW_R does not Granger Cause KSE_R		1.54798	0.1464
KSE_R does not Granger Cause TW_R	2974	0.33690	0.9373
TA_R does not Granger Cause KSE_R		4.74937	3.E-05*
KSE_R does not Granger Cause TA_R	2974	3.19690	0.0022*
SP_R does not Granger Cause KSE_R		1.57310	0.1386
KSE_R does not Granger Cause SP_R	2974	0.57229	0.7790
HS_R does not Granger Cause SC_R		5.30949	5.E-06*
SC_R does not Granger Cause HS_R	2974	3.86217	0.0003*
JC_R does not Granger Cause SC_R		14.2632	2.E-18*
SC_R does not Granger Cause JC_R	2974	1.72393	0.0988

Cont...

NIK_R does not Granger Cause SC_R		2.00042	0.0515
SC_R does not Granger Cause NIK_R	2974	0.84711	0.5481
ST_R does not Granger Cause SC_R		3.74836	0.0005*
SC_R does not Granger Cause ST_R	2974	2.28106	0.0257*
KSP_R does not Granger Cause SC_R		1.83180	0.0770
SC_R does not Granger Cause KSP_R	2974	1.23053	0.2820
TW_R does not Granger Cause SC_R		2.02758	0.0482*
SC_R does not Granger Cause TW_R	2974	0.90054	0.5049
TA_R does not Granger Cause SC_R		4.49834	5.E-05*
SC_R does not Granger Cause TA_R	2974	1.63464	0.1209
SP_R does not Granger Cause SC_R		3.36367	0.0014*
SC_R does not Granger Cause SP_R	2974	0.98117	0.4430
JC_R does not Granger Cause HS_R		0.57317	0.7783
HS_R does not Granger Cause JC_R	2974	6.26335	3.E-07*
KLSE_R does not Granger Cause HS_R		0.59802	0.7580
HS_R does not Granger Cause KLSE_R	2974	9.21058	3.E-11*
NIK_R does not Granger Cause HS_R		2.63523	0.0103*
HS_R does not Granger Cause NIK_R	2974	16.2379	4.E-21*
ST_R does not Granger Cause HS_R		12.4453	8.E-16*
HS_R does not Granger Cause ST_R	2974	10.5447	4.E-13*
KSP_R does not Granger Cause HS_R		3.21664	0.0021*
HS_R does not Granger Cause KSP_R	2974	14.2525	3.E-18*
TW_R does not Granger Cause HS_R		2.64066	0.0101*
HS_R does not Granger Cause TW_R	2974	13.2210	7.E-17*
TA_R does not Granger Cause HS_R		1.91361	0.0635
HS_R does not Granger Cause TA_R	2974	17.1877	2.E-22*
SP_R does not Granger Cause HS_R		55.4971	6.E-75*
HS_R does not Granger Cause SP_R	2974	1.41003	0.1965
KLSE_R does not Granger Cause JC_R		4.42164	7.E-05*
JC_R does not Granger Cause KLSE_R	2974	0.80830	0.5803
NIK_R does not Granger Cause JC_R		2.13150	0.0374*
JC_R does not Granger Cause NIK_R	2974	1.71266	0.1014
ST_R does not Granger Cause JC_R		8.15750	7.E-10*
JC_R does not Granger Cause ST_R	2974	2.87698	0.0054*
KSP_R does not Granger Cause JC_R		6.26560	3.E-07*
JC_R does not Granger Cause KSP_R	2974	1.05194	0.3923
TW_R does not Granger Cause JC_R		2.85782	0.0057*
JC_R does not Granger Cause TW_R	2974	4.22239	0.0001*
TA_R does not Granger Cause JC_R		6.82244	5.E-08*
JC_R does not Granger Cause TA_R	2974	2.63063	0.0104*
SP_R does not Granger Cause JC_R		7.07783	2.E-08*
JC_R does not Granger Cause SP_R	2974	1.22229	0.2865
NIK_R does not Granger Cause KLSE_R		4.19285	0.0001*
KLSE_R does not Granger Cause NIK_R	2974	3.44776	0.0011*
ST_R does not Granger Cause KLSE_R		9.45217	1.E-11*
KLSE_R does not Granger Cause ST_R	2974	2.61548	0.0108*
KSP_R does not Granger Cause KLSE_R		4.42296	7.E-05*
KLSE_R does not Granger Cause KSP_R	2974	1.32093	0.2359

Cont...

TW_R does not Granger Cause KLSE_R		4.67851	3.E-05*
KLSE_R does not Granger Cause TW_R	2974	3.90906	0.0003*
TA_R does not Granger Cause KLSE_R		4.17386	0.0001*
KLSE_R does not Granger Cause TA_R	2974	4.48277	6.E-05*
SP_R does not Granger Cause KLSE_R		19.4038	2.E-25*
KLSE_R does not Granger Cause SP_R	2974	0.43518	0.8806
ST_R does not Granger Cause NIK_R		15.7465	2.E-20*
NIK_R does not Granger Cause ST_R	2974	1.62435	0.1237
KSP_R does not Granger Cause NIK_R		5.05311	1.E-05*
NIK_R does not Granger Cause KSP_R	2974	6.98547	3.E-08*
TW_R does not Granger Cause NIK_R		4.90854	2.E-05*
NIK_R does not Granger Cause TW_R	2974	5.60556	2.E-06*
TA_R does not Granger Cause NIK_R		2.87023	0.0055*
NIK_R does not Granger Cause TA_R	2974	8.60570	2.E-10*
SP_R does not Granger Cause NIK_R		67.8179	5.E-91*
NIK_R does not Granger Cause SP_R	2974	1.67975	0.1093
KSP_R does not Granger Cause ST_R		1.88008	0.0687
ST_R does not Granger Cause KSP_R	2974	10.1133	1.E-12*
TW_R does not Granger Cause ST_R		2.46812	0.0159*
ST_R does not Granger Cause TW_R	2974	16.9988	4.E-22*
TA_R does not Granger Cause ST_R		1.78201	0.0865
ST_R does not Granger Cause TA_R	2974	18.7846	1.E-24*
SP_R does not Granger Cause ST_R		49.2949	1.E-66*
ST_R does not Granger Cause SP_R	2974	2.20724	0.0309*
TW_R does not Granger Cause KSP_R		2.47461	0.0156*
KSP_R does not Granger Cause TW_R	2974	8.92000	6.E-11*
TA_R does not Granger Cause KSP_R		5.26617	5.E-06*
KSP_R does not Granger Cause TA_R	2974	8.64110	2.E-10*
SP_R does not Granger Cause KSP_R		40.0524	4.E-54*
KSP_R does not Granger Cause SP_R	2974	1.90172	0.0653
TA_R does not Granger Cause TW_R		5.63283	2.E-06*
TW_R does not Granger Cause TA_R	2974	5.12771	8.E-06*
SP_R does not Granger Cause TW_R		29.6872	7.E-40*
TW_R does not Granger Cause SP_R	2974	0.27369	0.9643
SP_R does not Granger Cause TA_R		32.9149	2.E-44*
TA_R does not Granger Cause SP_R	2974	0.33100	0.9402

(*) Rejection of the null hypothesis at 5% and therefore there is Granger causality.

Table B1: Granger Causality Test (Period 1)			
Null Hypothesis	**Observations**	**F-Statistic**	**Probability**
KSE_R1 does not Granger Cause NSE_R1		1.32025	0.2677
NSE_R1 does not Granger Cause KSE_R1	748	0.69786	0.4980
SC_R1 does not Granger Cause NSE_R1		0.65860	0.5179
NSE_R1 does not Granger Cause SC_R1	748	0.80098	0.4493
HS_R1 does not Granger Cause NSE_R1		6.24271	0.0020*
NSE_R1 does not Granger Cause HS_R1	748	0.25634	0.7739
JC_R1 does not Granger Cause NSE_R1		2.14386	0.1179
NSE_R1 does not Granger Cause JC_R1	748	4.83226	0.0082*
KLSE_R1 does not Granger Cause NSE_R1		0.36991	0.6909
NSE_R1 does not Granger Cause KLSE_R1	748	2.67074	0.0699
NIK_R1 does not Granger Cause NSE_R1		0.54885	0.5778
NSE_R1 does not Granger Cause NIK_R1	748	3.58812	0.0281*
ST_R1 does not Granger Cause NSE_R1		3.83733	0.0220*
NSE_R1 does not Granger Cause ST_R1	748	3.79459	0.0229*
KSP_R1 does not Granger Cause NSE_R1		2.17602	0.1142
NSE_R1 does not Granger Cause KSP_R1	748	0.07815	0.9248
TW_R1 does not Granger Cause NSE_R1		2.23752	0.1074
NSE_R1 does not Granger Cause TW_R1	748	8.33907	0.0003*
TA_R1 does not Granger Cause NSE_R1		1.33998	0.2625
NSE_R1 does not Granger Cause TA_R1	748	4.11645	0.0167*
SP_R1 does not Granger Cause NSE_R1		9.91974	6.E-05*
NSE_R1 does not Granger Cause SP_R1	748	0.18788	0.8287
SC_R1 does not Granger Cause KSE_R1		0.41695	0.6592
KSE_R1 does not Granger Cause SC_R1	748	1.44394	0.2367
HS_R1 does not Granger Cause KSE_R1		0.65219	0.5212
KSE_R1 does not Granger Cause HS_R1	748	1.86281	0.1560
JC_R1 does not Granger Cause KSE_R1		1.50677	0.2223
KSE_R1 does not Granger Cause JC_R1	748	21.4497	9.E-10*
KLSE_R1 does not Granger Cause KSE_R1		2.56973	0.0772
KSE_R1 does not Granger Cause KLSE_R1	748	0.82551	0.4384
NIK_R1 does not Granger Cause KSE_R1		0.05803	0.9436
KSE_R1 does not Granger Cause NIK_R1	748	2.07864	0.1258
ST_R1 does not Granger Cause KSE_R1		0.02468	0.9756
KSE_R1 does not Granger Cause ST_R1	748	3.20140	0.0413*
KSP_R1 does not Granger Cause KSE_R1		0.64551	0.5247
KSE_R1 does not Granger Cause KSP_R1		0.50532	0.6035
TW_R1 does not Granger Cause KSE_R1		0.53850	0.5839
KSE_R1 does not Granger Cause TW_R1	748	0.15694	0.8548
TA_R1 does not Granger Cause KSE_R1		3.15601	0.0432*
KSE_R1 does not Granger Cause TA_R1	748	0.34771	0.7064
SP_R1 does not Granger Cause KSE_R1		1.56966	0.2088
KSE_R1 does not Granger Cause SP_R1	748	0.11586	0.8906
HS_R1 does not Granger Cause SC_R1		5.54065	0.0041*
SC_R1 does not Granger Cause HS_R1	748	3.06486	0.0473*
JC_R1 does not Granger Cause SC_R1		17.0252	6.E-08*
SC_R1 does not Granger Cause JC_R1	748	3.08746	0.0462*

Cont...

KLSE_R1 does not Granger Cause SC_R1		0.23411	0.7913
SC_R1 does not Granger Cause KLSE_R1	748	0.88695	0.4123
NIK_R1 does not Granger Cause SC_R1		0.59935	0.5494
SC_R1 does not Granger Cause NIK_R1	748	2.60832	0.0743
ST_R1 does not Granger Cause SC_R1		2.36268	0.0949
SC_R1 does not Granger Cause ST_R1	748	3.57366	0.0285*
KSP_R1 does not Granger Cause SC_R1		1.33213	0.2645
SC_R1 does not Granger Cause KSP_R1	748	2.27028	0.1040
TW_R1 does not Granger Cause SC_R1		0.47642	0.6212
SC_R1 does not Granger Cause TW_R1	748	0.85301	0.4265
TA_R1 does not Granger Cause SC_R1		3.85466	0.0216*
SC_R1 does not Granger Cause TA_R1	748	0.52233	0.5934
SP_R1 does not Granger Cause SC_R1		0.18355	0.8323
SC_R1 does not Granger Cause SP_R1	748	3.58535	0.0282*
JC_R1 does not Granger Cause HS_R1		1.61603	0.1994
HS_R1 does not Granger Cause JC_R1	748	0.19257	0.8249
KLSE_R1 does not Granger Cause HS_R1		0.08055	0.9226
HS_R1 does not Granger Cause KLSE_R1	748	2.51010	0.0819
NIK_R1 does not Granger Cause HS_R1		2.78105	0.0626
HS_R1 does not Granger Cause NIK_R1	748	7.34081	0.0007*
ST_R1 does not Granger Cause HS_R1		13.1316	2.E-06*
HS_R1 does not Granger Cause ST_R1	748	17.3837	4.E-08*
KSP_R1 does not Granger Cause HS_R1		5.73121	0.0034*
HS_R1 does not Granger Cause KSP_R1	748	4.26834	0.0144*
TW_R1 does not Granger Cause HS_R1		2.51315	0.0817
HS_R1 does not Granger Cause TW_R1	748	5.40657	0.0047*
TA_R1 does not Granger Cause HS_R1		0.18577	0.8305
HS_R1 does not Granger Cause TA_R1	748	0.25266	0.7768
SP_R1 does not Granger Cause HS_R1		19.8061	4.E-09*
HS_R1 does not Granger Cause SP_R1	748	2.65543	0.0709
KLSE_R1 does not Granger Cause JC_R1		1.00261	0.3674
JC_R1 does not Granger Cause KLSE_R1	748	0.99157	0.3715
NIK_R1 does not Granger Cause JC_R1		0.72242	0.4859
JC_R1 does not Granger Cause NIK_R1	748	1.14412	0.3191
ST_R1 does not Granger Cause JC_R1		0.29032	0.7481
JC_R1 does not Granger Cause ST_R1	748	2.20867	0.1106
KSP_R1 does not Granger Cause JC_R1		1.87345	0.1543
JC_R1 does not Granger Cause KSP_R1	748	1.08011	0.3401
TW_R1 does not Granger Cause JC_R1		1.97794	0.1391
JC_R1 does not Granger Cause TW_R1	748	8.97475	0.0001*
TA_R1 does not Granger Cause JC_R1		3.71189	0.0249*
JC_R1 does not Granger Cause TA_R1	748	1.58751	0.2051
SP_R1 does not Granger Cause JC_R1		0.17544	0.8391
JC_R1 does not Granger Cause SP_R1	748	2.05642	0.1286
NIK_R1 does not Granger Cause KLSE_R1		1.13638	0.3215
KLSE_R1 does not Granger Cause NIK_R1	748	1.16134	0.3136
ST_R1 does not Granger Cause KLSE_R1		0.76518	0.4656
KLSE_R1 does not Granger Cause ST_R1	748	0.41863	0.6581

Cont...

KSP_R1 does not Granger Cause KLSE_R1		0.04088	0.9600
KLSE_R1 does not Granger Cause KSP_R1	748	1.62897	0.1968
TW_R1 does not Granger Cause KLSE_R1		0.99594	0.3699
KLSE_R1 does not Granger Cause TW_R1	748	0.20395	0.8155
TA_R1 does not Granger Cause KLSE_R1		0.40440	0.6675
KLSE_R1 does not Granger Cause TA_R1	748	0.28838	0.7496
SP_R1 does not Granger Cause KLSE_R1		6.68982	0.0013*
KLSE_R1 does not Granger Cause SP_R1	748	1.68590	0.1860
ST_R1 does not Granger Cause NIK_R1		5.56496	0.0040*
NIK_R1 does not Granger Cause ST_R1	748	0.40591	0.6665
KSP_R1 does not Granger Cause NIK_R1		2.28422	0.1026
NIK_R1 does not Granger Cause KSP_R1	748	0.91277	0.4019
TW_R1 does not Granger Cause NIK_R1		2.68362	0.0690
NIK_R1 does not Granger Cause TW_R1	748	4.77551	0.0087*
TA_R1 does not Granger Cause NIK_R1		0.14646	0.8638
NIK_R1 does not Granger Cause TA_R1	748	1.05987	0.3470
SP_R1 does not Granger Cause NIK_R1		25.9372	1.E-11*
NIK_R1 does not Granger Cause SP_R1	748	0.48843	0.6138
KSP_R1 does not Granger Cause ST_R1		1.24955	0.2872
ST_R1 does not Granger Cause KSP_R1	748	3.55073	0.0292*
TW_R1 does not Granger Cause ST_R1		2.11171	0.1218
ST_R1 does not Granger Cause TW_R1	748	7.95963	0.0004*
TA_R1 does not Granger Cause ST_R1		0.63086	0.5324
ST_R1 does not Granger Cause TA_R1	748	2.71366	0.0670
SP_R1 does not Granger Cause ST_R1		36.8230	6.E-16*
ST_R1 does not Granger Cause SP_R1	748	1.82340	0.1622
TW_R1 does not Granger Cause KSP_R1		0.34680	0.7071
KSP_R1 does not Granger Cause TW_R1	748	6.07555	0.0024*
TA_R1 does not Granger Cause KSP_R1		2.70394	0.0676
KSP_R1 does not Granger Cause TA_R1	748	0.83525	0.4342
SP_R1 does not Granger Cause KSP_R1		24.2514	6.E-11*
KSP_R1 does not Granger Cause SP_R1	748	1.67386	0.1882
TA_R1 does not Granger Cause TW_R1		5.96362	0.0027*
TW_R1 does not Granger Cause TA_R1	748	0.80802	0.4461
SP_R1 does not Granger Cause TW_R1		4.38193	0.0128*
TW_R1 does not Granger Cause SP_R1	748	0.29912	0.7416
SP_R1 does not Granger Cause TA_R1		3.16689	0.0427*
TA_R1 does not Granger Cause SP_R1	748	1.05658	0.3482

(*) Rejection of the null hypothesis at 5% and therefore there is Granger causality.

Table B2: Granger Causality Test (Period 2)			
Null Hypothesis	**Observations**	**F-Statistic**	**Probability**
KSE_R2 does not Granger Cause NSE_R2		0.95376	0.4642
NSE_R2 does not Granger Cause KSE_R2	742	0.70196	0.6705
SC_R2 does not Granger Cause NSE_R2		1.18884	0.3066
NSE_R2 does not Granger Cause SC_R2	742	0.52702	0.8144
HS_R2 does not Granger Cause NSE_R2		0.66810	0.6992
NSE_R2 does not Granger Cause HS_R2	742	2.41796	0.0188*
JC_R2 does not Granger Cause NSE_R2		0.60480	0.7522
NSE_R2 does not Granger Cause JC_R2	742	1.19588	0.3026
KLSE_R2 does not Granger Cause NSE_R2		0.99539	0.4332
NSE_R2 does not Granger Cause KLSE_R2	742	1.20389	0.2980
NIK_R2 does not Granger Cause NSE_R2		0.92324	0.4876
NSE_R2 does not Granger Cause NIK_R2	742	2.39474	0.0199*
ST_R2 does not Granger Cause NSE_R2		0.37312	0.9181
NSE_R2 does not Granger Cause ST_R2	742	1.44000	0.1860
KSP_R2 does not Granger Cause NSE_R2		1.33683	0.2298
NSE_R2 does not Granger Cause KSP_R2	742	2.64827	0.0104*
TW_R2 does not Granger Cause NSE_R2		1.68073	0.1105
NSE_R2 does not Granger Cause TW_R2	742	1.79071	0.0861
TA_R2 does not Granger Cause NSE_R2		0.51983	0.8199
NSE_R2 does not Granger Cause TA_R2	742	1.29104	0.2518
SP_R2 does not Granger Cause NSE_R2		2.17691	0.0343*
NSE_R2 does not Granger Cause SP_R2	742	0.82729	0.5647
SC_R2 does not Granger Cause KSE_R2		1.55191	0.1467
KSE_R2 does not Granger Cause SC_R2	742	1.15166	0.3287
HS_R2 does not Granger Cause KSE_R2		1.73032	0.0988
KSE_R2 does not Granger Cause HS_R2	742	1.45578	0.1800
JC_R2 does not Granger Cause KSE_R2		1.23973	0.2783
KSE_R2 does not Granger Cause JC_R2	742	1.08814	0.3689
KLSE_R2 does not Granger Cause KSE_R2		1.31221	0.2414
KSE_R2 does not Granger Cause KLSE_R2	742	2.21637	0.0312*
NIK_R2 does not Granger Cause KSE_R2		0.18143	0.9891
KSE_R2 does not Granger Cause NIK_R2	742	0.80595	0.5825
ST_R2 does not Granger Cause KSE_R2		3.35628	0.0016*
KSE_R2 does not Granger Cause ST_R2	742	1.20526	0.2973
KSP_R2 does not Granger Cause KSE_R2		3.52897	0.0010*
KSE_R2 does not Granger Cause KSP_R2	742	3.64422	0.0007*
TW_R2 does not Granger Cause KSE_R2		1.92292	0.0633
KSE_R2 does not Granger Cause TW_R2	742	0.53971	0.8046
TA_R2 does not Granger Cause KSE_R2		3.71360	0.0006*
KSE_R2 does not Granger Cause TA_R2	742	1.48988	0.1675
SP_R2 does not Granger Cause KSE_R2		0.91215	0.4963
KSE_R2 does not Granger Cause SP_R2	742	0.93036	0.4821
HS_R2 does not Granger Cause SC_R2		1.23499	0.2808
SC_R2 does not Granger Cause HS_R2	742	1.07401	0.3782
JC_R2 does not Granger Cause SC_R2		0.54056	0.8040
SC_R2 does not Granger Cause JC_R2	742	0.70220	0.6703
KLSE_R2 does not Granger Cause SC_R2		0.72265	0.6528
SC_R2 does not Granger Cause KLSE_R2	742	2.62878	0.0110*

Cont...

NIK_R2 does not Granger Cause SC_R2		2.64847	0.0104*
SC_R2 does not Granger Cause NIK_R2	742	0.55449	0.7930
ST_R2 does not Granger Cause SC_R2		1.12186	0.3471
SC_R2 does not Granger Cause ST_R2	742	2.04028	0.0479*
KSP_R2 does not Granger Cause SC_R2		0.79407	0.5924
SC_R2 does not Granger Cause KSP_R2	742	0.89138	0.5127
TW_R2 does not Granger Cause SC_R2		0.93337	0.4798
SC_R2 does not Granger Cause TW_R2	742	2.03538	0.0484*
TA_R2 does not Granger Cause SC_R2		1.72710	0.0995
SC_R2 does not Granger Cause TA_R2	742	0.44814	0.8717
SP_R2 does not Granger Cause SC_R2		1.38773	0.2073
SC_R2 does not Granger Cause SP_R2	742	1.60922	0.1294
JC_R2 does not Granger Cause HS_R2		0.21068	0.9831
HS_R2 does not Granger Cause JC_R2	742	0.96632	0.4547
KLSE_R2 does not Granger Cause HS_R2		0.53294	0.8099
HS_R2 does not Granger Cause KLSE_R2	742	4.34788	0.0001*
NIK_R2 does not Granger Cause HS_R2		3.12526	0.0029*
HS_R2 does not Granger Cause NIK_R2	742	3.37875	0.0015*
ST_R2 does not Granger Cause HS_R2		1.39962	0.2023
HS_R2 does not Granger Cause ST_R2	742	4.99984	2.E-05*
KSP_R2 does not Granger Cause HS_R2		0.25075	0.9720
HS_R2 does not Granger Cause KSP_R2	742	10.2150	3.E-12*
TW_R2 does not Granger Cause HS_R2		0.53949	0.8048
HS_R2 does not Granger Cause TW_R2	742	4.26773	0.0001*
TA_R2 does not Granger Cause HS_R2		0.88660	0.5165
HS_R2 does not Granger Cause TA_R2	742	3.34490	0.0016*
SP_R2 does not Granger Cause HS_R2		12.3888	5.E-15*
HS_R2 does not Granger Cause SP_R2	742	1.81248	0.0819
KLSE_R2 does not Granger Cause JC_R2		2.19441	0.0329*
JC_R2 does not Granger Cause KLSE_R2	742	1.21030	0.2944
NIK_R2 does not Granger Cause JC_R2		0.68638	0.6837
JC_R2 does not Granger Cause NIK_R2	742	1.37122	0.2144
ST_R2 does not Granger Cause JC_R2		2.03020	0.0490*
JC_R2 does not Granger Cause ST_R2	742	0.96890	0.4528
KSP_R2 does not Granger Cause JC_R2		1.68791	0.1087
JC_R2 does not Granger Cause KSP_R2	742	1.09341	0.3654
TW_R2 does not Granger Cause JC_R2		1.13755	0.3373
JC_R2 does not Granger Cause TW_R2	742	0.56983	0.7807
TA_R2 does not Granger Cause JC_R2		1.16900	0.3183
JC_R2 does not Granger Cause TA_R2	742	1.47135	0.1742
SP_R2 does not Granger Cause JC_R2		2.95573	0.0046*
JC_R2 does not Granger Cause SP_R2	742	0.61539	0.7435
NIK_R2 does not Granger Cause KLSE_R2		2.37790	0.0208*
KLSE_R2 does not Granger Cause NIK_R2	742	0.82247	0.5687
ST_R2 does not Granger Cause KLSE_R2		2.42257	0.0186*
KLSE_R2 does not Granger Cause ST_R2	742	1.08508	0.3709
KSP_R2 does not Granger Cause KLSE_R2		1.80336	0.0836
KLSE_R2 does not Granger Cause KSP_R2	742	1.39172	0.2056

Cont...

