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Does Volatility Spillover among Sectors Varies from Normal to Turbulent Periods? Evidence from Pakistan Stock Exchange

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ABSTRACT

This study investigates how six financial market performances are affected by spillover volatility sectors in both during and following the 2007 financial crisis in Pakistan. By offering a wealth of material to fill in the gaps during the 2007 pre- and post-financial crisis timeframe, this study adds to the body of current knowledge. The pre-crisis era, which ran from January 1, 2003, to December 31, 2007, was used for the analysis on the Pakistani sectors. The period from January 1, 2008, to December 31, 2015, was known as the post-crisis era. The Pakistan Stock Exchange and other sources provided the data, which was routinely gathered. An ARCH, GARCH & EGARCH model is used to investigate the asymmetric volatility spillover among the six industries. The results provide compelling evidence for the existence of a spillover impact in Pakistani businesses in the years after the crisis. Furthermore, there is a significant transmission of volatility throughout Pakistan's many industries during the financial crisis. Overall, the results provide insight into the varying degrees of integration between sectors in Pakistan, ranging from stable to volatile eras. The results indicate that no significant vulnerability was detected. Additional elements can be included and the timing of data can be adjusted. In this study, data is currently gathered monthly. However, in the future, data might be collected on a daily, weekly, or yearly basis to enhance the reliability of the data and its corresponding conclusions. This study expands the existing body of research on volatility and spillover effects in several industries of Pakistan. This research is an innovative study being conducted in six market sectors. The primary impetus for conducting this inquiry is the financial catastrophe in the United States, which has had repercussions on global markets as a whole. Moreover, this time frame is also utilized to inspect the correlation in between financial crises and stock market returns in Asian emerging markets.

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1. Introduction

Since the 1930s Great Depression, the financial crisis of 2007–2008 was the most disastrous (Coudert, Hervé, & Mabille, 2015). This economic downturn transpired subsequent to the collapse of the American real estate industry precipitated by the market bubble, and insurance companies announced bankruptcy as a result of overpaying Lehman Brothers Bank and other entities with excessive claims. Pakistan was impacted by the repercussions of this financial crisis. The global business enterprises' investors, proprietors, and shareholders

incurred enormous losses because of the economic downturn. It results in numerous bankruptcies, as previously stated, and consequently, shareholder confidence and trust progressively diminished. Consequently, the investors divested their equities at extremely low prices in an effort to recoup their losses. This resulted in currency crises, high inflation, low GDP growth, and excessive lending in an excessive number of economies. All of these explain why the effects of spillovers within and between nations should be investigated. Similar to other nations worldwide, Pakistan was unable to evade the financial crisis of 2007. Prior to the onset of the crisis, Pakistan was plagued by severe political instability and macroeconomic instability imbalances (Tanveer Ahmed Shahid, Rahman, Sheikh, & Allahrakha, 2024).

The impact of a crisis and its subsequent ripple effects on global financial markets have garnered considerable interest from scholars and professionals in the field. Over the past two decades, this phenomenon has garnered considerable interest from researchers. This research applies the theory of equity valuation to determine whether future expected cash flows discounted to the sum of present stock prices are equal. The interdependence of economic sectors is such that any negative consequences that occur in one sector have a domino effect on the others. The primary conclusions drawn from prior research were that there is volatility contagion between sectors of the nation. The Pakistan Stock Exchange is an energy-strapped and underperforming exchange. It falls short of its objectives and has amassed over 45,000 points at its peak prior to its emergence. In addition, the country's currency has been depreciating steadily since 2015; consequently, the servicing and repayment of foreign debts further discourage investors from purchasing equities and shares (Minhas, Maqsood, Shahid, & Rehman, 2024). As the country's central bank, the State Bank of Pakistan, has continued to raise the policy rate, it has now established a policy rate of 7.50 percent for commercial bank transactions in an effort to alleviate inflationary pressure on the currency. As a result, the market has exhibited subpar performance subsequent to the government's dissolution. The spillover of volatility from the Pakistan Stock Exchange to its sector-specific returns prior to and subsequent to the 2007 crisis. The nature of the study is distinctive in that no prior investigation had explored this void. Upon conducting an analysis of the research literature, it becomes evident that scholars have authored a substantial body of work catering to developed and advanced nations. An examination of the correlation between information availability and stock volatility in Saudi Arabia during the day and night by Alsubaie and Najand (2009) led to the conclusion that transaction volumes are accurate predictors of volatility (Tanveer Ahmad Shahid, Zafar, & Minhas, 2023).