TW_R2 does not Granger Cause KLSE_R2	742	3.95646	0.0003*
KLSE_R2 does not Granger Cause TW_R2		1.39692	0.2034
TA_R2 does not Granger Cause KLSE_R2	742	3.68252	0.0006*
KLSE_R2 does not Granger Cause TA_R2		1.09344	0.3654
SP_R2 does not Granger Cause KLSE_R2	742	3.56273	0.0009*
KLSE_R2 does not Granger Cause SP_R2		0.63298	0.7288
ST_R2 does not Granger Cause NIK_R2	742	2.74806	0.0080*
NIK_R2 does not Granger Cause ST_R2		1.95168	0.0591
KSP_R2 does not Granger Cause NIK_R2	742	1.01482	0.4192
NIK_R2 does not Granger Cause KSP_R2		2.88119	0.0057*
TW_R2 does not Granger Cause NIK_R2	742	1.04110	0.4007
NIK_R2 does not Granger Cause TW_R2		1.75439	0.0936
TA_R2 does not Granger Cause NIK_R2	742	0.68889	0.6816
NIK_R2 does not Granger Cause TA_R2		2.00056	0.0527
SP_R2 does not Granger Cause NIK_R2	742	9.90723	8.E-12*
NIK_R2 does not Granger Cause SP_R2		2.16583	0.0353*
KSP_R2 does not Granger Cause ST_R2	742	1.52712	0.1547
ST_R2 does not Granger Cause KSP_R2		3.14986	0.0028*
TW_R2 does not Granger Cause ST_R2	742	3.24572	0.0021*
ST_R2 does not Granger Cause TW_R2		3.80725	0.0005*
TA_R2 does not Granger Cause ST_R2	742	1.46035	0.1783
ST_R2 does not Granger Cause TA_R2		2.48835	0.0157*
SP_R2 does not Granger Cause ST_R2	742	9.82435	1.E-11*
ST_R2 does not Granger Cause SP_R2		1.45434	0.1805
TW_R2 does not Granger Cause KSP_R2	742	4.69468	4.E-05*
KSP_R2 does not Granger Cause TW_R2		1.25664	0.2693
TA_R2 does not Granger Cause KSP_R2	742	2.30846	0.0248*
KSP_R2 does not Granger Cause TA_R2		0.91341	0.4953
SP_R2 does not Granger Cause KSP_R2	742	7.74284	5.E-09*
KSP_R2 does not Granger Cause SP_R2		1.79212	0.0858
TA_R2 does not Granger Cause TW_R2	742	1.48152	0.1705
TW_R2 does not Granger Cause TA_R2		1.35747	0.2204
SP_R2 does not Granger Cause TW_R2	742	8.99132	1.E-10*
TW_R2 does not Granger Cause SP_R2		1.38673	0.2077
SP_R2 does not Granger Cause TA_R2	742	5.69770	2.E-06*
TA_R2 does not Granger Cause SP_R2		0.88685	0.5163

(*) Rejection of the null hypothesis at 5% and therefore there is Granger causality.

Table B3: Granger Causality Test (Period 3)			
Null Hypothesis	**Observations**	**F-Statistic**	**Probability**
KSE_R3 does not Granger Cause NSE_R3	739	1.09025	0.3643
NSE_R3 does not Granger Cause KSE_R3		2.53862	0.0273*
SC_R3 does not Granger Cause NSE_R3	739	2.69152	0.0202*
NSE_R3 does not Granger Cause SC_R3		1.35223	0.2404
HS_R3 does not Granger Cause NSE_R3	739	2.08521	0.0653
NSE_R3 does not Granger Cause HS_R3		3.02676	0.0103*
JC_R3 does not Granger Cause NSE_R3	739	0.31219	0.9058
NSE_R3 does not Granger Cause JC_R3		1.98965	0.0781
KLSE_R3 does not Granger Cause NSE_R3	739	1.67442	0.1384
NSE_R3 does not Granger Cause KLSE_R3		2.48530	0.0303*
NIK_R3 does not Granger Cause NSE_R3	739	1.16715	0.3237
NSE_R3 does not Granger Cause NIK_R3		5.55476	5.E-05*
ST_R3 does not Granger Cause NSE_R3	739	0.81364	0.5401*
NSE_R3 does not Granger Cause ST_R3		5.04973	0.0001*
KSP_R3 does not Granger Cause NSE_R3	739	3.56562	0.0034*
NSE_R3 does not Granger Cause KSP_R3		4.81326	0.0002*
TW_R3 does not Granger Cause NSE_R3	739	1.91787	0.0892
NSE_R3 does not Granger Cause TW_R3		3.98118	0.0014*
TA_R3 does not Granger Cause NSE_R3	739	0.97055	0.4349
NSE_R3 does not Granger Cause TA_R3		5.82574	3.E-05*
SP_R3 does not Granger Cause NSE_R3	739	18.0964	6.E-17*
NSE_R3 does not Granger Cause SP_R3		2.55975	0.0262*
SC_R3 does not Granger Cause KSE_R3	739	0.14937	0.9802
KSE_R3 does not Granger Cause SC_R3		0.25852	0.9355
HS_R3 does not Granger Cause KSE_R3	739	0.74121	0.5927
KSE_R3 does not Granger Cause HS_R3		0.82124	0.5347
JC_R3 does not Granger Cause KSE_R3	739	0.84168	0.5203
KSE_R3 does not Granger Cause JC_R3		2.90467	0.0132*
KLSE_R3 does not Granger Cause KSE_R3	739	1.12227	0.3470
KSE_R3 does not Granger Cause KLSE_R3		3.84810	0.0019*
NIK_R3 does not Granger Cause KSE_R3	739	1.22622	0.2949
KSE_R3 does not Granger Cause NIK_R3		0.98828	0.4239
ST_R3 does not Granger Cause KSE_R3	739	1.15246	0.3312
KSE_R3 does not Granger Cause ST_R3		0.76672	0.5739
KSP_R3 does not Granger Cause KSE_R3	739	1.70059	0.1321
KSE_R3 does not Granger Cause KSP_R3		1.09081	0.3640
TW_R3 does not Granger Cause KSE_R3	739	2.23431	0.0493*
KSE_R3 does not Granger Cause TW_R3		0.37856	0.8636
TA_R3 does not Granger Cause KSE_R3	739	1.44709	0.2052
KSE_R3 does not Granger Cause TA_R3		1.78829	0.1129
SP_R3 does not Granger Cause KSE_R3	739	1.14314	0.3360
KSE_R3 does not Granger Cause SP_R3		0.54136	0.7450
HS_R3 does not Granger Cause SC_R3	739	2.54857	0.0268*
SC_R3 does not Granger Cause HS_R3		2.02742	0.0728
JC_R3 does not Granger Cause SC_R3	739	1.36667	0.2347
SC_R3 does not Granger Cause JC_R3		3.66325	0.0028*
KLSE_R3 does not Granger Cause SC_R3	739	0.78518	0.5605
SC_R3 does not Granger Cause KLSE_R3		1.42681	0.2123

Cont...

NIK_R3 does not Granger Cause SC_R3	739	0.36499	0.8726
SC_R3 does not Granger Cause NIK_R3		0.94052	0.4539
ST_R3 does not Granger Cause SC_R3	739	0.77700	0.5664
SC_R3 does not Granger Cause ST_R3		1.03345	0.3967
KSP_R3 does not Granger Cause SC_R3	739	1.17977	0.3174
SC_R3 does not Granger Cause KSP_R3		0.66098	0.6532
TW_R3 does not Granger Cause SC_R3	739	3.08700	0.0091*
SC_R3 does not Granger Cause TW_R3		1.22676	0.2947
TA_R3 does not Granger Cause SC_R3	739	1.08404	0.3678
SC_R3 does not Granger Cause TA_R3		2.33138	0.0409*
SP_R3 does not Granger Cause SC_R3	739	2.97902	0.0114*
SC_R3 does not Granger Cause SP_R3		1.11203	0.3525
JC_R3 does not Granger Cause HS_R3	739	2.09800	0.0638
HS_R3 does not Granger Cause JC_R3		3.19692	0.0073*
KLSE_R3 does not Granger Cause HS_R3	739	1.59980	0.1578
HS_R3 does not Granger Cause KLSE_R3		2.34797	0.0396*
NIK_R3 does not Granger Cause HS_R3	739	0.30425	0.9104
HS_R3 does not Granger Cause NIK_R3		4.04130	0.0013*
ST_R3 does not Granger Cause HS_R3		2.69348	0.0201*
HS_R3 does not Granger Cause ST_R3	739	1.96969	0.0810
KSP_R3 does not Granger Cause HS_R3		1.02221	0.4034
HS_R3 does not Granger Cause KSP_R3	739	3.13476	0.0083*
TW_R3 does not Granger Cause HS_R3		4.47999	0.0005*
HS_R3 does not Granger Cause TW_R3	739	3.09850	0.0089*
TA_R3 does not Granger Cause HS_R3		1.00625	0.4129
HS_R3 does not Granger Cause TA_R3	739	7.85136	3.E-07*
SP_R3 does not Granger Cause HS_R3		22.9557	2.E-21*
HS_R3 does not Granger Cause SP_R3	739	1.24502	0.2862
KLSE_R3 does not Granger Cause JC_R3		3.35333	0.0053*
JC_R3 does not Granger Cause KLSE_R3	739	1.29905	0.2623
NIK_R3 does not Granger Cause JC_R3		1.40916	0.2187
JC_R3 does not Granger Cause NIK_R3	739	1.60491	0.1564
ST_R3 does not Granger Cause JC_R3		1.70896	0.1302
JC_R3 does not Granger Cause ST_R3	739	2.27449	0.0456*
KSP_R3 does not Granger Cause JC_R3		2.68117	0.0206*
JC_R3 does not Granger Cause KSP_R3	739	5.18429	0.0001*
TW_R3 does not Granger Cause JC_R3		4.38690	0.0006*
JC_R3 does not Granger Cause TW_R3	739	0.88477	0.4907
TA_R3 does not Granger Cause JC_R3		3.32132	0.0057*
JC_R3 does not Granger Cause TA_R3	739	5.19412	0.0001*
SP_R3 does not Granger Cause JC_R3		12.0111	3.E-11*
JC_R3 does not Granger Cause SP_R3	739	2.92276	0.0127*
NIK_R3 does not Granger Cause KLSE_R3		1.57565	0.1646
KLSE_R3 does not Granger Cause NIK_R3	739	2.14614	0.0582
ST_R3 does not Granger Cause KLSE_R3		1.19900	0.3079
KLSE_R3 does not Granger Cause ST_R3	739	2.76138	0.0176*
KSP_R3 does not Granger Cause KLSE_R3		1.95175	0.0838
KLSE_R3 does not Granger Cause KSP_R3	739	2.47975	0.0307*

Cont...

TW_R3 does not Granger Cause KLSE_R3		5.92175	2.E-05*
KLSE_R3 does not Granger Cause TW_R3	739	2.26685	0.0463*
TA_R3 does not Granger Cause KLSE_R3		3.98888	0.0014*
KLSE_R3 does not Granger Cause TA_R3	739	6.63446	5.E-06*
SP_R3 does not Granger Cause KLSE_R3		12.7212	7.E-12*
KLSE_R3 does not Granger Cause SP_R3	739	3.96535	0.0015*
ST_R3 does not Granger Cause NIK_R3		4.39015	0.0006*
NIK_R3 does not Granger Cause ST_R3	739	3.20823	0.0071*
KSP_R3 does not Granger Cause NIK_R3		5.05830	0.0001*
NIK_R3 does not Granger Cause KSP_R3	739	1.79077	0.1124
TW_R3 does not Granger Cause NIK_R3		6.32013	9.E-06*
NIK_R3 does not Granger Cause TW_R3	739	1.77335	0.1160
TA_R3 does not Granger Cause NIK_R3		2.44319	0.0329*
NIK_R3 does not Granger Cause TA_R3	739	2.56801	0.0258*
SP_R3 does not Granger Cause NIK_R3		21.9950	1.E-20*
NIK_R3 does not Granger Cause SP_R3	739	0.36578	0.8721
KSP_R3 does not Granger Cause ST_R3		3.10921	0.0087*
ST_R3 does not Granger Cause KSP_R3	739	5.35319	8.E-05*
TW_R3 does not Granger Cause ST_R3		7.26817	1.E-06*
ST_R3 does not Granger Cause TW_R3	739	1.69800	0.1327
TA_R3 does not Granger Cause ST_R3		3.39834	0.0048*
ST_R3 does not Granger Cause TA_R3	739	9.77129	5.E-09*
SP_R3 does not Granger Cause ST_R3		27.4365	2.E-25*
ST_R3 does not Granger Cause SP_R3	739	3.14302	0.0082*
TW_R3 does not Granger Cause KSP_R3		4.18112	0.0009*
KSP_R3 does not Granger Cause TW_R3	739	2.65207	0.0219*
TA_R3 does not Granger Cause KSP_R3		2.32592	0.0413*
KSP_R3 does not Granger Cause TA_R3	739	3.93697	0.0016*
SP_R3 does not Granger Cause KSP_R3		19.7541	2.E-18*
KSP_R3 does not Granger Cause SP_R3	739	2.80982	0.0160*
TA_R3 does not Granger Cause TW_R3		3.44446	0.0044*
TW_R3 does not Granger Cause TA_R3	739	6.94958	2.E-06*
SP_R3 does not Granger Cause TW_R3		19.6767	2.E-18*
TW_R3 does not Granger Cause SP_R3	739	1.68273	0.1364
SP_R3 does not Granger Cause TA_R3		14.6953	1.E-13*
TA_R3 does not Granger Cause SP_R3	739	0.89265	0.4854

(*) Rejection of the null hypothesis at 5% and therefore there is Granger causality.

Table B4: Granger Causality Test (Period 4)			
Null Hypothesis	**Observations**	**F-Statistic**	**Probability**
KSE_R4 does not Granger Cause NSE_R4	732	0.07333	0.9743
NSE_R4 does not Granger Cause KSE_R4		0.32717	0.8057
SC_R4 does not Granger Cause NSE_R4	732	1.83473	0.1394
NSE_R4 does not Granger Cause SC_R4		0.55584	0.6444
HS_R4 does not Granger Cause NSE_R4	732	1.65393	0.1756
NSE_R4 does not Granger Cause HS_R4		0.06116	0.9802
JC_R4 does not Granger Cause NSE_R4	732	3.14382	0.0247*
NSE_R4 does not Granger Cause JC_R4		0.18804	0.9046
KLSE_R4 does not Granger Cause NSE_R4	732	0.58878	0.6225
NSE_R4 does not Granger Cause KLSE_R4		0.93420	0.4236
NIK_R4 does not Granger Cause NSE_R4	732	3.77954	0.0104*
NSE_R4 does not Granger Cause NIK_R4		0.96723	0.4076
ST_R4 does not Granger Cause NSE_R4	732	1.73280	0.1588
NSE_R4 does not Granger Cause ST_R4		0.02964	0.9931
KSP_R4 does not Granger Cause NSE_R4	732	1.82473	0.1412
NSE_R4 does not Granger Cause KSP_R4		0.44622	0.7200
TW_R4 does not Granger Cause NSE_R4	732	0.96040	0.4109
NSE_R4 does not Granger Cause TW_R4		0.48138	0.6953
TA_R4 does not Granger Cause NSE_R4	732	0.44112	0.7237
NSE_R4 does not Granger Cause TA_R4		1.36746	0.2515
SP_R4 does not Granger Cause NSE_R4	732	2.10723	0.0980
NSE_R4 does not Granger Cause SP_R4		0.18982	0.9033
SC_R4 does not Granger Cause KSE_R4	732	1.34757	0.2578
KSE_R4 does not Granger Cause SC_R4		0.97344	0.4047
HS_R4 does not Granger Cause KSE_R4	732	1.22231	0.3006
KSE_R4 does not Granger Cause HS_R4		0.11645	0.9505
JC_R4 does not Granger Cause KSE_R4	732	0.55529	0.6447
KSE_R4 does not Granger Cause JC_R4		3.50165	0.0152*
KLSE_R4 does not Granger Cause KSE_R4	732	2.10911	0.0977
KSE_R4 does not Granger Cause KLSE_R4		0.32137	0.8099
NIK_R4 does not Granger Cause KSE_R4	732	1.46874	0.2218
KSE_R4 does not Granger Cause NIK_R4		1.01629	0.3848
ST_R4 does not Granger Cause KSE_R4	732	2.33311	0.0728
KSE_R4 does not Granger Cause ST_R4		4.17617	0.0060*
KSP_R4 does not Granger Cause KSE_R4	732	2.38157	0.0683
KSE_R4 does not Granger Cause KSP_R4		0.56449	0.6386
TW_R4 does not Granger Cause KSE_R4	732	2.29382	0.0767
KSE_R4 does not Granger Cause TW_R4		1.60113	0.1878
TA_R4 does not Granger Cause KSE_R4	732	1.66693	0.1727
KSE_R4 does not Granger Cause TA_R4		0.76994	0.5110
SP_R4 does not Granger Cause KSE_R4	732	0.29116	0.8318
KSE_R4 does not Granger Cause SP_R4		0.68487	0.5615
HS_R4 does not Granger Cause SC_R4	732	1.48359	0.2177
SC_R4 does not Granger Cause HS_R4		4.68197	0.0030*
JC_R4 does not Granger Cause SC_R4	732	2.70166	0.0447*
SC_R4 does not Granger Cause JC_R4		0.44389	0.7217
KLSE_R4 does not Granger Cause SC_R4	732	0.23221	0.8740
SC_R4 does not Granger Cause KLSE_R4		3.01912	0.0292*

Cont...

NIK_R4 does not Granger Cause SC_R4	732	0.31043	0.8179
SC_R4 does not Granger Cause NIK_R4		0.24004	0.8684
ST_R4 does not Granger Cause SC_R4	732	0.80071	0.4937
SC_R4 does not Granger Cause ST_R4		0.49548	0.6855
KSP_R4 does not Granger Cause SC_R4	732	0.38354	0.7649
SC_R4 does not Granger Cause KSP_R4		2.14743	0.0929
TW_R4 does not Granger Cause SC_R4	732	0.09308	0.9639
SC_R4 does not Granger Cause TW_R4		0.78960	0.4999
TA_R4 does not Granger Cause SC_R4	732	2.67094	0.0465*
SC_R4 does not Granger Cause TA_R4		5.74296	0.0007*
SP_R4 does not Granger Cause SC_R4	732	3.14119	0.0248*
SC_R4 does not Granger Cause SP_R4		0.37826	0.7687
JC_R4 does not Granger Cause HS_R4	732	2.61290	0.0503
HS_R4 does not Granger Cause JC_R4		3.27263	0.0207*
KLSE_R4 does not Granger Cause HS_R4	732	0.30860	0.8192
HS_R4 does not Granger Cause KLSE_R4		20.5546	9.E-13*
NIK_R4 does not Granger Cause HS_R4	732	0.85789	0.4626
HS_R4 does not Granger Cause NIK_R4		23.9077	9.E-15*
ST_R4 does not Granger Cause HS_R4		7.17934	9.E-05*
HS_R4 does not Granger Cause ST_R4	732	3.52873	0.0146*
KSP_R4 does not Granger Cause HS_R4		3.48645	0.0155*
HS_R4 does not Granger Cause KSP_R4	732	4.62785	0.0032*
TW_R4 does not Granger Cause HS_R4		0.90087	0.4403
HS_R4 does not Granger Cause TW_R4	732	10.8015	6.E-07*
TA_R4 does not Granger Cause HS_R4		3.23082	0.0219*
HS_R4 does not Granger Cause TA_R4	732	11.2227	3.E-07*
SP_R4 does not Granger Cause HS_R4		40.5796	3.E-24*
HS_R4 does not Granger Cause SP_R4	732	2.65851	0.0473*
KLSE_R4 does not Granger Cause JC_R4		0.36708	0.7768
JC_R4 does not Granger Cause KLSE_R4	732	22.5076	6.E-14*
NIK_R4 does not Granger Cause JC_R4		1.18986	0.3126
JC_R4 does not Granger Cause NIK_R4	732	17.4865	6.E-11*
ST_R4 does not Granger Cause JC_R4		7.94817	3.E-05*
JC_R4 does not Granger Cause ST_R4	732	2.56925	0.0533
KSP_R4 does not Granger Cause JC_R4		3.12859	0.0252*
JC_R4 does not Granger Cause KSP_R4	732	3.64866	0.0124*
TW_R4 does not Granger Cause JC_R4		0.26889	0.8478
JC_R4 does not Granger Cause TW_R4	732	5.97745	0.0005*
TA_R4 does not Granger Cause JC_R4		2.74750	0.0420*
JC_R4 does not Granger Cause TA_R4	732	8.16244	2.E-05*
SP_R4 does not Granger Cause JC_R4		21.4410	3.E-13*
JC_R4 does not Granger Cause SP_R4	732	1.87649	0.1321
NIK_R4 does not Granger Cause KLSE_R4		7.85494	4.E-05*
KLSE_R4 does not Granger Cause NIK_R4	732	4.56906	0.0035*
ST_R4 does not Granger Cause KLSE_R4		23.9085	9.E-15*
KLSE_R4 does not Granger Cause ST_R4	732	0.75120	0.5218
KSP_R4 does not Granger Cause KLSE_R4		14.4331	4.E-09*
KLSE_R4 does not Granger Cause KSP_R4	732	1.01265	0.3865

Cont...