An investigation was conducted by Javed and Ahmed (1999). It was discovered that the explosions were substantial in weight and promoted an overall decline in growth. Nonetheless, they had a generally favourable effect on investors, as the stock markets of both nations expanded in the months that followed. An ARCH Model was employed to examine this phenomenon. In a study conducted by Miyakoshi (2002), the EGARCH and GARCH models were examined to determine whether a change in information volume affects market volatility. Ashraf Hameed and Hameed examined the effects of the September 11th terrorist attacks on the United States and the Karachi Stock Exchange at the time. These incidents were discovered to have decreased the volatility of stock returns in Pakistan.

1.1. Gap in research

Upon conducting an analysis of the research literature, it becomes evident that scholars have authored a substantial body of work catering to developed and advanced nations. In their study, S. P. Hussain and Harris (1998) employed a G.A.R.C.H. Model to assess market volatility in anticipation of the Islamic holy month of Ramadan. An examination of the correlation between information availability and stock volatility in Saudi Arabia during the day and night by Alsubaie and Najand (2009) led to the conclusion that transaction volumes are accurate predictors of volatility. It was discovered that the explosions were substantial in weight and promoted an overall decline in growth. Nonetheless, they had a generally favourable effect on investors, as the stock markets of both nations expanded in the months that followed. An ARCH Model was employed to examine this phenomenon (Maqsood, Shahid, & Rehman, 2024). In a study conducted by Miyakoshi (2002), the EGARCH and GARCH models were examined to determine whether a change in information volume affects market volatility. Ashraf Hameed and Hameed examined the effects of the September 11th terrorist attacks on the United States and the Karachi Stock Exchange at the time. These incidents were discovered to have decreased the volatility of stock returns in Pakistan. All of these studies, as well as numerous

others, were consulted in order to determine whether or not there are any studies that Analyze the effects of the financial crisis of 2007 on the volatility contagion of Pakistan's sectors. As far as we are aware, not a single study was discovered. Hence, in order to address this deficiency in the existing literature, we shall conduct this investigation.

1.2. Objective of the Research

The purpose of this study is to look into the effects of asymmetric volatility contagion that existed both before and after the financial crisis of 2007. The asymmetric volatility spillover model, known as the Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model, is being used to study the phenomena.

1.3. Scope of the Research

1. Determine whether a volatility risk existed prior to and subsequent to the 2007 financial crisis.
2. Determine whether volatility contagion occurred concurrently across the various economic sectors of Pakistan.
3. Ascertain whether the EGARCH model is pertinent to the Pakistani economy in the same way that it fails to perform.

1.4. Questions of Research

1. Is there a risk of volatility during and following the 2007 financial crisis?
2. Was the volatility perceptible across various segments of Pakistan, if it indeed existed?
3. To what extent does the EGARCH Model effectively ascertain the internal sectors of Pakistan?

1.5. Importance of the Research

Finance consistently prioritizes strategies to enhance the wealth and contentment of shareholders. The novice investor, who possesses greater technological and intellectual acumen, seeks low risk and high returns. Volatility is a characteristic of all stocks and shares, although it can differ depending on the management's policies. Diverse corporations exhibit varying degrees of volatility. Any international event that occurs will affect the stock market. There are crises comparable to the 1997 Asian tsunami, the 1930s Great Depression and the 2007 financial crisis. Each of these factors exerts a distinct momentum and altitude of influence on the stock markets. Prior investigations were conducted to elucidate and interpret analogous associations in other developed markets. Pakistan is undeniably an emerging market, which consequently introduces a multitude of variables that influence its microstructure and economy. As a result, it was imperative to ascertain the degree to which Pakistan's stock exchanges react to global crises and changes. This research will additionally facilitate the examination of the spillover effects in other emerging markets by the scientists. In addition, the study will detail the strategies employed by companies that managed to avert the crisis, as well as provide recommendations for professionals and practitioners interested in mitigating this volatility contagion effect.