TW_R4 does not Granger Cause KLSE_R4		2.37921	0.0685
KLSE_R4 does not Granger Cause TW_R4	732	0.86089	0.4610
TA_R4 does not Granger Cause KLSE_R4		6.87110	0.0001*
KLSE_R4 does not Granger Cause TA_R4	732	3.40279	0.0174*
SP_R4 does not Granger Cause KLSE_R4		25.9234	6.E-16*
KLSE_R4 does not Granger Cause SP_R4	732	0.12574	0.9449
ST_R4 does not Granger Cause NIK_R4		25.2189	2.E-15*
NIK_R4 does not Granger Cause ST_R4	732	3.45965	0.0161*
KSP_R4 does not Granger Cause NIK_R4		21.5355	2.E-13*
NIK_R4 does not Granger Cause KSP_R4	732	0.69263	0.5567
TW_R4 does not Granger Cause NIK_R4		3.02556	0.0289*
NIK_R4 does not Granger Cause TW_R4	732	2.19156	0.0877
TA_R4 does not Granger Cause NIK_R4		3.27159	0.0208*
NIK_R4 does not Granger Cause TA_R4	732	3.95329	0.0082*
SP_R4 does not Granger Cause NIK_R4		73.0064	3.E-41*
NIK_R4 does not Granger Cause SP_R4	732	1.02177	0.3823
KSP_R4 does not Granger Cause ST_R4		5.82140	0.0006*
ST_R4 does not Granger Cause KSP_R4	732	6.21282	0.0004*
TW_R4 does not Granger Cause ST_R4		0.92288	0.4293
ST_R4 does not Granger Cause TW_R4	732	11.3854	3.E-07*
TA_R4 does not Granger Cause ST_R4		1.77779	0.1500
ST_R4 does not Granger Cause TA_R4	732	13.0733	3.E-08*
SP_R4 does not Granger Cause ST_R4		29.0630	9.E-18*
ST_R4 does not Granger Cause SP_R4	732	2.08849	0.1004
TW_R4 does not Granger Cause KSP_R4		4.27491	0.0053*
KSP_R4 does not Granger Cause TW_R4	732	6.21201	0.0004*
TA_R4 does not Granger Cause KSP_R4		1.50494	0.2119
KSP_R4 does not Granger Cause TA_R4	732	7.91839	3.E-05*
SP_R4 does not Granger Cause KSP_R4		30.2698	2.E-18*
KSP_R4 does not Granger Cause SP_R4	732	3.93721	0.0084*
TA_R4 does not Granger Cause TW_R4		1.70398	0.1648
TW_R4 does not Granger Cause TA_R4	732	4.61278	0.0033*
SP_R4 does not Granger Cause TW_R4		32.3097	1.E-19*
TW_R4 does not Granger Cause SP_R4	732	0.47037	0.7030
SP_R4 does not Granger Cause TA_R4		20.4023	1.E-12*
TA_R4 does not Granger Cause SP_R4	732	0.14422	0.9334

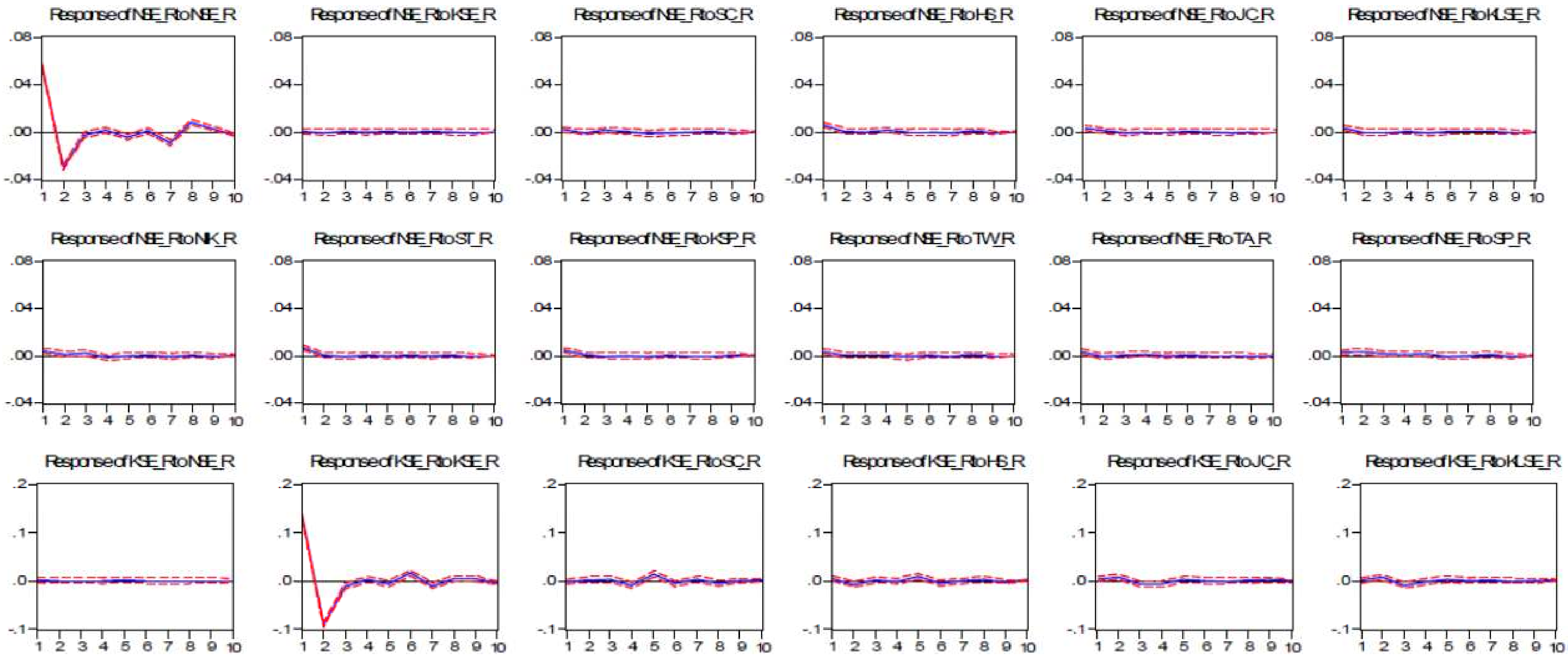
(*) Rejection of the null hypothesis at 5% and therefore there is Granger causality.

Table C: Ordering of Stock Markets for Impulse Response Function (Cholesky Decomposition)

		Local		GMT		Rank
Index	**Country**	**Open**	**Close**	**Open**	**Close**	
Shanghai Composite	China	9.30	3.00	1.30	7.00	7
Hang Seng Index	Hongkong	9.30	4.00	1.30	8.00	8
S&P CNX Nifty	India	9.15	3.30	3.45	10.00	10
Jakarta Composite	Indonesia	9.30	4.00	2.30	9.00	9
NIKKEI 225	Japan	9.00	3.00	0.00	6.00	1
Korea Composite Stock Price Index	South Korea	9.00	3.15	0.00	6.15	2
Bursa Malaysia Kuala Lumpur Composite Index	Malaysia	9.00	5.00	01.00	9.00	4
Straits Times	Singapore	9.00	5.15	01.00	9.15	5
Taiwan Stock Exchange Capitalization Weighted Stock Index	Taiwan	9.00	1.30	01.00	5.30	3
Tel Aviv-100	Israel	9.30	4.30	7.30	2.30	12
KSE 100	Karachi	9.30	3:30	4.30	10.30	11
S&P 500	USA	8.30	3.15	12.30	7.15	6

ANNEXURE B

Figure A: Impulse Response Function (Total Period)



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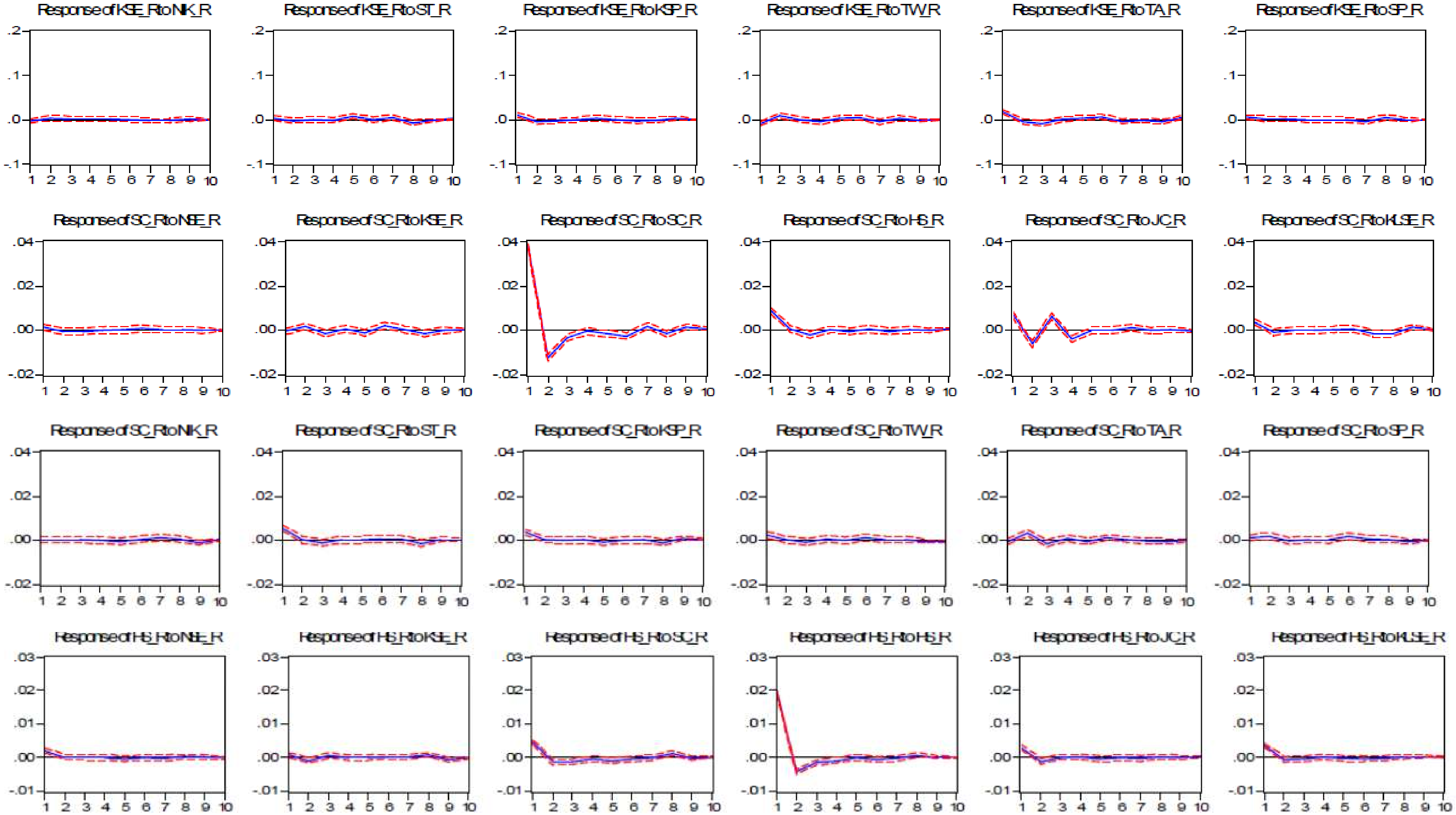
Response of KSE_R to NK_R
Response of KSE_R to ST_R
Response of KSE_R to KSP_R
Response of KSE_R to TW_R
Response of KSE_R to TA_R
Response of KSE_R to SP_R
Response of SC_R to NSE_R
Response of SC_R to KSE_R
Response of SC_R to SC_R
Response of SC_R to HS_R
Response of SC_R to JC_R
Response of SC_R to KLSE_R
Response of SC_R to NK_R
Response of SC_R to ST_R
Response of SC_R to KSP_R
Response of SC_R to TW_R
Response of SC_R to TA_R
Response of SC_R to SP_R
Response of HS_R to NSE_R
Response of HS_R to KSE_R
Response of HS_R to SC_R
Response of HS_R to HS_R
Response of HS_R to JC_R
Response of HS_R to KLSE_R

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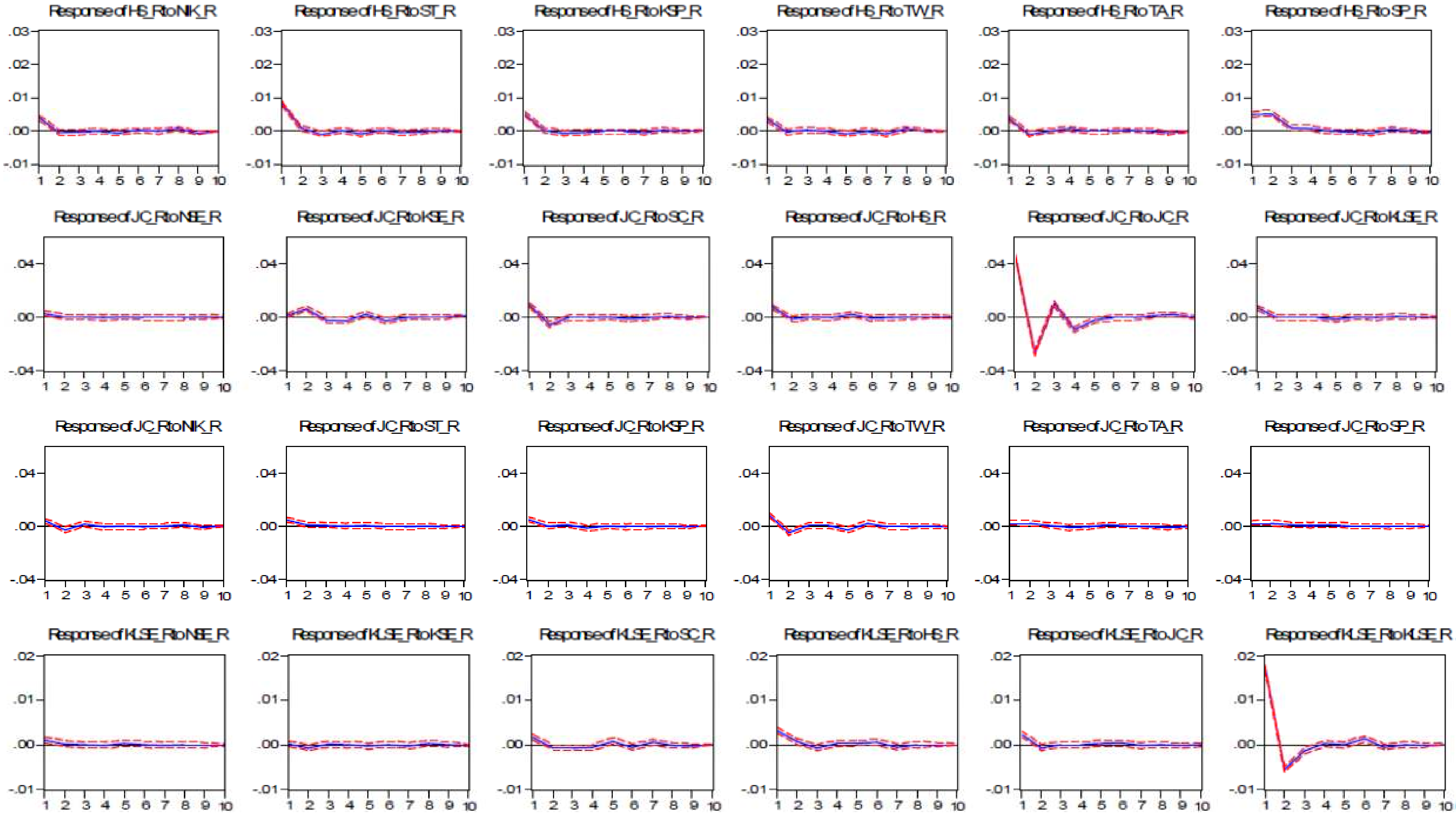
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Response of HS_R to ST_R
Response of HS_R to KSP_R
Response of HS_R to TW_R
Response of HS_R to TA_R
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Response of JC_R to NSE_R
Response of JC_R to KSE_R
Response of JC_R to SC_R
Response of JC_R to HS_R
Response of JC_R to JC_R
Response of JC_R to KLSE_R
Response of JC_R to NIK_R
Response of JC_R to ST_R
Response of JC_R to KSP_R
Response of JC_R to TW_R
Response of JC_R to TA_R
Response of JC_R to SP_R
Response of KLSE_R to NSE_R
Response of KLSE_R to KSE_R
Response of KLSE_R to SC_R
Response of KLSE_R to HS_R
Response of KLSE_R to JC_R
Response of KLSE_R to KLSE_R

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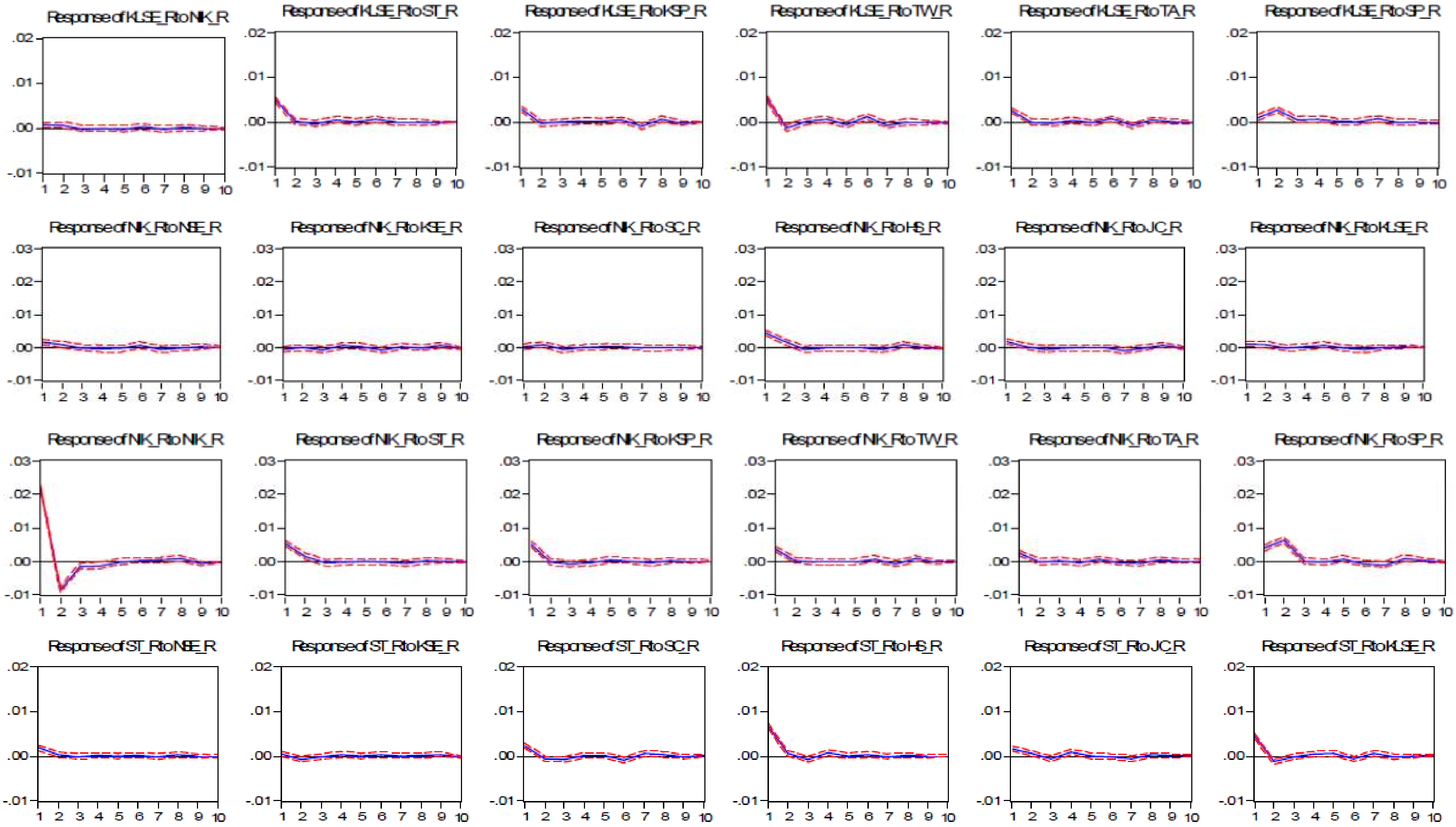
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Response of KLSE_R to KSP_R
Response of KLSE_R to TW_R
Response of KLSE_R to TA_R
Response of KLSE_R to SP_R
Response of NK_R to NSE_R
Response of NK_R to KSE_R
Response of NK_R to SC_R
Response of NK_R to HS_R
Response of NK_R to JC_R
Response of NK_R to KLSE_R
Response of NK_R to NK_R
Response of NK_R to ST_R
Response of NK_R to KSP_R
Response of NK_R to TW_R
Response of NK_R to TA_R
Response of NK_R to SP_R
Response of ST_R to NSE_R
Response of ST_R to KSE_R
Response of ST_R to SC_R
Response of ST_R to HS_R
Response of ST_R to JC_R
Response of ST_R to KLSE_R

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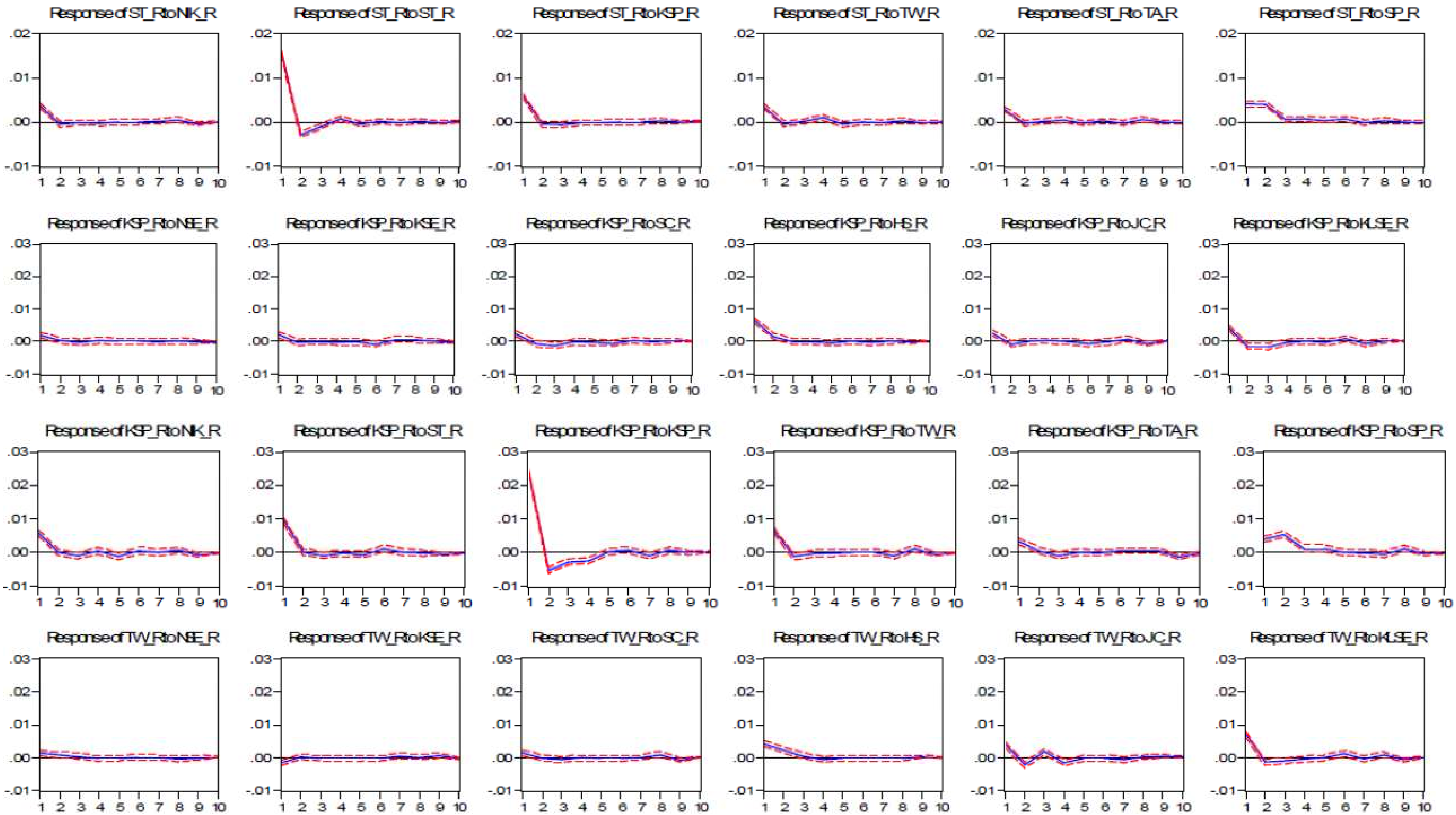
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Response of ST_R to KSP_R
Response of ST_R to TW_R
Response of ST_R to TA_R
Response of ST_R to SP_R
Response of KSP_R to NSE_R
Response of KSP_R to KSE_R
Response of KSP_R to SC_R
Response of KSP_R to HS_R
Response of KSP_R to JC_R
Response of KSP_R to KLSE_R
Response of KSP_R to NIK_R
Response of KSP_R to ST_R
Response of KSP_R to KSP_R
Response of KSP_R to TW_R
Response of KSP_R to TA_R
Response of KSP_R to SP_R
Response of TW_R to NSE_R
Response of TW_R to KSE_R
Response of TW_R to SC_R
Response of TW_R to HS_R
Response of TW_R to JC_R
Response of TW_R to KLSE_R