The completion of the study's results will augment the corpus of knowledge and make a contribution to the finance literature. The volatility contagion effect before and following the 2007 financial crisis is examined for the first time in the context of Pakistan in our study. All of these studies, as well as numerous others, were consulted in order to determine whether or not there are any studies that Analyze the effects of the financial crisis of 2007 on the volatility contagion of Pakistan's sectors. As far as we are aware, not a single study was discovered. Hence, to address this deficiency in the existing literature, we shall conduct this investigation.

1.6. Spillovers of Volatility in Pakistan

In the finance literature, the reconciliation of securities exchanges has been analyzed in great detail as an aspect of the stock market. Cheng and French (2000) define securities exchange incorporation as "the state in which stock markets engage in reciprocal and enduring associations." Potential expansion opportunities for financial specialists would be eradicated, according to Jebran (2018), if securities exchanges were coordinated. Similarly, when faultless money-related joining occurs, speculators are unable to generate profits via arbitrage opportunities, according to Abbes and Trichilli (2015). Financial experts must therefore have a comprehensive understanding of the coordination mechanisms employed by securities

exchanges so that they can make well-informed judgments concerning universal portfolios. The significance of investigating the integration of financial markets prompted a large number of researchers to explore potential industry-wide development opportunities. Examining reconciliations of newly established value markets comprises the vast majority of assessments. as precise confirmations demonstrate that Islamic stock records exhibit favourable performance and present potential growth advantages in both tranquil and tumultuous periods (Abbes & Trichilli, 2015; Qureshi, Ahmad, Ullah, & ul Mustafa, 2023; Saiti, Bacha, & Masih, 2014).

Several distinct characteristics of Islamic stock records, such as the capacity to elude economic downturns, contribute to their exceptional performance. Specific attributes that were previously alluded to may reduce the danger posed by an Islamic product. There is a prevailing argument that the attributes of conventional securities differ from those of Islamic equities, owing to the former's dependence on Islamic Shariah principles. As such, the idea of the risk-return trade-off will likewise be unique, and it is crucial to look at the possible avenues for conventional and Islamic list enhancements. A study Peca Amaral Gomes, Kyriazis, Schwinger, Montagne, and Zhand (2023) indicates that Abu Dhabi, a nation adjacent to Dubai, has put forth a proposition to allocate an extra $10 billion for debt management purposes. Amid that specific temporal interval, Dubai acquired a financial liability amounting to $59 billion, whereas the worldwide obligation exceeded it by a magnitude of ten. The consequences of the 2008 US mortgage crisis that extended to our continent (2010) were profound for countries that supplied oil, including Dubai. Due to this cascading effect, portfolio interest in the Dubai financial market fell by 42%; Dubai also experienced a 2009 crisis of internal debt. Five out of a total of four financial crises (1958, 1974, 1979, 1997, and 2008) had a substantial impact on the economy of Pakistan. Additionally, internal factors significantly impacted the economy of Pakistan (Draz, 2011). Furthermore, research showed that Pakistan's economy was impacted by the global financial crisis of 2008 (Xin, Bin Dost, Akram, & Watto, 2022). Attari and Safdar (2013); KARIM et al. (2009); Mushtaq, Zia ur Rehman, Ali Shah, and Murtaza (2011) among others, have investigated the specific coordinate relationships through which the stock markets of Pakistan were impacted by the world economic downturn. The impact and interrelationships of volatility contagion in India and twelve developed and emergent Asian markets. Volatility spillover was observed in one American nation, five ASEAN nations, and one Japanese nation (KARIM et al., 2009). It was determined that the mean and volatility transmission effects of the Japanese securities exchange are less pronounced than those of the United States securities exchange on ASEAN securities exchanges.