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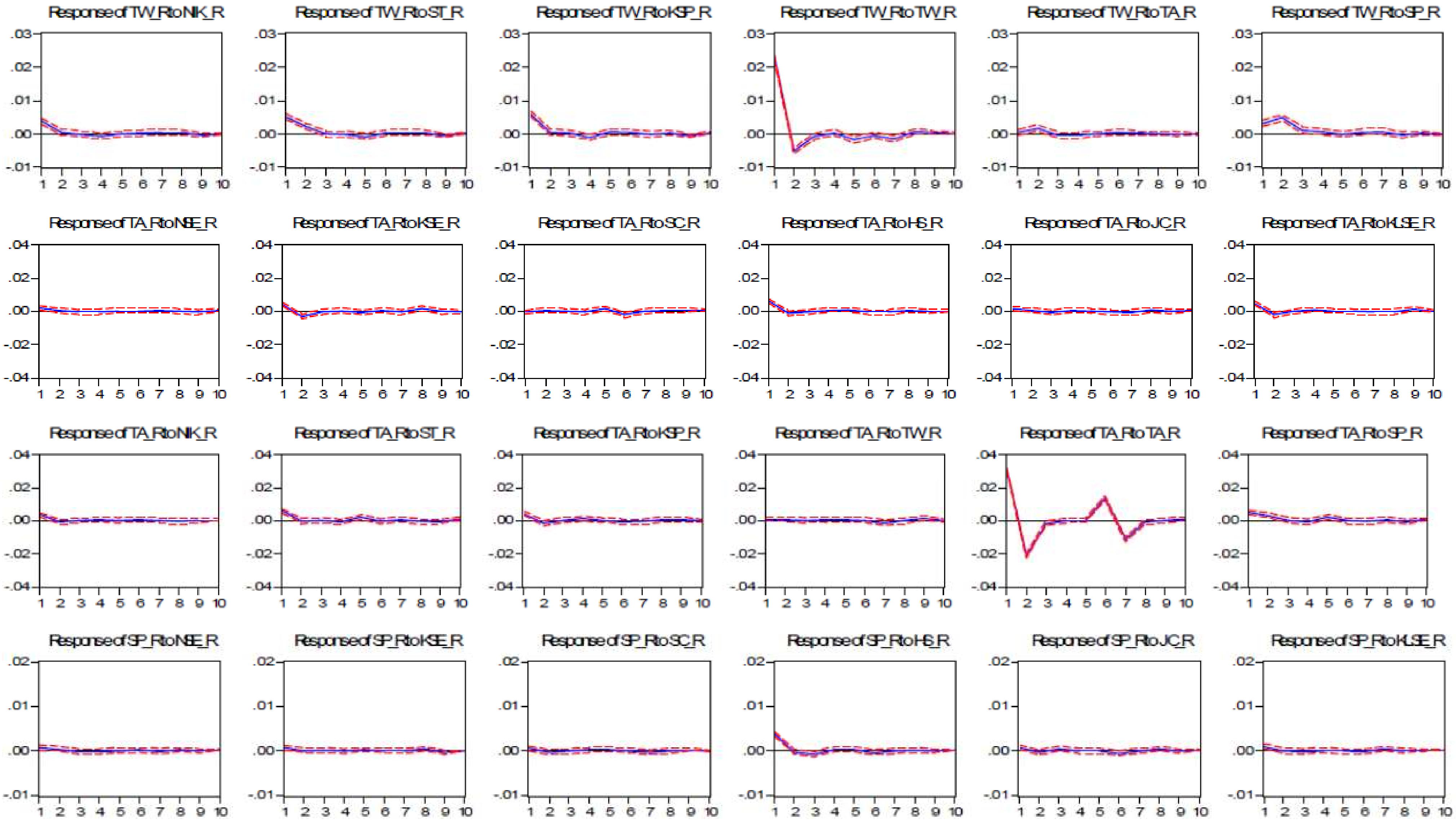
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Response of TW_R to KSP_R
Response of TW_R to TW_R
Response of TW_R to TA_R
Response of TW_R to SP_R
Response of TA_R to NSE_R
Response of TA_R to KSE_R
Response of TA_R to SC_R
Response of TA_R to HS_R
Response of TA_R to JC_R
Response of TA_R to KLSE_R
Response of TA_R to NK_R
Response of TA_R to ST_R
Response of TA_R to KSP_R
Response of TA_R to TW_R
Response of TA_R to TA_R
Response of TA_R to SP_R
Response of SP_R to NSE_R
Response of SP_R to KSE_R
Response of SP_R to SC_R
Response of SP_R to HS_R
Response of SP_R to JC_R
Response of SP_R to KLSE_R

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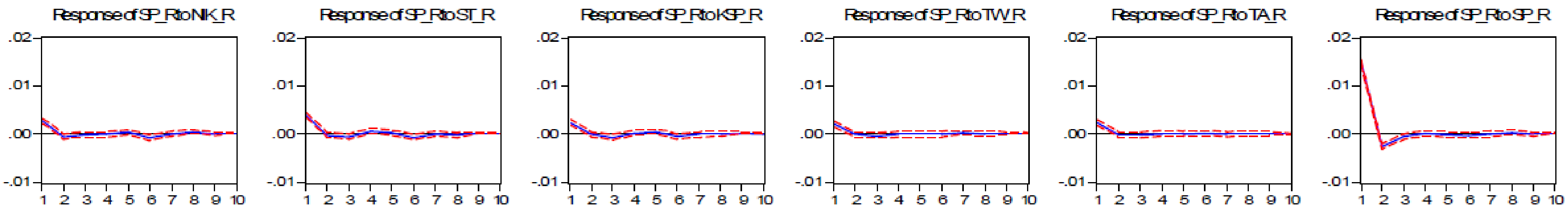
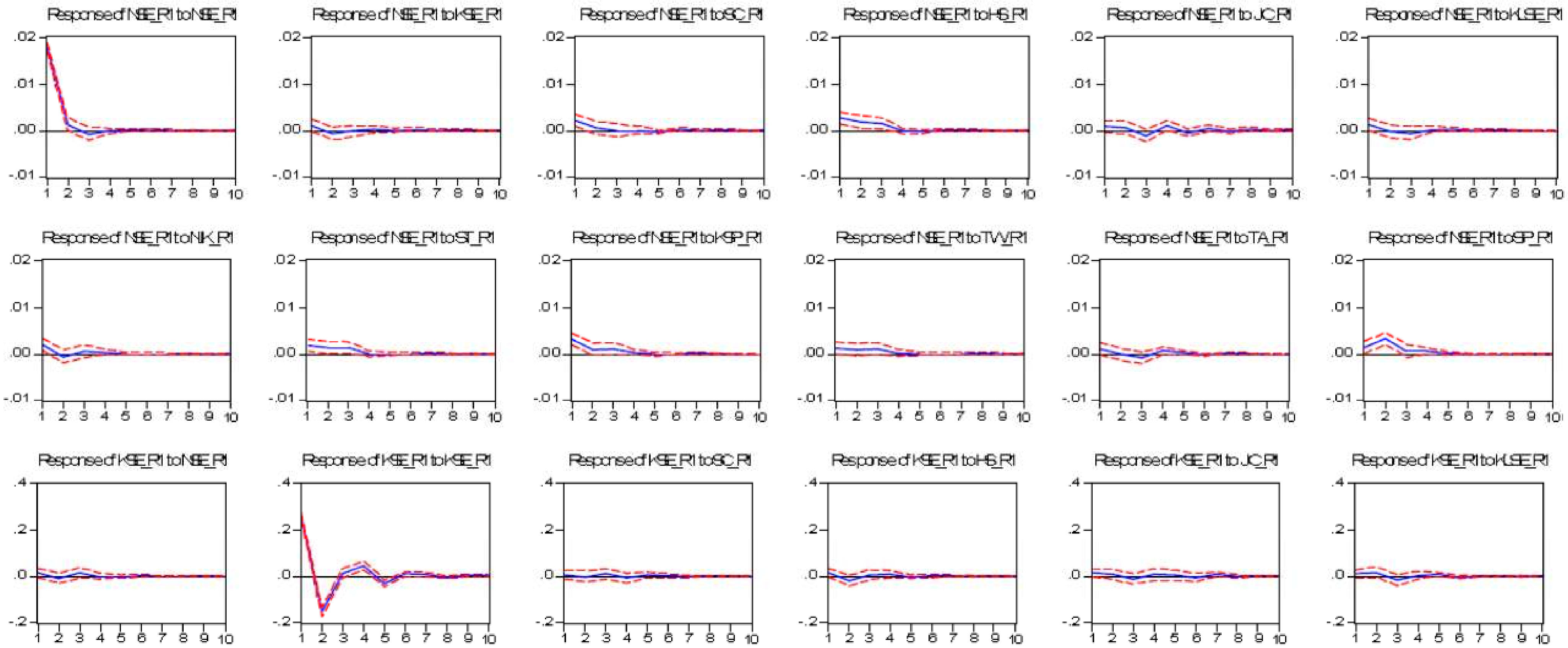


Response of SP_R to NK_R
Response of SP_R to ST_R
Response of SP_R to KSP_R
Response of SP_R to TW_R
Response of SP_R to TA_R
Response of SP_R to SP_R
.02
.01
.00
-.01
1 2 3 4 5 6 7 8 9 10

Figure A1: Impulse Response Function (Period-1)



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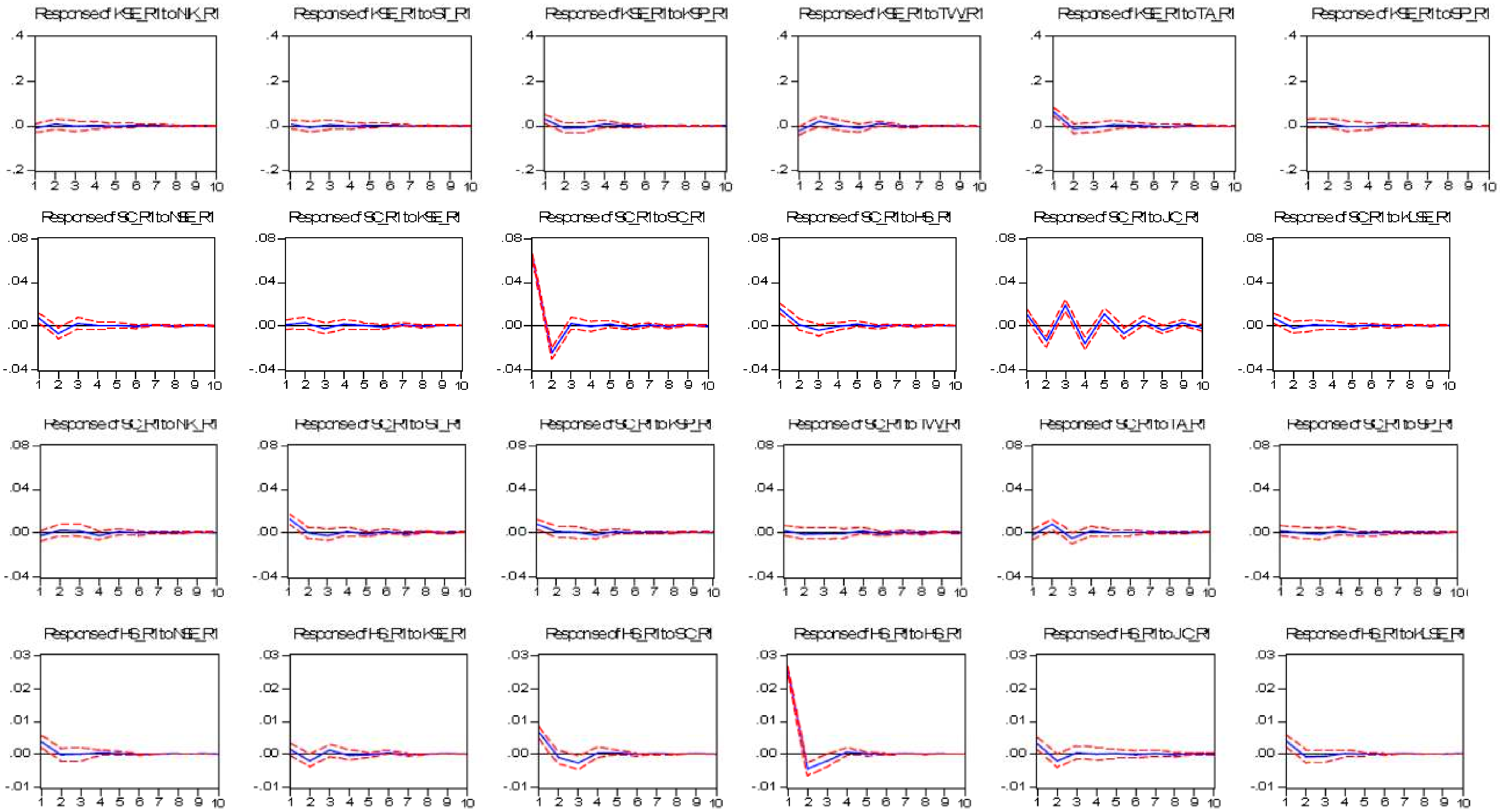
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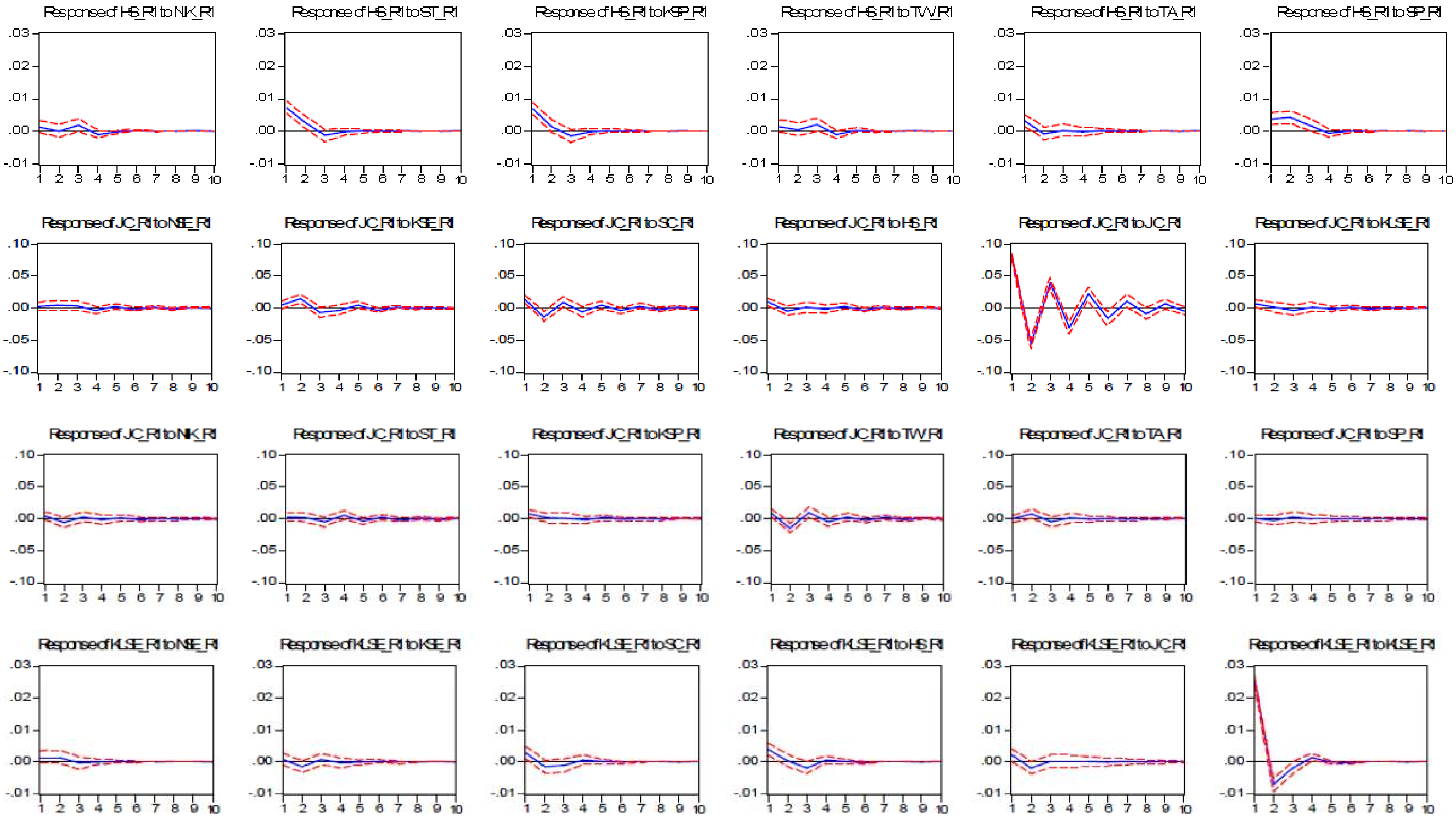
Response of KSE_RI to ST_RI
Response of KSE_RI to KSP_RI
Response of KSE_RI to TW_RI
Response of KSE_RI to TA_RI
Response of KSE_RI to SP_RI
Response of SC_RI to NSE_RI
Response of SC_RI to KSE_RI
Response of SC_RI to SC_RI
Response of SC_RI to HS_RI
Response of SC_RI to JC_RI
Response of SC_RI to KLSE_RI
Response of SC_RI to NK_RI
Response of SC_RI to ST_RI
Response of SC_RI to KSP_RI
Response of SC_RI to TW_RI
Response of SC_RI to TA_RI
Response of SC_RI to SP_RI
Response of HS_RI to NSE_RI
Response of HS_RI to KSE_RI
Response of HS_RI to SC_RI
Response of HS_RI to HS_RI
Response of HS_RI to JC_RI
Response of HS_RI to KLSE_RI

Cont...



Response of HS_RI to NK_RI
Response of HS_RI to ST_RI
Response of HS_RI to KSP_RI
Response of HS_RI to TW_RI
Response of HS_RI to TA_RI
Response of HS_RI to SP_RI
Response of JC_RI to NSE_RI
Response of JC_RI to KSE_RI
Response of JC_RI to SC_RI
Response of JC_RI to HS_RI
Response of JC_RI to JC_RI
Response of JC_RI to KLSE_RI
Response of JC_RI to NK_RI
Response of JC_RI to ST_RI
Response of JC_RI to KSP_RI
Response of JC_RI to TW_RI
Response of JC_RI to TA_RI
Response of JC_RI to SP_RI
Response of KLSE_RI to NSE_RI
Response of KLSE_RI to KSE_RI
Response of KLSE_RI to SC_RI
Response of KLSE_RI to HS_RI
Response of KLSE_RI to JC_RI
Response of KLSE_RI to KLSE_RI

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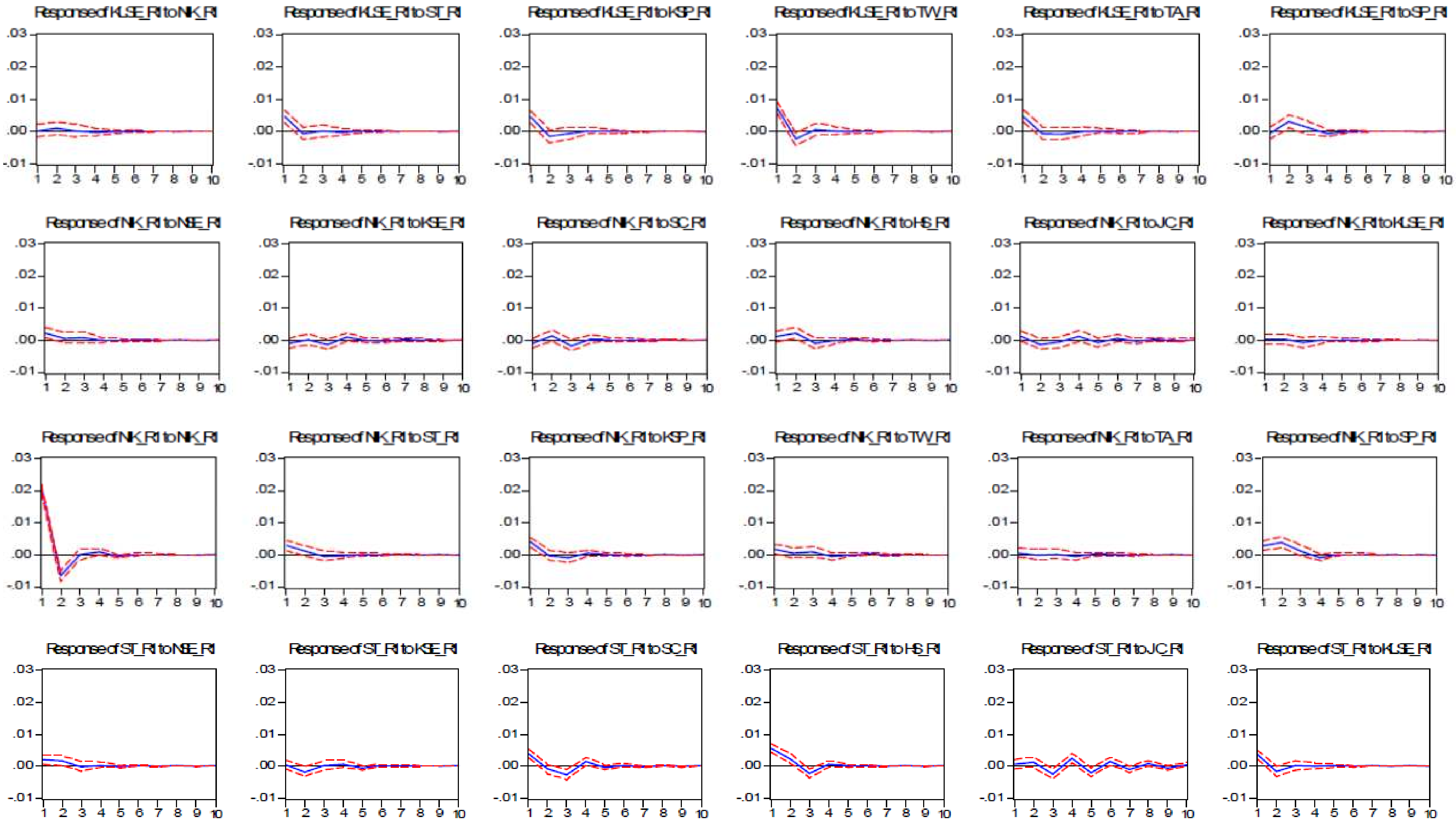

Response of KLSE_RI to NK_RI
Response of KLSE_RI to ST_RI
Response of KLSE_RI to KSP_RI
Response of KLSE_RI to TW_RI
Response of KLSE_RI to TA_RI
Response of KLSE_RI to SP_RI
Response of NK_RI to NSE_RI
Response of NK_RI to KSE_RI
Response of NK_RI to SC_RI
Response of NK_RI to HS_RI
Response of NK_RI to JC_RI
Response of NK_RI to KLSE_RI
Response of NK_RI to NK_RI
Response of NK_RI to ST_RI
Response of NK_RI to KSP_RI
Response of NK_RI to TW_RI
Response of NK_RI to TA_RI
Response of NK_RI to SP_RI
Response of ST_RI to NSE_RI
Response of ST_RI to KSE_RI
Response of ST_RI to SC_RI
Response of ST_RI to HS_RI
Response of ST_RI to JC_RI
Response of ST_RI to KLSE_RI

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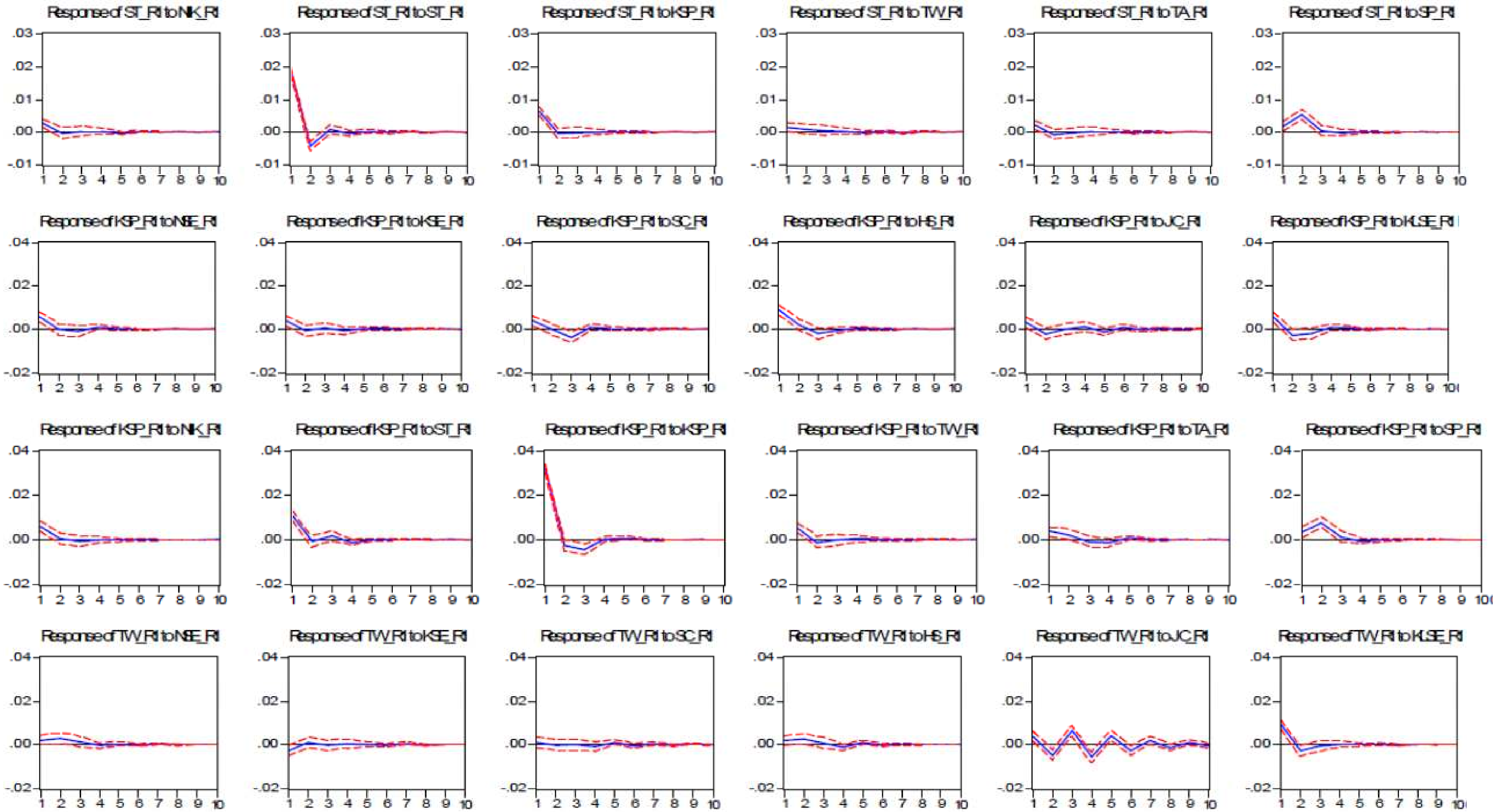
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Response of KSP_RI to NSE_RI
Response of KSP_RI to KSE_RI
Response of KSP_RI to SC_RI
Response of KSP_RI to HS_RI
Response of KSP_RI to JC_RI
Response of KSP_RI to KLSE_RI
Response of KSP_RI to NK_RI
Response of KSP_RI to ST_RI
Response of KSP_RI to KSP_RI
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Response of KSP_RI to SP_RI
Response of TW_RI to NSE_RI
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Response of TW_RI to KLSE_RI

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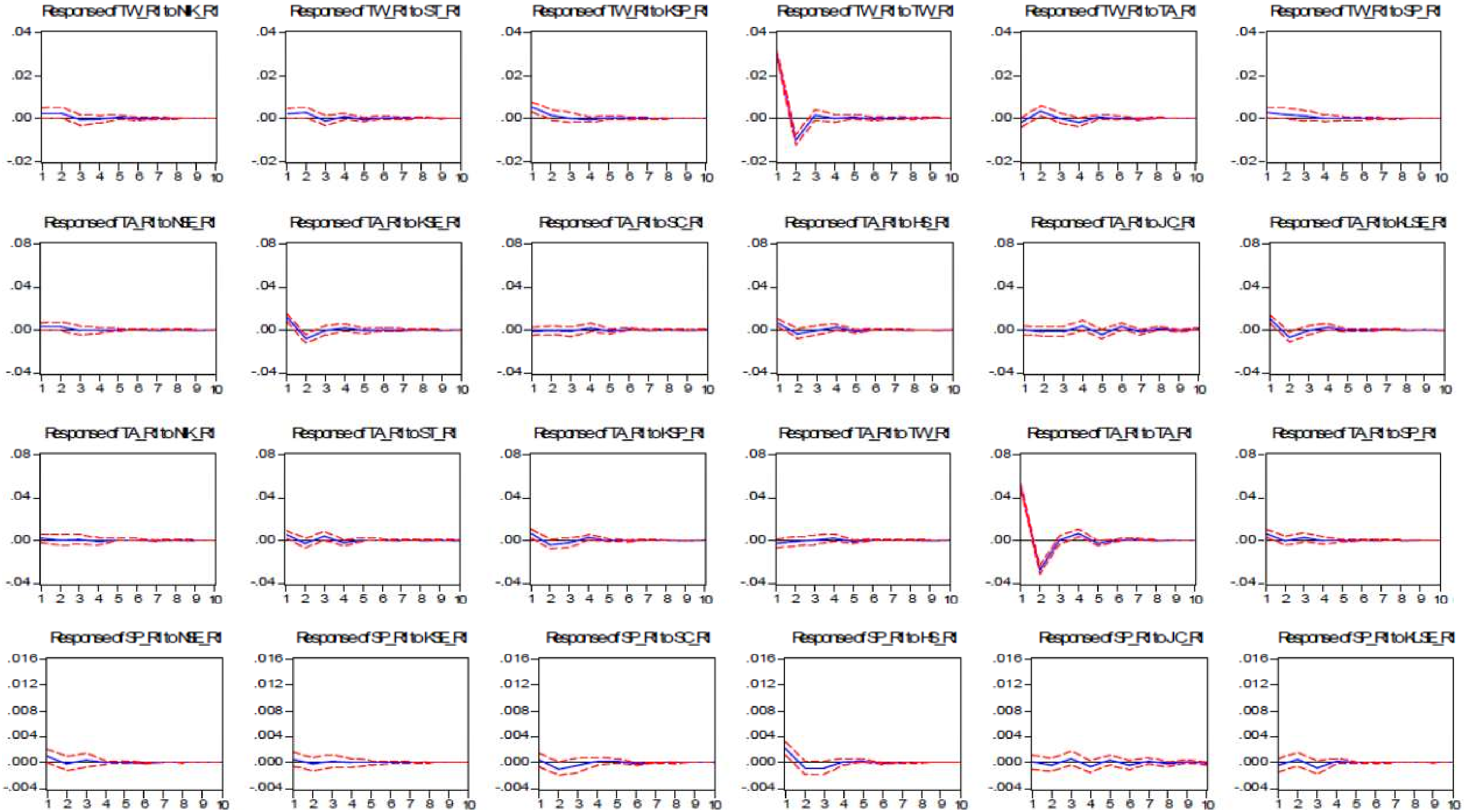
Response of TW_RI to NIK_RI
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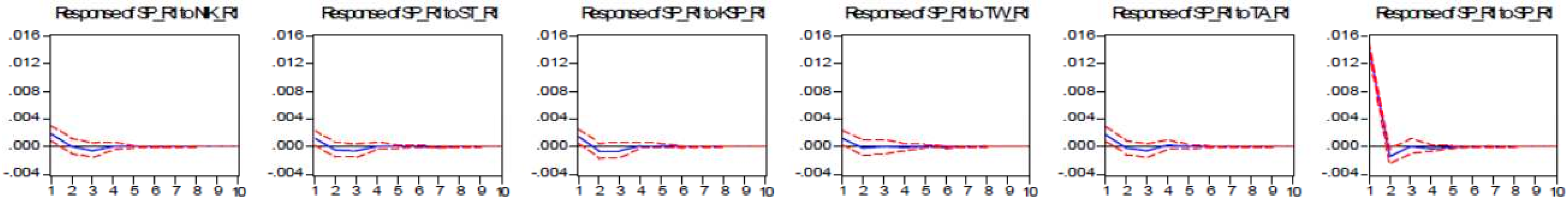
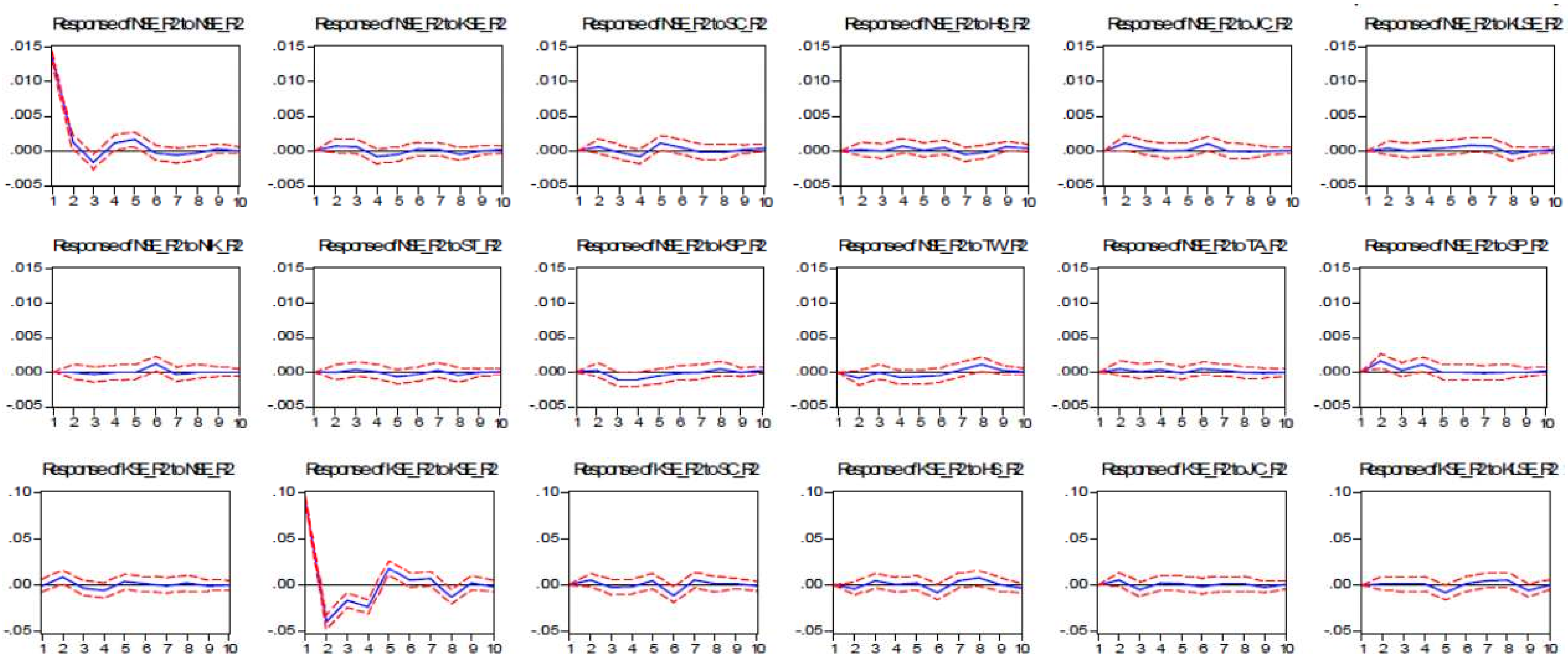
Response of TW_RI to KSP_RI
Response of TW_RI to TW_RI
Response of TW_RI to TA_RI
Response of TW_RI to SP_RI
Response of TA_RI to NSE_RI
Response of TA_RI to KSE_RI
Response of TA_RI to SC_RI
Response of TA_RI to HS_RI
Response of TA_RI to JC_RI
Response of TA_RI to KLSE_RI
Response of TA_RI to NIK_RI
Response of TA_RI to ST_RI
Response of TA_RI to KSP_RI
Response of TA_RI to TW_RI
Response of TA_RI to TA_RI
Response of TA_RI to SP_RI
Response of SP_RI to NSE_RI
Response of SP_RI to KSE_RI
Response of SP_RI to SC_RI
Response of SP_RI to HS_RI
Response of SP_RI to JC_RI
Response of SP_RI to KLSE_RI

Cont...



Response of SP_RI to NIK_RI
Response of SP_RI to ST_RI
Response of SP_RI to KSP_RI
Response of SP_RI to TW_RI
Response of SP_RI to TA_RI
Response of SP_RI to SP_RI
.016
.012
.008
.004
.000
-.004
1 2 3 4 5 6 7 8 9 10

Figure A2: Impulse Response Function (Period-2)



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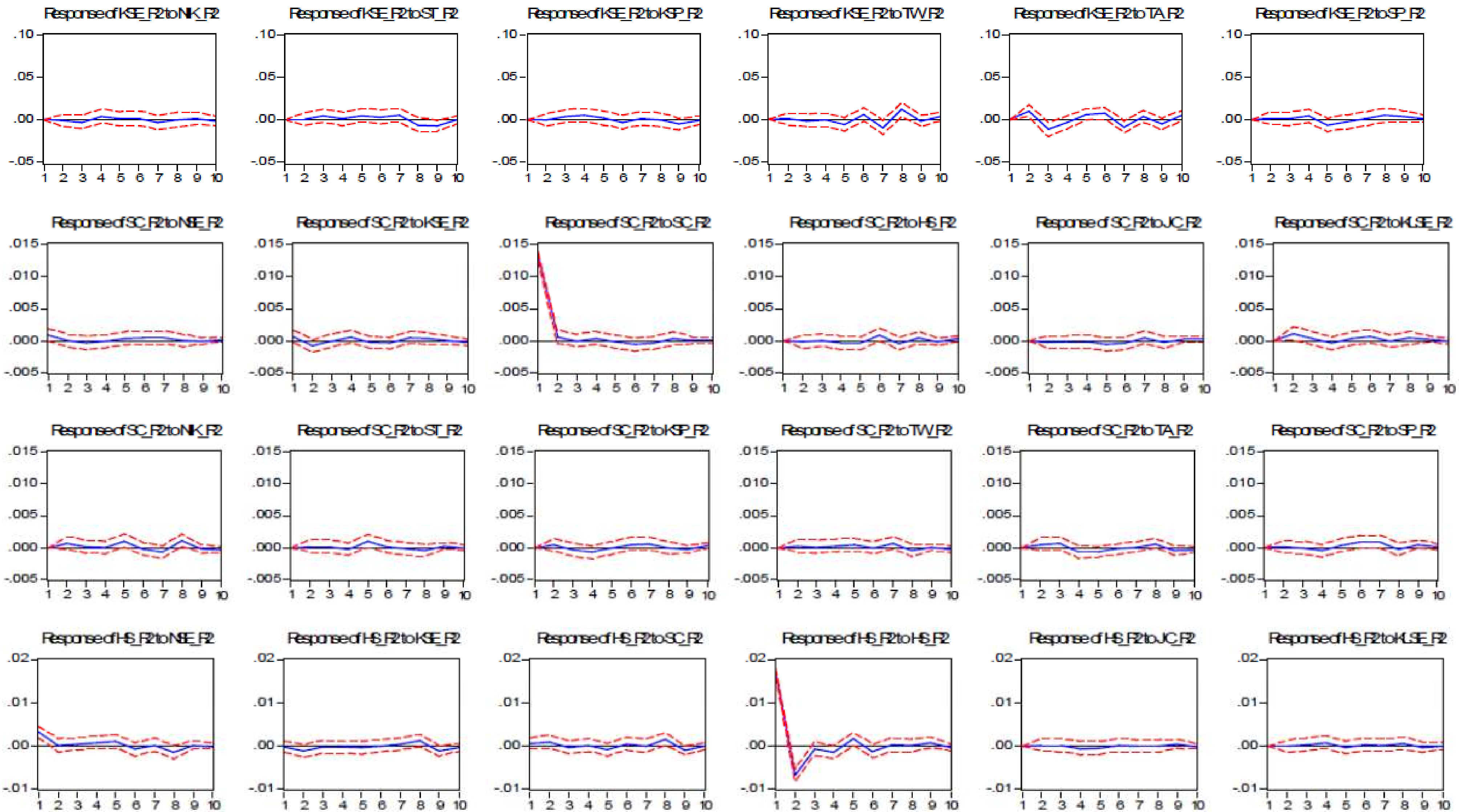
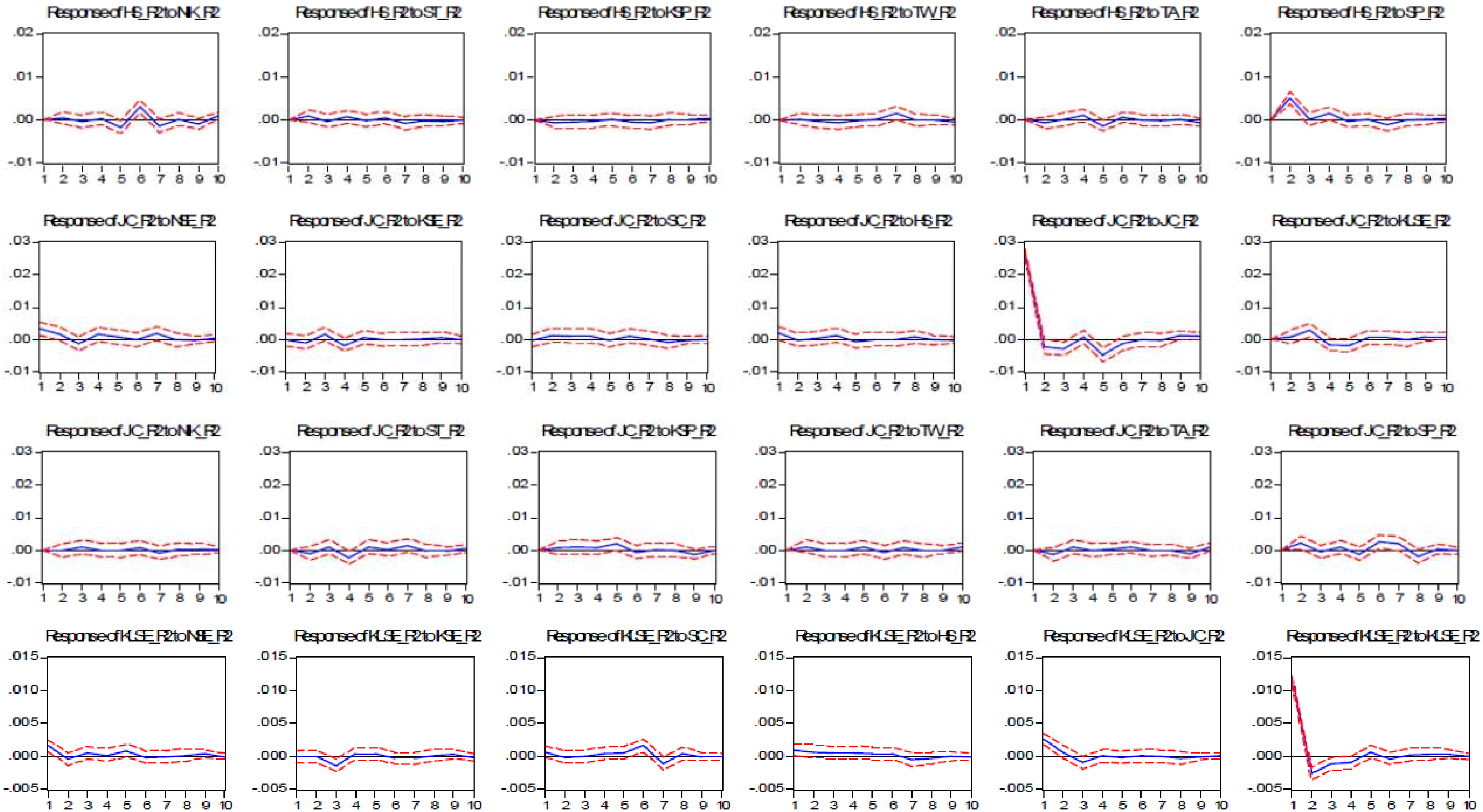
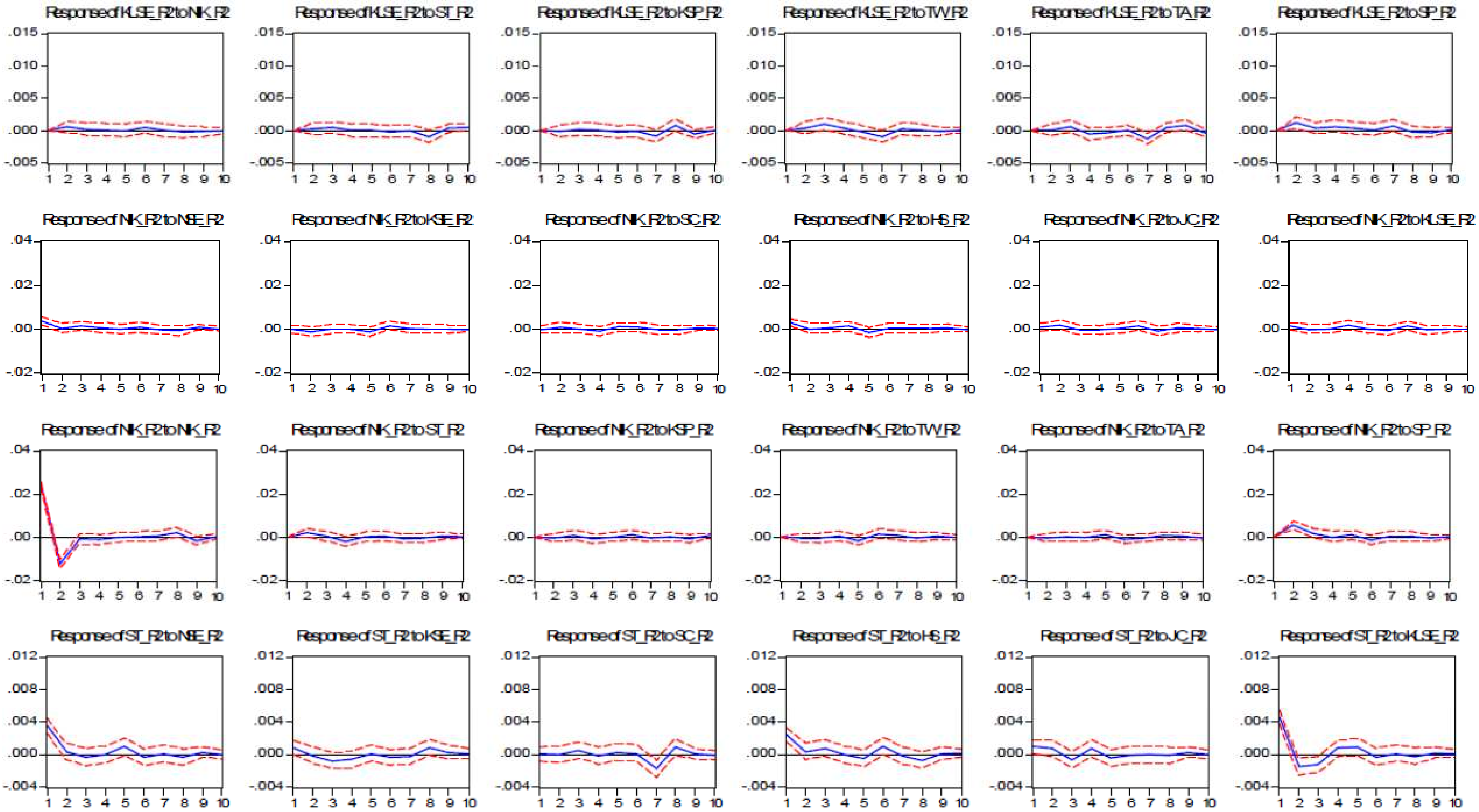