2. Literature Review

2.1. Volatility Definition

In order to determine the spread in proximity to the average return of a security, volatility is utilized. Standard deviations can also be employed to assess volatility, providing insight into the degree to which the value of a stock is concentrated around its mean or moving average (MA). A standard deviation that is undersized indicates that the prices are densely clustered, while one that is excessive indicates that the prices are extended separately. Volatility is another instrument utilized to assess the likelihood of future price fluctuations or asset return turbulence. With respect to the variables that limit volatility, there are two viewpoints. According to one researcher, it is determined exogenously by unidentified factors that are linked to the returns of assets. Countries that are highly interconnected and dependent on one another in a global market are impacted by the free and rapid flow of capital; therefore, a recession in the economy of one nation can rapidly spread to other connected nations (Abro, Ul Mustafa, Ali, & Nayyar, 2021; Dymski, 2005; T. Hussain, Maitlo, Raza-ul-Mustafa, & Mujahid, 2022).

When discussing the characteristics of volatility spillovers, Mulyadi mentions two strategies: simultaneous volatility spillover and aggressive spillover. These are the two methods utilized in his work titled to volatility spillover that typically occurs when stock markets remain stationary during trading time in the same region on the same day. Therefore, in markets where trading is to occur, market information must be transmitted the same day. Because investors can easily make a decision that will cause a significant upheaval in the capital market by relying on such information. Dynamic volatility spillover, in the interim, refers to volatility spillover that may occur between capital markets in various regions. Discrepancies in time-trading are attributed to the initial and final times of the transaction. One security market commences trading at a time when all others have ceased or are nearing their closing

periods. As a result, information from one capital market will influence the other on the subsequent trading day (Anwar & Mulyadi, 2009).

2.2. Definition and Measuring of Volatility

The volatility in the context of financial markets refers to the increase in return on assets, with an expansion encompassing all potential outcomes of an uncertain variable. Volatility can be quantified in statistics through the utilization of standard deviation or variance (Poon & Granger, 2003). The second attribute of the sample can be mathematically depicted using standard deviation statistics or other distribution-free constraints. To obtain cumulative probability substance and probability hardness systematically or logically, they must be combined according to a specific distribution. Additionally, the volatility carryover anticipated in a sequence consists of the stream's unconfirmed discrepancy (Mossin, 1966), which creates an essential exchange between return and risk. Consequently, the majority of studies frequently substitute the variance of return on assets for market volatility. An investigation by Fayyad (2013) looked at the features that set developed markets apart from emerging ones, using standard deviation to replace market volatility to provide a more thorough picture of the two. The researchers determined the dollar return difference between developing and emergent markets by calculating the average standard deviation: 34.8% for the former category of markets and 19.8% for the latter, in terms of return. While the application of "standard deviation" as an approximation for the volatility of security markets is quite permissive, there are discernible constraints (Engle, 1982). Moreover, this limitation causes the volatility model that was anticipated to be softened to collapse (Bini-Smaghi, 1991). Furthermore, it is worth noting that time series data are more susceptible to heteroscedastic errors, which is a substantial concern, compared to cross-sectional data (Darrat, Amyx et al. 2010). Time was of the essence in identifying the significant instruments for determining volatility in light of the aforementioned constraints. Shiller (1980) established that increasing the standard deviation (SD) was the foundation for investigating volatility and expanding volatility tests. This is an example of a variance rebound test. The intricacy of the methods employed to manipulate volatility has been further complicated by the collaborative investigation of stock and capital market volatility. In lieu of relying on standard deviation volatility measures, econometric techniques are being employed to construct the conditional variance. There are two distinct categories of provisional heteroscedastic models. The initial category is referred to as the ARCH class, which specifies precise functions for calculating the progression of time. Conversely, the supplementary class utilizes a stochastic equivalence as an example. This classification aligned with the stochastic volatility (SV) model (Tsay, 2002).

2.3. Effect of Spillover

This study utilizes the spillover effect to examine how the dissemination of information influences the volatility of assets in a reciprocal fashion. Consequently, two explanations are employed: "Return spillover outcome" refers to a situation in which even marginal fluctuations in returns on a single market have an impact on the returns on an alternative market. As a result, this study posits that spillover effects may manifest diagonally in returns (return spillovers), followed by volatility (volatility spillovers), with the spillover culmination concentration fluctuating over time. A subsequent crisis distress is attributed to the escalation in volatility and return spillover, or "explosion in spillover." This is akin to contracting an infection. As stated by Forbes and Rigobon (2002), the conditional correlation coefficient may increase subsequent to the occurrence of a disaster by scrutinizing studies that employed this methodology to examine infections. This argument provided support for the aforementioned position. This is typically the result of increased market volatility and not any unqualified correlation between markets. For this reason, a rise in the cross-market correlation coefficient is a biased measure, making it challenging to establish whether the outcome is infectivity or overflow across markets.

2.4. Spillovers of Volatility between the Islamic and Conventional Stock Markets

Interest has been piqued as the ethical implications of Islamic speculative products have become more widely recognized. The primary emphasis is placed on conducting a thorough analysis of the dependability and accuracy of the Islamic financial market (Elgari, Siddiqi, & Zarqa, 1993; Khan & ur Rehman, 2018). After this preliminary speculative trend, a subsequent particular trend emerged concerning common assets. In recent decades, the implementation of more sophisticated approaches to oversee Islamic research to ensure its smooth functioning

has increased. Furthermore, the quantity of empirical profundity is exceedingly restricted (T. Hussain et al., 2022). The limited attention given to Islamic files in comparison to the extensive research conducted on conventional files can be attributed to the prevailing perception of these databases (Xiang, Shaikh, Tunio, Watto, & Lyu, 2022). In light of the speculator's objective of maximizing returns at a given level of risk, voluminous research on Islamic corporations has established a correlation between the CAPM and alpha and beta, as described in the file by Jensen (1968); Treynor (1965), respectively.

Our perceptive observation has led us to partition this concept into two distinct components. Standards are assessed against a sample of Islami files by the primary assembly. These examinations have been the most exceptional thus far. Prior studies have implemented benchmark risk wages in prominent nations, the final category of research studies is implemented. In contrast to scholarly inquiries concerning the financial performance of conventional securities exchange records, the observational literature analysing the volatility of Islamic records is largely unexplored. Prior research has solely investigated the minute-by-minute initial disparity between the two markets (Albaity, Mallek, Bakather, & Al-Tamimi). In recent months, the quantity of scholarly articles devoted to the administration of Islamic indices has increased. These analyses have made use of accepted practices. Using the Multifractal de-inclined vacillation research approach (MF-DFA), a study was undertaken by Rizvi, Dewandaru, Bacha, and Masih (2014) to examine the co-development of conventional and Islamic value advertisements across Pacific Asia and the United States. By utilizing wavelet disintegration, the researchers were able to discern the existence of multiple skylines within the co-development. By employing a non-straight-gauging technique known as the nearest neighbor (NN), Alvarez-Diaz et al. (2014) examined, which consists of two items. The investigators, assess the productivity level of Islamic lists through the implementation of multi-fractal drifted vacillation analysis (MF-DFA). They accomplish this by utilizing an instance of Islamic securities documented in the USDJIM file spanning sixteen years, commencing in 1996 (Watto, Monium, Qurban, & Ali, 2020).

3. Methodology

3.1. Data set

The objective of this research is to examine the financial market returns witnessed volatility contagion across sectors in Pakistan prior to and following the 2007 financial crisis. The returns on the stock markets of six major sectors were utilized in this empirical study. This study uses monthly stock market data to provide a more thorough examination than what is possible with weekly and daily data sets. Monthly financial data about the stock market is available for the entire year. Two sub-periods are also distinguished within the financial market data set: before the crises in 2007 and after the crises in 2007. The primary reason for devoting this period to investigation is the US financial crisis and its subsequent impact on global markets as a whole. Likewise, this time frame is scrutinized in Asian emerging markets to elucidate the correlation between stock market returns and financial crises. Current study prolonged the post-periods by an additional six years due to the fact that market correlation is continuously assessed, as stated by Li and Giles (2015). The information was obtained from the PSX, or Pakistan Stock Exchange.