Response of KSE_R2 to NK_R2
Response of KSE_R2 to ST_R2
Response of KSE_R2 to KSP_R2
Response of KSE_R2 to TW_R2
Response of KSE_R2 to TA_R2
Response of KSE_R2 to SP_R2
Response of SC_R2 to NSE_R2
Response of SC_R2 to KSE_R2
Response of SC_R2 to SC_R2
Response of SC_R2 to HS_R2
Response of SC_R2 to JC_R2
Response of SC_R2 to KLSE_R2
Response of SC_R2 to NK_R2
Response of SC_R2 to ST_R2
Response of SC_R2 to KSP_R2
Response of SC_R2 to TW_R2
Response of SC_R2 to TA_R2
Response of SC_R2 to SP_R2
Response of HS_R2 to NSE_R2
Response of HS_R2 to KSE_R2
Response of HS_R2 to SC_R2
Response of HS_R2 to HS_R2
Response of HS_R2 to JC_R2
Response of HS_R2 to KLSE_R2

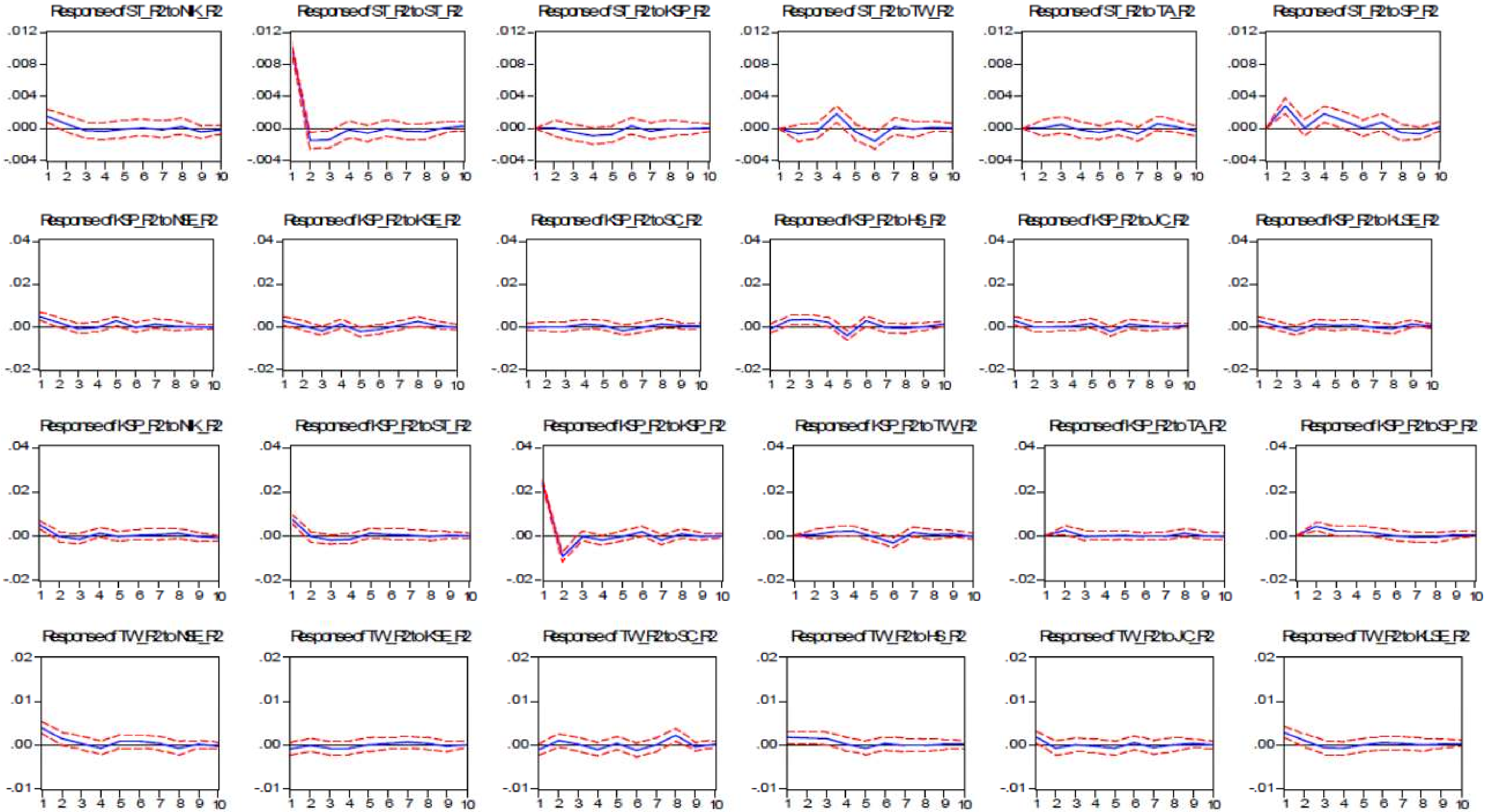
Cont...


Response of HS_R2 to NK_R2
Response of HS_R2 to ST_R2
Response of HS_R2 to KSP_R2
Response of HS_R2 to TW_R2
Response of HS_R2 to TA_R2
Response of HS_R2 to SP_R2
Response of JC_R2 to NSE_R2
Response of JC_R2 to KSE_R2
Response of JC_R2 to SC_R2
Response of JC_R2 to HS_R2
Response of JC_R2 to JC_R2
Response of JC_R2 to KLSE_R2
Response of JC_R2 to NK_R2
Response of JC_R2 to ST_R2
Response of JC_R2 to KSP_R2
Response of JC_R2 to TW_R2
Response of JC_R2 to TA_R2
Response of JC_R2 to SP_R2
Response of KLSE_R2 to NSE_R2
Response of KLSE_R2 to KSE_R2
Response of KLSE_R2 to SC_R2
Response of KLSE_R2 to HS_R2
Response of KLSE_R2 to JC_R2
Response of KLSE_R2 to KLSE_R2

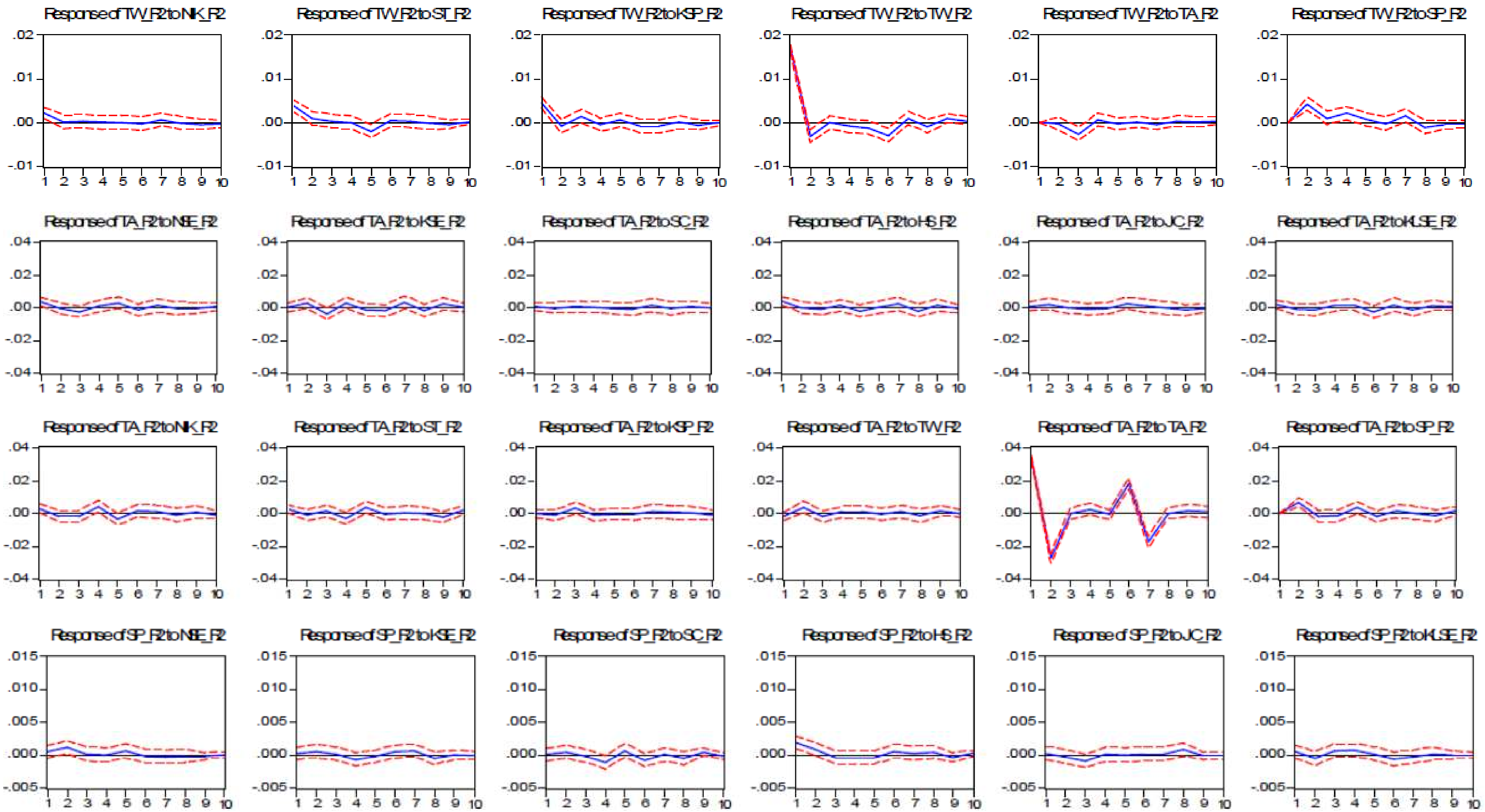
Cont...


Response of KLSE_R2 to NK_R2
Response of KLSE_R2 to ST_R2
Response of KLSE_R2 to KSP_R2
Response of KLSE_R2 to TW_R2
Response of KLSE_R2 to TA_R2
Response of KLSE_R2 to SP_R2
Response of NK_R2 to NSE_R2
Response of NK_R2 to KSE_R2
Response of NK_R2 to SC_R2
Response of NK_R2 to HS_R2
Response of NK_R2 to JC_R2
Response of NK_R2 to KLSE_R2
Response of NK_R2 to NK_R2
Response of NK_R2 to ST_R2
Response of NK_R2 to KSP_R2
Response of NK_R2 to TW_R2
Response of NK_R2 to TA_R2
Response of NK_R2 to SP_R2
Response of ST_R2 to NSE_R2
Response of ST_R2 to KSE_R2
Response of ST_R2 to SC_R2
Response of ST_R2 to HS_R2
Response of ST_R2 to JC_R2
Response of ST_R2 to KLSE_R2

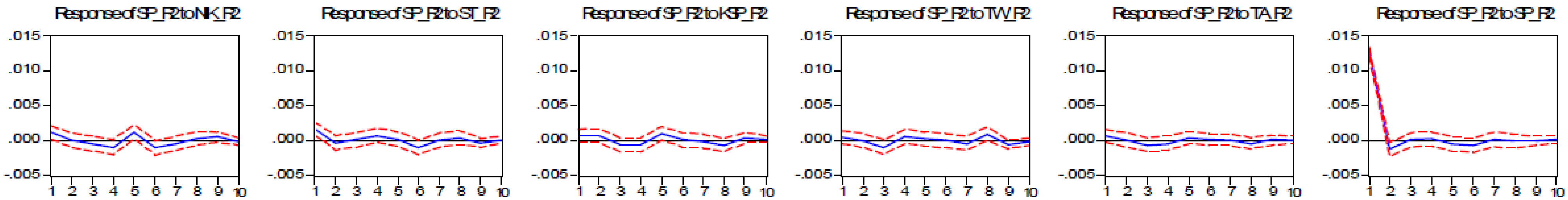
Cont...


Response of ST_R2 to NIK_R2
Response of ST_R2 to ST_R2
Response of ST_R2 to KSP_R2
Response of ST_R2 to TW_R2
Response of ST_R2 to TA_R2
Response of ST_R2 to SP_R2
Response of KSP_R2 to NSE_R2
Response of KSP_R2 to KSE_R2
Response of KSP_R2 to SC_R2
Response of KSP_R2 to HS_R2
Response of KSP_R2 to JC_R2
Response of KSP_R2 to KLSE_R2
Response of KSP_R2 to NIK_R2
Response of KSP_R2 to ST_R2
Response of KSP_R2 to KSP_R2
Response of KSP_R2 to TW_R2
Response of KSP_R2 to TA_R2
Response of KSP_R2 to SP_R2
Response of TW_R2 to NSE_R2
Response of TW_R2 to KSE_R2
Response of TW_R2 to SC_R2
Response of TW_R2 to HS_R2
Response of TW_R2 to JC_R2
Response of TW_R2 to KLSE_R2

Cont...

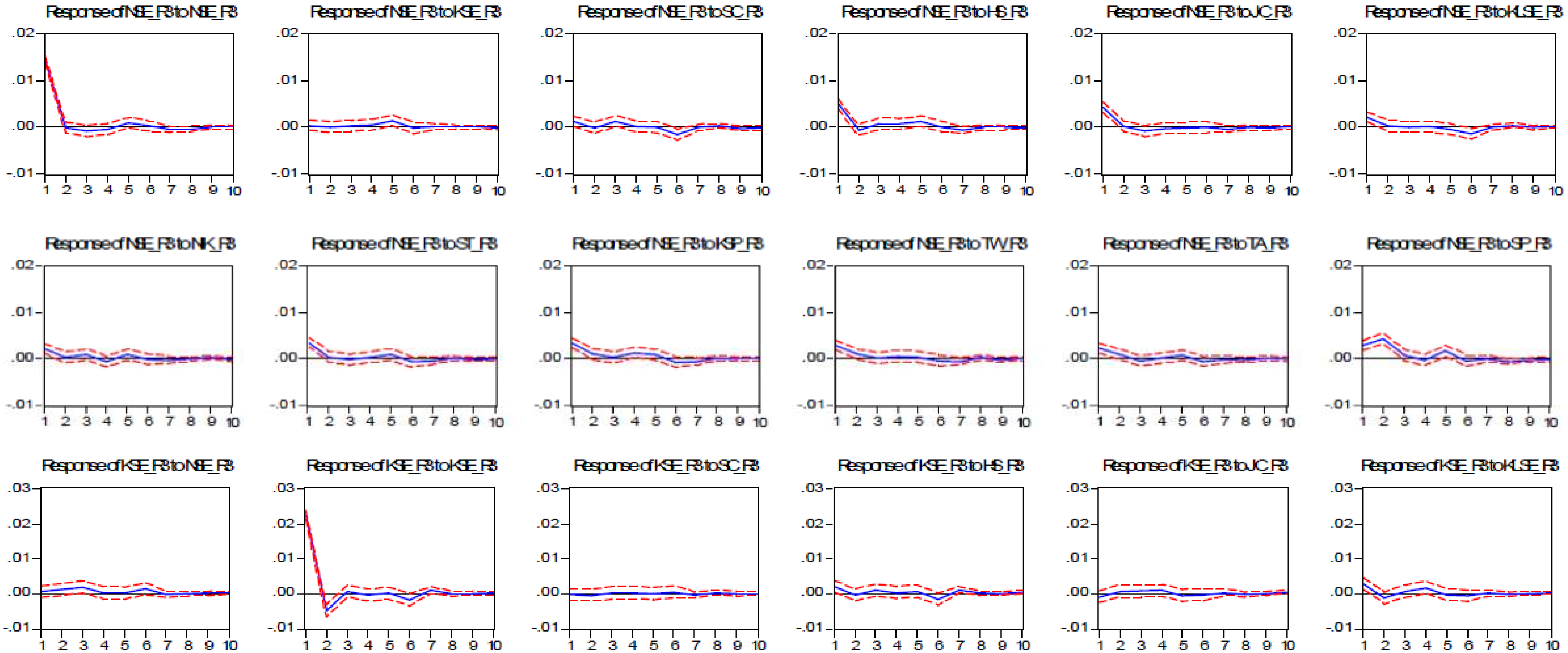

Response of TW_R2 to NK_R2
Response of TW_R2 to ST_R2
Response of TW_R2 to KSP_R2
Response of TW_R2 to TW_R2
Response of TW_R2 to TA_R2
Response of TW_R2 to SP_R2
Response of TA_R2 to NSE_R2
Response of TA_R2 to KSE_R2
Response of TA_R2 to SC_R2
Response of TA_R2 to HS_R2
Response of TA_R2 to JC_R2
Response of TA_R2 to KLSE_R2
Response of TA_R2 to NK_R2
Response of TA_R2 to ST_R2
Response of TA_R2 to KSP_R2
Response of TA_R2 to TW_R2
Response of TA_R2 to TA_R2
Response of TA_R2 to SP_R2
Response of SP_R2 to NSE_R2
Response of SP_R2 to KSE_R2
Response of SP_R2 to SC_R2
Response of SP_R2 to HS_R2
Response of SP_R2 to JC_R2
Response of SP_R2 to KLSE_R2

Cont...



Response of SP_R2 to NK_R2
Response of SP_R2 to ST_R2
Response of SP_R2 to KSP_R2
Response of SP_R2 to TW_R2
Response of SP_R2 to TA_R2
Response of SP_R2 to SP_R2
.015
.010
.005
.000
-.005
1 2 3 4 5 6 7 8 9 10

Figure A3: Impulse Response Function (Period-3)



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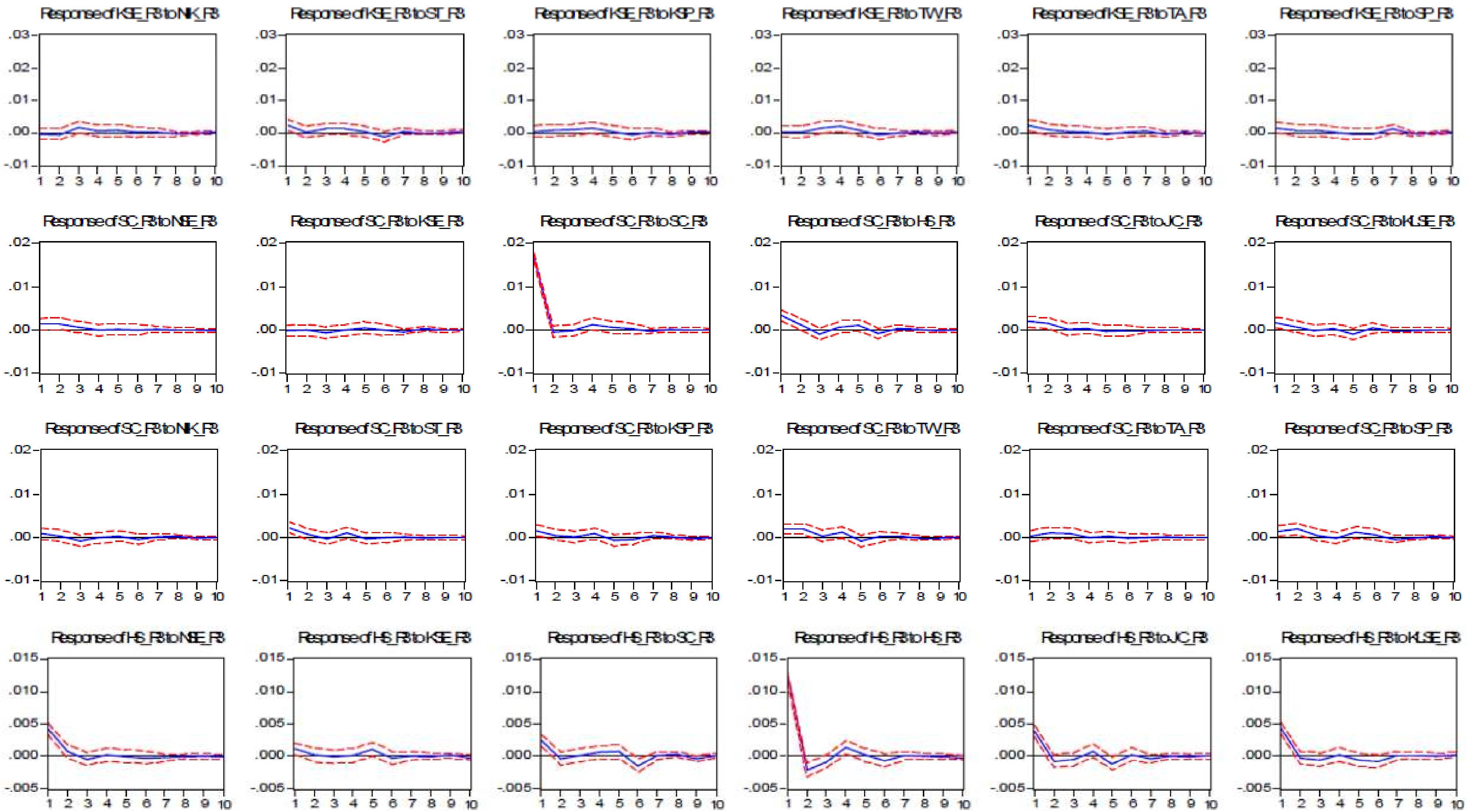
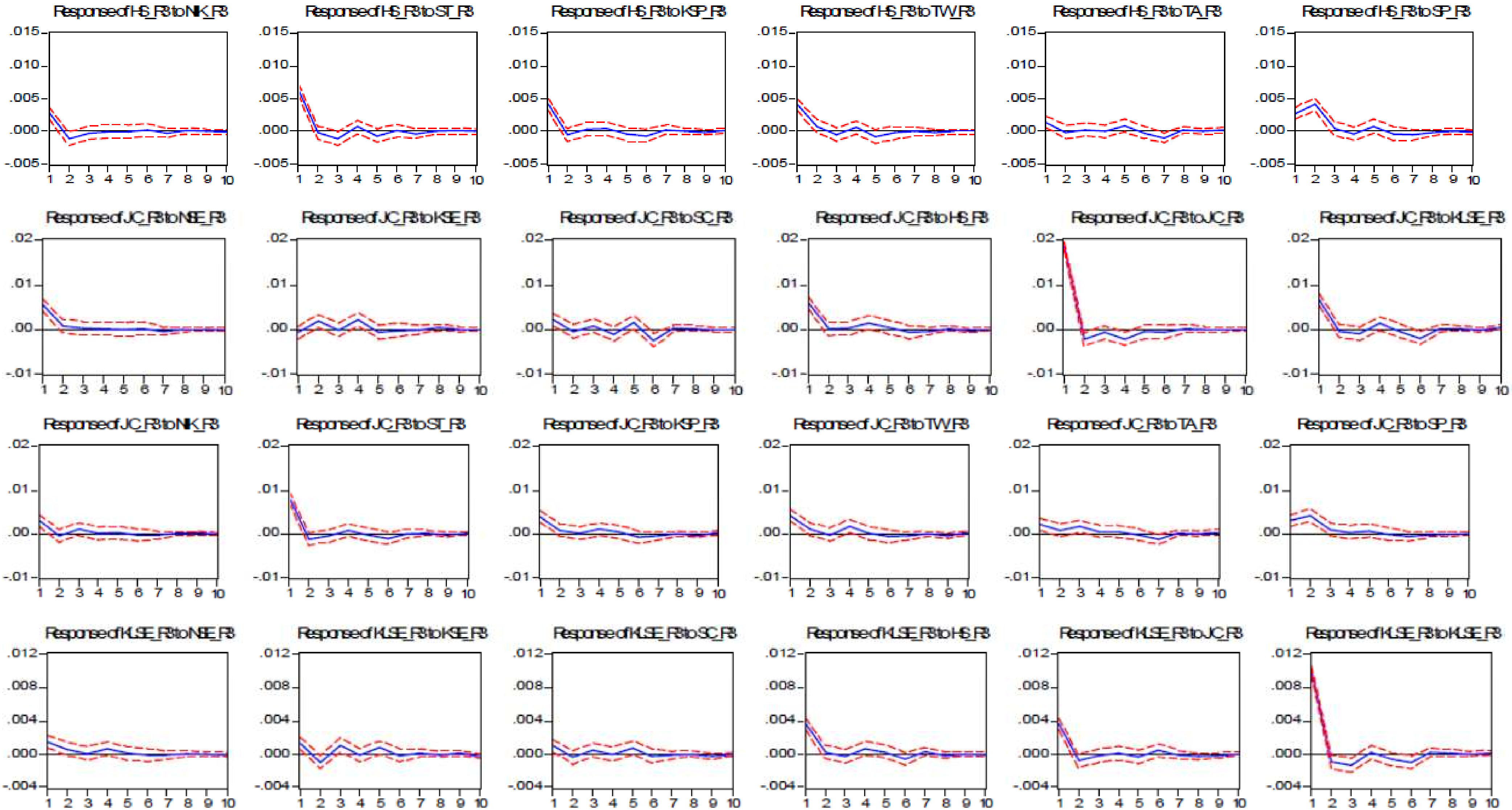
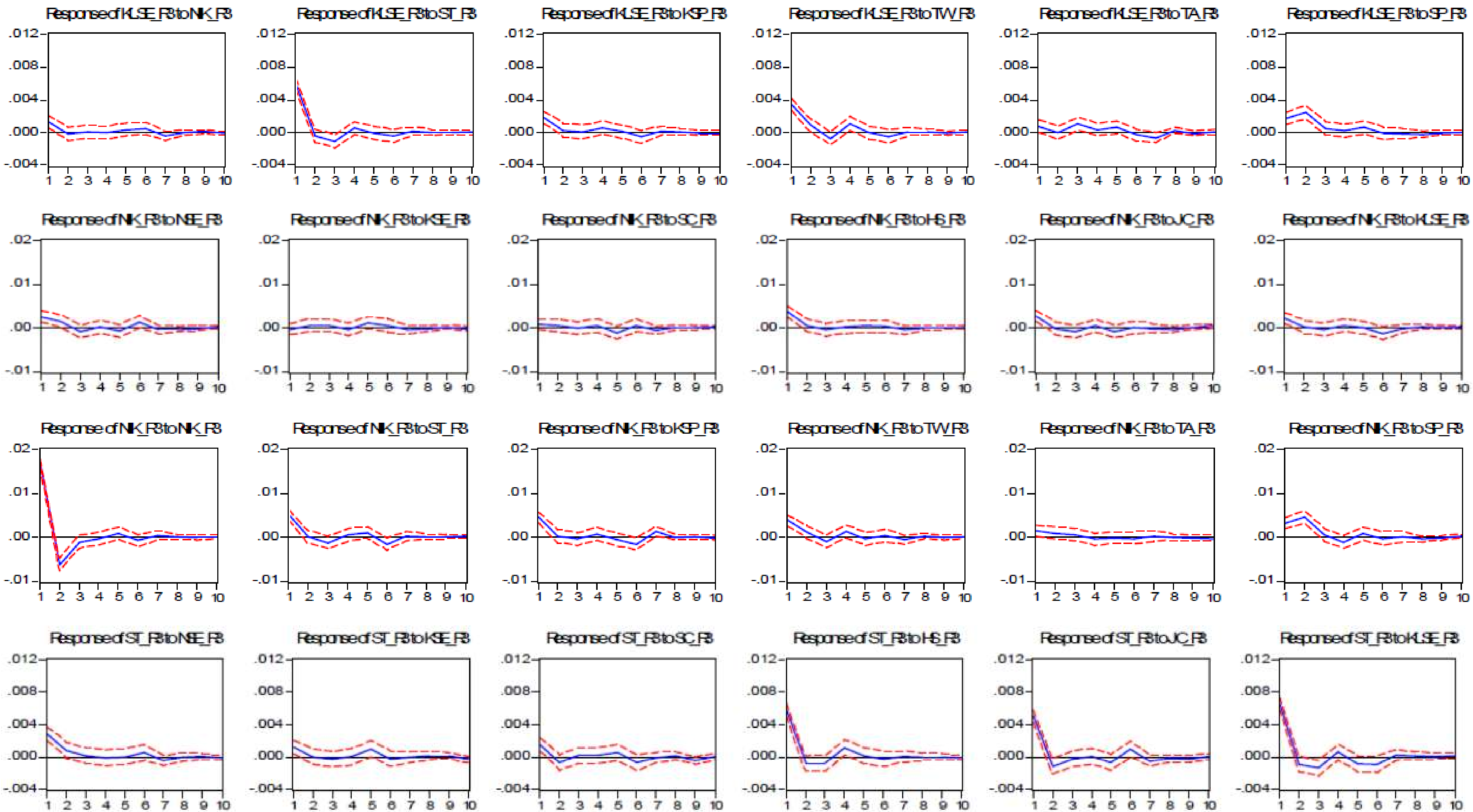


Response of KSE_R3 to NK_R3
Response of KSE_R3 to ST_R3
Response of KSE_R3 to KSP_R3
Response of KSE_R3 to TW_R3
Response of KSE_R3 to TA_R3
Response of KSE_R3 to SP_R3
Response of SC_R3 to NSE_R3
Response of SC_R3 to KSE_R3
Response of SC_R3 to SC_R3
Response of SC_R3 to HS_R3
Response of SC_R3 to JC_R3
Response of SC_R3 to KLSE_R3
Response of SC_R3 to NK_R3
Response of SC_R3 to ST_R3
Response of SC_R3 to KSP_R3
Response of SC_R3 to TW_R3
Response of SC_R3 to TA_R3
Response of SC_R3 to SP_R3
Response of HS_R3 to NSE_R3
Response of HS_R3 to KSE_R3
Response of HS_R3 to SC_R3
Response of HS_R3 to HS_R3
Response of HS_R3 to JC_R3
Response of HS_R3 to KLSE_R3

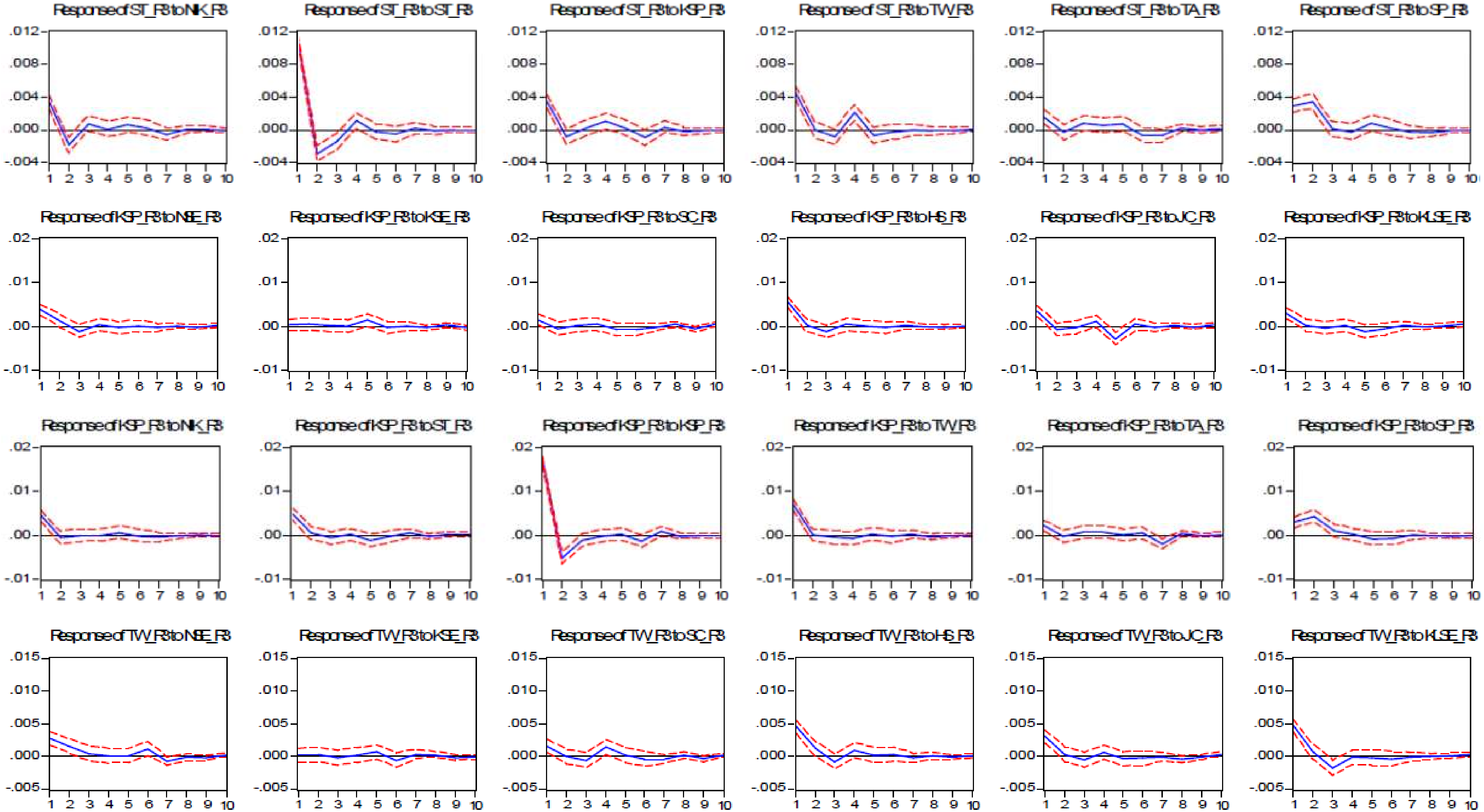
Cont...


Response of HS_R3 to NIK_R3
Response of HS_R3 to ST_R3
Response of HS_R3 to KSP_R3
Response of HS_R3 to TW_R3
Response of HS_R3 to TA_R3
Response of HS_R3 to SP_R3
Response of JC_R3 to NSE_R3
Response of JC_R3 to KSE_R3
Response of JC_R3 to SC_R3
Response of JC_R3 to HS_R3
Response of JC_R3 to JC_R3
Response of JC_R3 to KLSE_R3
Response of JC_R3 to NIK_R3
Response of JC_R3 to ST_R3
Response of JC_R3 to KSP_R3
Response of JC_R3 to TW_R3
Response of JC_R3 to TA_R3
Response of JC_R3 to SP_R3
Response of KLSE_R3 to NSE_R3
Response of KLSE_R3 to KSE_R3
Response of KLSE_R3 to SC_R3
Response of KLSE_R3 to HS_R3
Response of KLSE_R3 to JC_R3
Response of KLSE_R3 to KLSE_R3

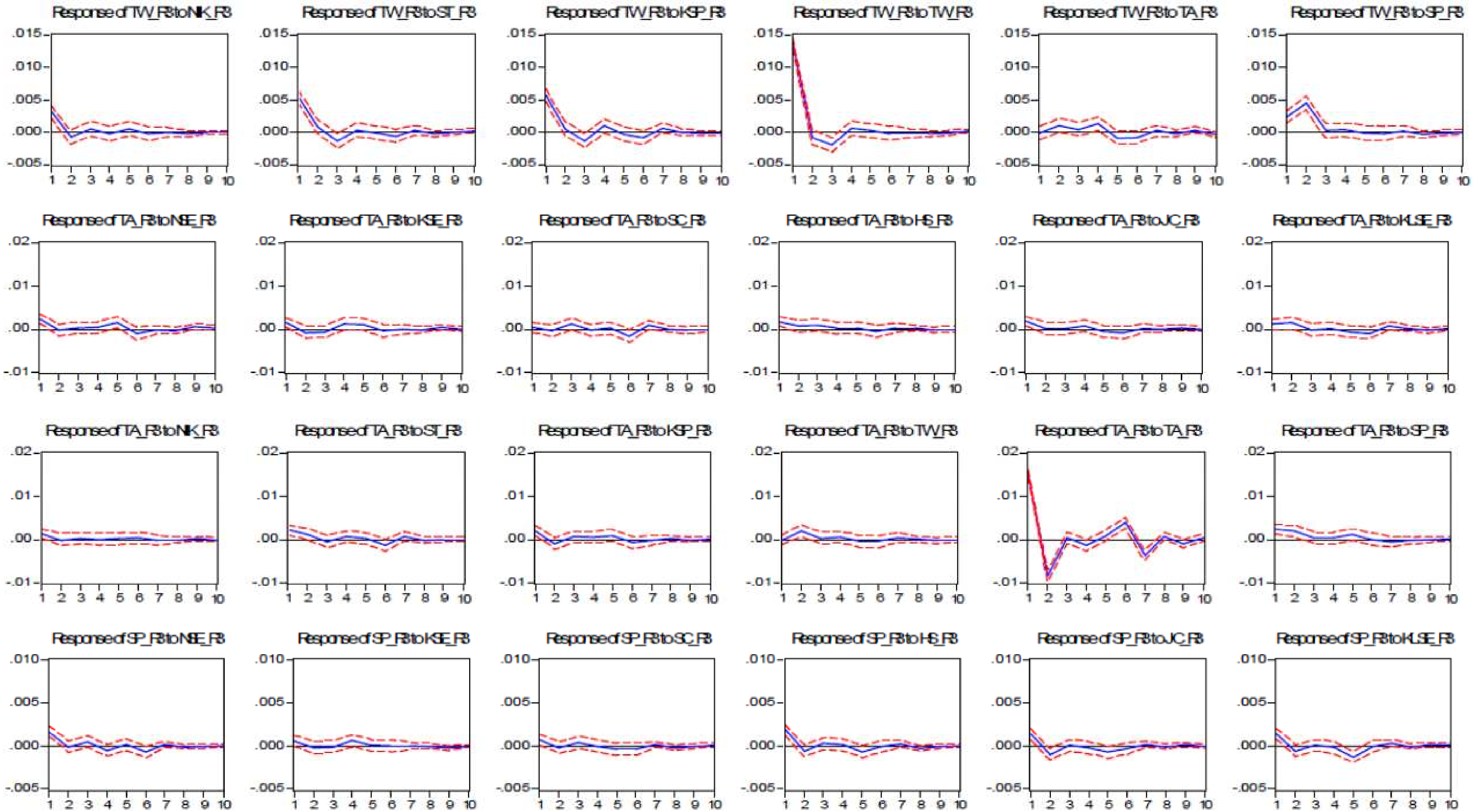
Cont...


Response of KLSE_R3 to NK_R3
Response of KLSE_R3 to ST_R3
Response of KLSE_R3 to KSP_R3
Response of KLSE_R3 to TW_R3
Response of KLSE_R3 to TA_R3
Response of KLSE_R3 to SP_R3
Response of NK_R3 to NSE_R3
Response of NK_R3 to KSE_R3
Response of NK_R3 to SC_R3
Response of NK_R3 to HS_R3
Response of NK_R3 to JC_R3
Response of NK_R3 to KLSE_R3
Response of NK_R3 to NK_R3
Response of NK_R3 to ST_R3
Response of NK_R3 to KSP_R3
Response of NK_R3 to TW_R3
Response of NK_R3 to TA_R3
Response of NK_R3 to SP_R3
Response of ST_R3 to NSE_R3
Response of ST_R3 to KSE_R3
Response of ST_R3 to SC_R3
Response of ST_R3 to HS_R3
Response of ST_R3 to JC_R3
Response of ST_R3 to KLSE_R3

Cont...


Response of ST_R3 to NK_R3
Response of ST_R3 to ST_R3
Response of ST_R3 to KSP_R3
Response of ST_R3 to TW_R3
Response of ST_R3 to TA_R3
Response of ST_R3 to SP_R3
Response of KSP_R3 to NSE_R3
Response of KSP_R3 to KSE_R3
Response of KSP_R3 to SC_R3
Response of KSP_R3 to HS_R3
Response of KSP_R3 to JC_R3
Response of KSP_R3 to KLSE_R3
Response of KSP_R3 to NK_R3
Response of KSP_R3 to ST_R3
Response of KSP_R3 to KSP_R3
Response of KSP_R3 to TW_R3
Response of KSP_R3 to TA_R3
Response of KSP_R3 to SP_R3
Response of TW_R3 to NSE_R3
Response of TW_R3 to KSE_R3
Response of TW_R3 to SC_R3
Response of TW_R3 to HS_R3
Response of TW_R3 to JC_R3
Response of TW_R3 to KLSE_R3

Cont...


Response of TW_R3 to NK_R3
Response of TW_R3 to ST_R3
Response of TW_R3 to KSP_R3
Response of TW_R3 to TW_R3
Response of TW_R3 to TA_R3
Response of TW_R3 to SP_R3
Response of TA_R3 to NSE_R3
Response of TA_R3 to KSE_R3
Response of TA_R3 to SC_R3
Response of TA_R3 to HS_R3
Response of TA_R3 to JC_R3
Response of TA_R3 to KLSE_R3
Response of TA_R3 to NK_R3
Response of TA_R3 to ST_R3
Response of TA_R3 to KSP_R3
Response of TA_R3 to TW_R3
Response of TA_R3 to TA_R3
Response of TA_R3 to SP_R3
Response of SP_R3 to NSE_R3
Response of SP_R3 to KSE_R3
Response of SP_R3 to SC_R3
Response of SP_R3 to HS_R3
Response of SP_R3 to JC_R3
Response of SP_R3 to KLSE_R3

Cont...

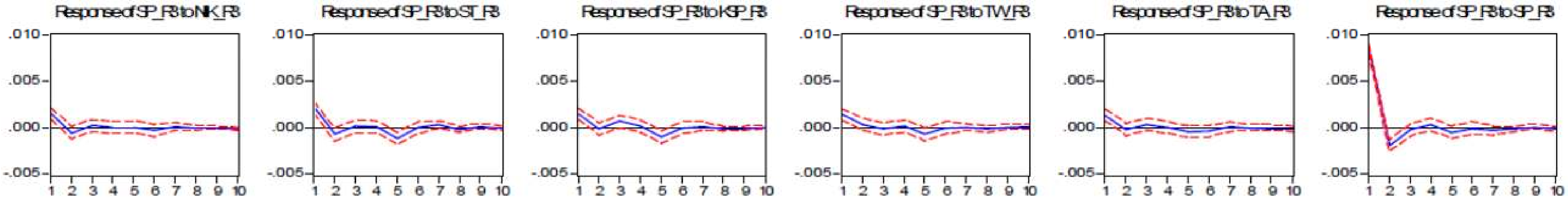
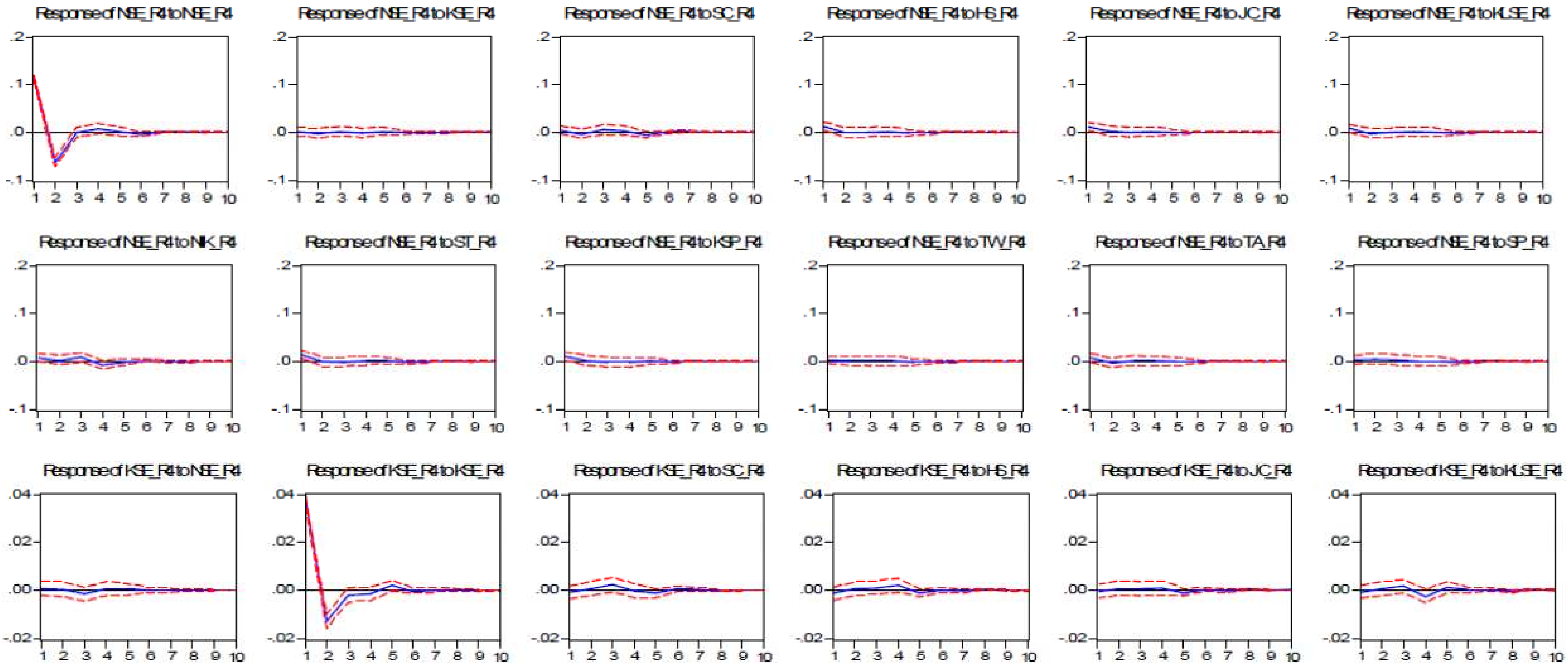

Response of SP_R3 to NIK_R3
Response of SP_R3 to ST_R3
Response of SP_R3 to KSP_R3
Response of SP_R3 to TW_R3
Response of SP_R3 to TA_R3
Response of SP_R3 to SP_R3
.010
.005
.000
-.005
1 2 3 4 5 6 7 8 9 10

Figure A4: Impulse Response Function (Period-4)



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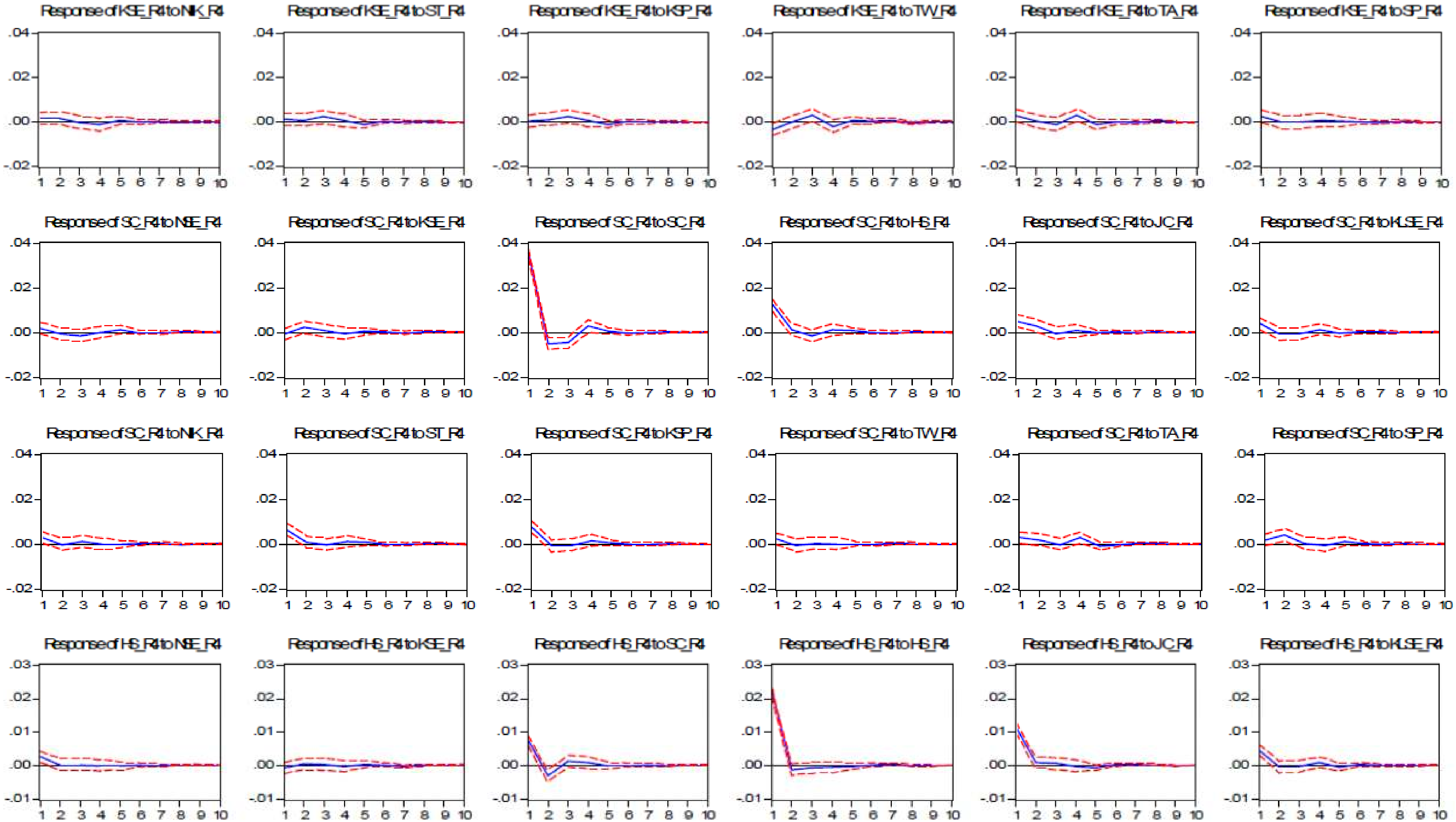
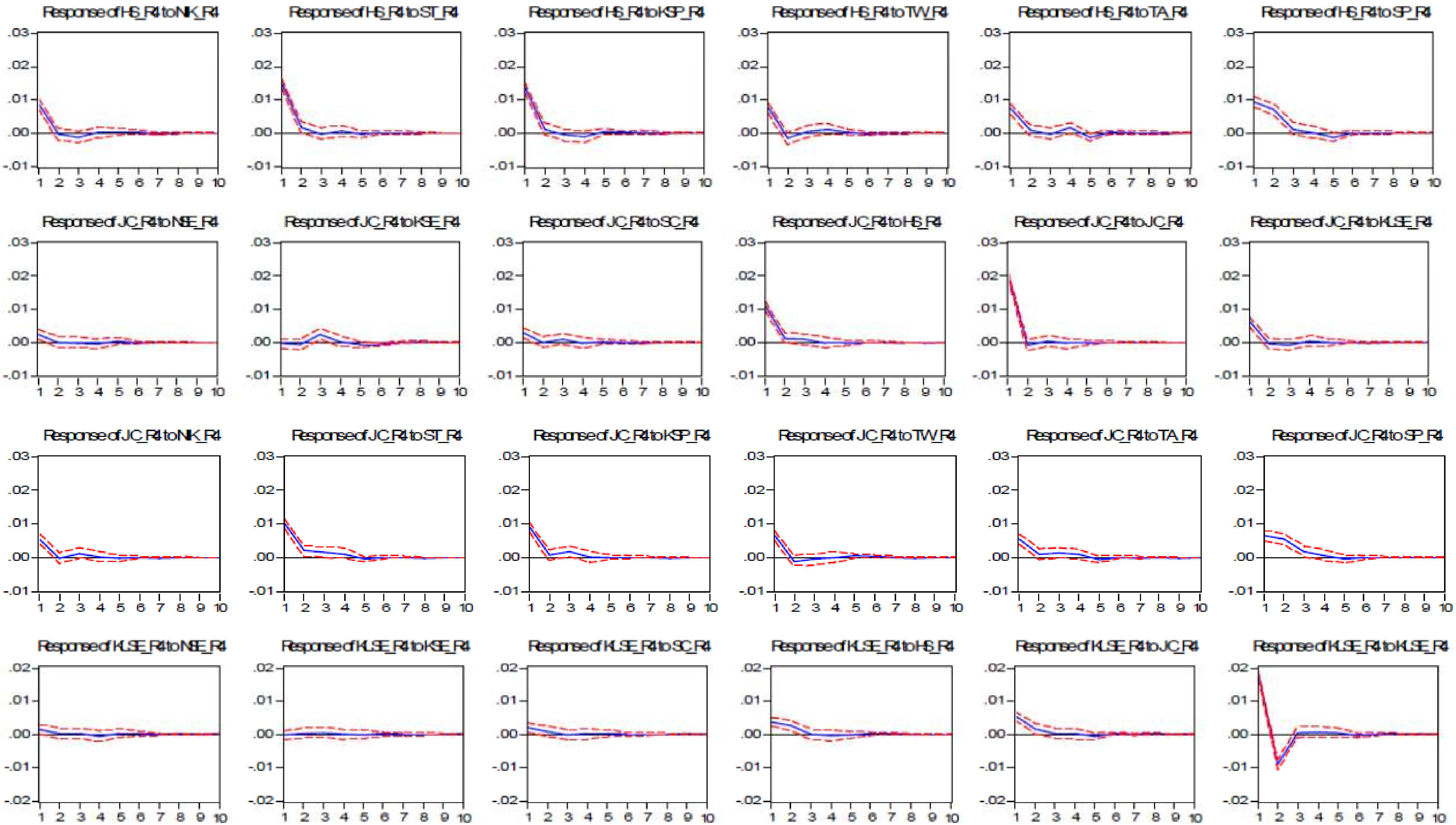
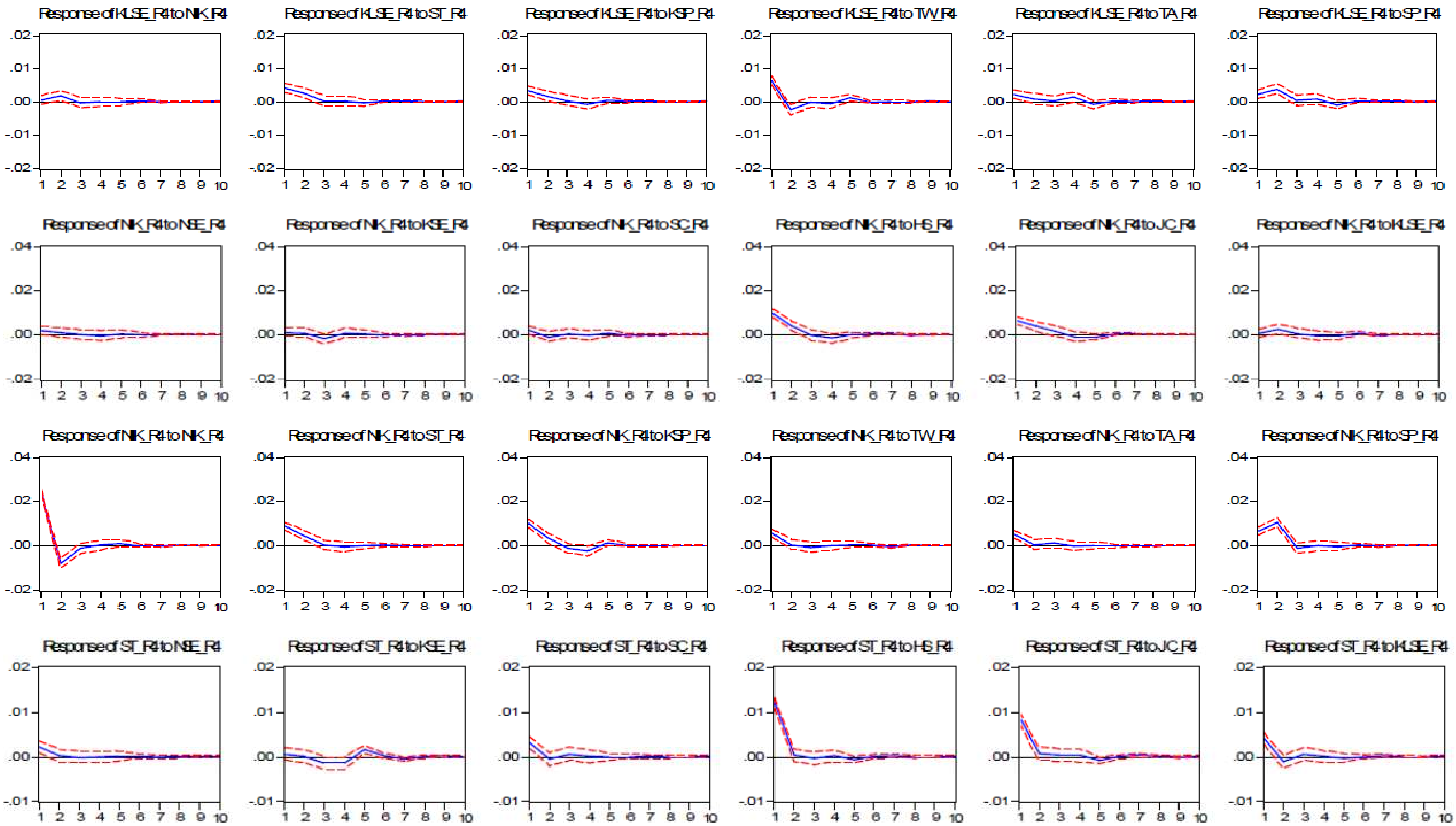

Response of KSE_R4 to NK_R4
Response of KSE_R4 to ST_R4
Response of KSE_R4 to KSP_R4
Response of KSE_R4 to TW_R4
Response of KSE_R4 to TA_R4
Response of KSE_R4 to SP_R4
Response of SC_R4 to NSE_R4
Response of SC_R4 to KSE_R4
Response of SC_R4 to SC_R4
Response of SC_R4 to HS_R4
Response of SC_R4 to JC_R4
Response of SC_R4 to KLSE_R4
Response of SC_R4 to NK_R4
Response of SC_R4 to ST_R4
Response of SC_R4 to KSP_R4
Response of SC_R4 to TW_R4
Response of SC_R4 to TA_R4
Response of SC_R4 to SP_R4
Response of HS_R4 to NSE_R4
Response of HS_R4 to KSE_R4
Response of HS_R4 to SC_R4
Response of HS_R4 to HS_R4
Response of HS_R4 to JC_R4
Response of HS_R4 to KLSE_R4

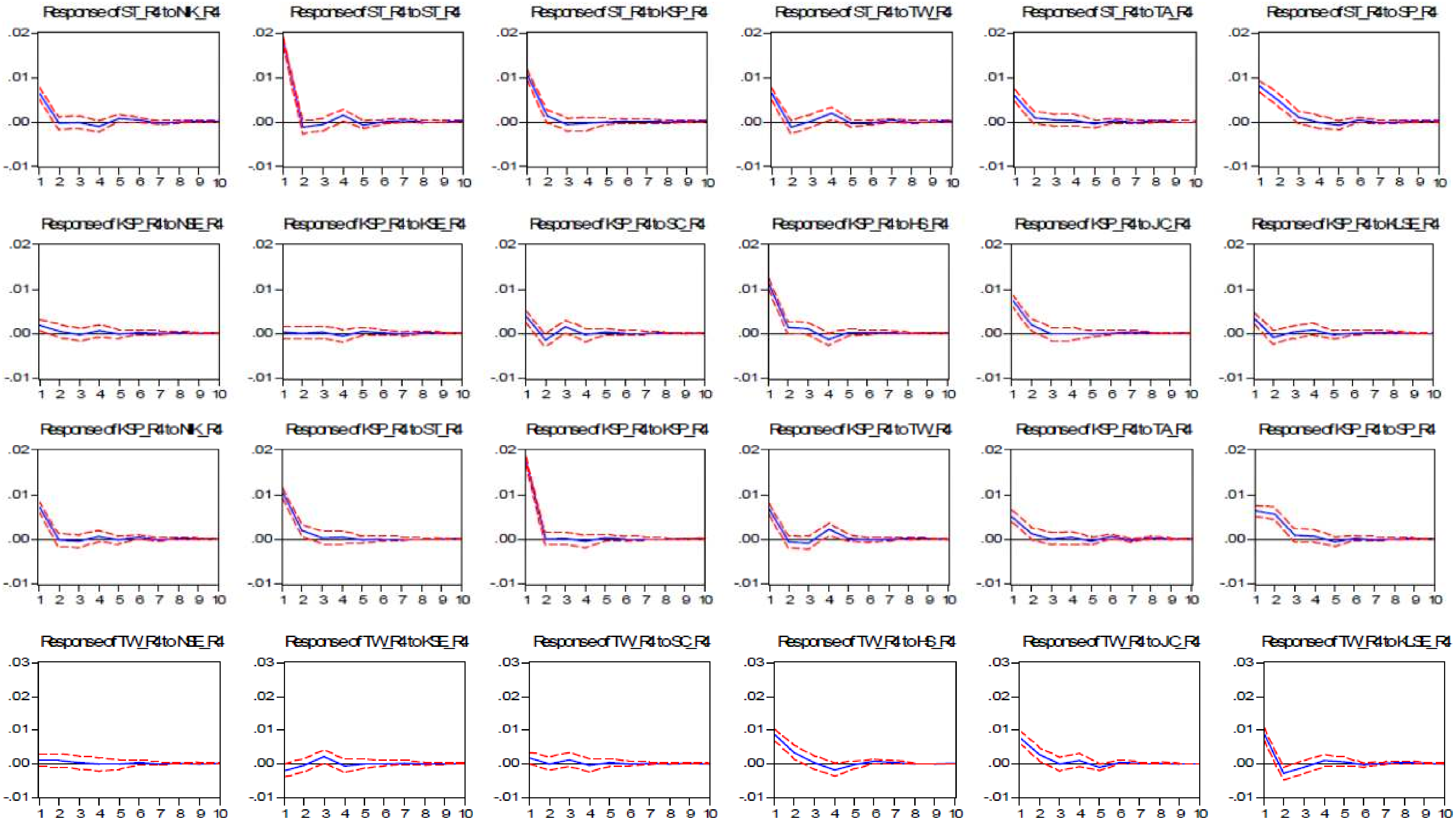
Cont...

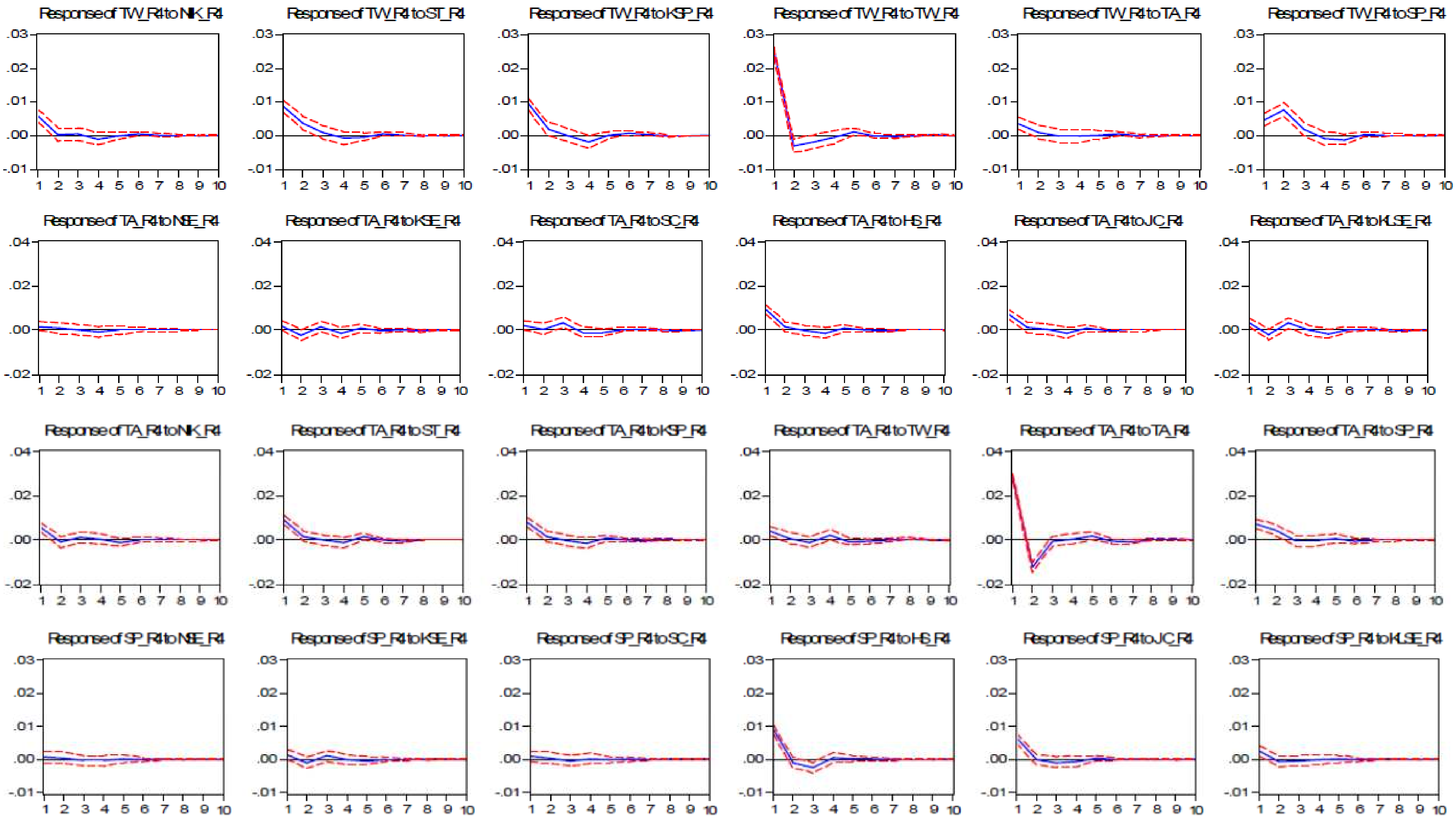

Response of HS_R4 to NK_R4
Response of HS_R4 to ST_R4
Response of HS_R4 to KSP_R4
Response of HS_R4 to TW_R4
Response of HS_R4 to TA_R4
Response of HS_R4 to SP_R4
Response of JC_R4 to NSE_R4
Response of JC_R4 to KSE_R4
Response of JC_R4 to SC_R4
Response of JC_R4 to HS_R4
Response of JC_R4 to JC_R4
Response of JC_R4 to KLSE_R4
Response of JC_R4 to NK_R4
Response of JC_R4 to ST_R4
Response of JC_R4 to KSP_R4
Response of JC_R4 to TW_R4
Response of JC_R4 to TA_R4
Response of JC_R4 to SP_R4
Response of KLSE_R4 to NSE_R4
Response of KLSE_R4 to KSE_R4
Response of KLSE_R4 to SC_R4
Response of KLSE_R4 to HS_R4
Response of KLSE_R4 to JC_R4
Response of KLSE_R4 to KLSE_R4

Cont...

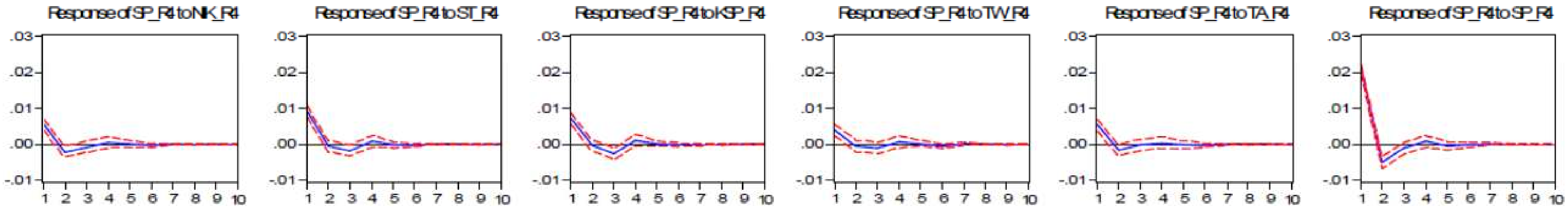

Response of KLSE_R4 to NIK_R4
Response of KLSE_R4 to ST_R4
Response of KLSE_R4 to KSP_R4
Response of KLSE_R4 to TW_R4
Response of KLSE_R4 to TA_R4
Response of KLSE_R4 to SP_R4
Response of NIK_R4 to NSE_R4
Response of NIK_R4 to KSE_R4
Response of NIK_R4 to SC_R4
Response of NIK_R4 to HS_R4
Response of NIK_R4 to JC_R4
Response of NIK_R4 to KLSE_R4
Response of NIK_R4 to NIK_R4
Response of NIK_R4 to ST_R4
Response of NIK_R4 to KSP_R4
Response of NIK_R4 to TW_R4
Response of NIK_R4 to TA_R4
Response of NIK_R4 to SP_R4
Response of ST_R4 to NSE_R4
Response of ST_R4 to KSE_R4
Response of ST_R4 to SC_R4
Response of ST_R4 to HS_R4
Response of ST_R4 to JC_R4
Response of ST_R4 to KLSE_R4

Cont...


Response of ST_R4 to NK_R4
Response of ST_R4 to ST_R4
Response of ST_R4 to KSP_R4
Response of ST_R4 to TW_R4
Response of ST_R4 to TA_R4
Response of ST_R4 to SP_R4
Response of KSP_R4 to NSE_R4
Response of KSP_R4 to KSE_R4
Response of KSP_R4 to SC_R4
Response of KSP_R4 to HS_R4
Response of KSP_R4 to JC_R4
Response of KSP_R4 to KLSE_R4
Response of KSP_R4 to NK_R4
Response of KSP_R4 to ST_R4
Response of KSP_R4 to KSP_R4
Response of KSP_R4 to TW_R4
Response of KSP_R4 to TA_R4
Response of KSP_R4 to SP_R4
Response of TW_R4 to NSE_R4
Response of TW_R4 to KSE_R4
Response of TW_R4 to SC_R4
Response of TW_R4 to HS_R4
Response of TW_R4 to JC_R4
Response of TW_R4 to KLSE_R4


Response of TW_R4 to NK_R4
Response of TW_R4 to ST_R4
Response of TW_R4 to KSP_R4
Response of TW_R4 to TW_R4
Response of TW_R4 to TA_R4
Response of TW_R4 to SP_R4
Response of TA_R4 to NSE_R4
Response of TA_R4 to KSE_R4
Response of TA_R4 to SC_R4
Response of TA_R4 to HS_R4
Response of TA_R4 to JC_R4
Response of TA_R4 to KLSE_R4
Response of TA_R4 to NK_R4
Response of TA_R4 to ST_R4
Response of TA_R4 to KSP_R4
Response of TA_R4 to TW_R4
Response of TA_R4 to TA_R4
Response of TA_R4 to SP_R4
Response of SP_R4 to NSE_R4
Response of SP_R4 to KSE_R4
Response of SP_R4 to SC_R4
Response of SP_R4 to HS_R4
Response of SP_R4 to JC_R4
Response of SP_R4 to KLSE_R4

Cont...


Response of SP_R4 to NIK_R4
Response of SP_R4 to ST_R4
Response of SP_R4 to KSP_R4
Response of SP_R4 to TW_R4
Response of SP_R4 to TA_R4
Response of SP_R4 to SP_R4
.03
.02
.01
.00
-.01
1 2 3 4 5 6 7 8 9 10