3.2. Population and sample size

The population of a scientific study refers to a substantial group of individuals or objects that are the primary subject of investigation (Akram, Li, Anser, Irfan, & Watto, 2023). Investigative efforts have been undertaken in an effort to resolve the issue pertaining to this demographic. However, due to the magnitude of the population, it is unfeasible for the researcher to gather information on every individual. It is costly and time-consuming.The purpose of conducting research inquiry is to benefit the population in question. For this purpose, a sample is chosen from the population (Almaida, Abbas, Watto, Asdullah, Fahlevi, & Ichdan, 2024). In general, "sample" denotes the subset of the accessible population that is being discussed. The theory of samples is formulated as a result of the impracticability of testing the entire target population. A sample must be as representative of the population as possible for results to be obtained in the most generalizable manner. The researcher is only able to conduct the study with the assistance of the sample, and these findings have been extrapolated to the entire population. A researcher selects a sample from the population and then proceeds to the results. To investigate a particular facet of individual behaviour, it is not feasible to gather information about the entire population. In general, information is gathered

from a reduced number of target pupations. Results can be extrapolated to the entire population if the sample is representative (Almaida et al., 2024).

3.3. Temporal span

This empirical inquiry encompasses the fiscal year 2003 and concludes in 2015. This analysis employs time series data as followed by Xiang et al. (2022).

3.4. Research Framework

This research investigates the correlation between volatility contagion and financial market return across sectors in Pakistan both before and after the world financial crisis in 2007. This study aims to investigate the degree to which financial market returns in Pakistan both before and after the 2007 financial crisis exhibit volatility spillover across sectors. Financial data, including stock market returns and exchange rates, has a problem. When analyzing financial data, the mean does not exhibit a consistent value and demonstrates significant volatility relative to the corresponding period. Certain unique characteristics associated with stock market return. As a result, it is favorable to comprehend these facts and subsequently apply their model in accordance with the circumstance. When examining content spillover between two series, one assumption is made: that content spillover exists between those series. This presumption is false. Consequently, correlation and the GARCH model for estimation are insufficient.

3.5. The purpose of the Autoregressive Conditional Heteroscedasticity (ARCH) and Heteroscedasticity (EGARCH) models is to examine the volatility spillover.

Equation 1:

$$R_t = B_1 + BR_{t-1} + \psi R_{t-1\ (stock\ indices)} + \varepsilon_t$$

The EGARCH model can be seen in action in Equations (1) and (2). To measure the stock market index's compounding returns, use the variable Rt. It remains in the equation as a persistent. The stock index is used to evaluate the impact of lags on returns using beta. A "spillover return" is the return that percolates into the underlying sector from the stock indexes.

Equation 2:

$$R_t = \gamma_0 + \gamma_1 h_{t-1} + \left|\frac{\partial_t - 1}{\sqrt{h_{t-1}}}\right| + \varphi i \frac{\partial_t - 1}{\sqrt{h_{t-1}}} + \gamma_2 h_{t-1\ (\text{ðvolatility residuals of stock indices})} + \partial_t$$

Equation (2) quantifies the asymmetric outcome of volatility, explains how volatility responds to shifts in crisis news, and uses ln Rt to represent the logarithm of the variance of the stock market. It also shows the task related to volatility in order to make its consistency clear.

4. Results and Discussion

4.1. Prior to a Crisis

4.1.1. Descriptive Analysis

Based on the descriptive statistics of pre-crisis data mentioned earlier, the kurtosis value for the automobile industry is below 3, indicating that the data is negatively biased. The kurtosis value for the cement industry is below 3, indicating that the data in this sector is negatively distorted. The kurtosis value for the chemical industry is 2.811753, which is less than 3, indicating that the data in this industry is negatively distorted. The food and care items category's kurtosis score is larger than 3, indicating a positive bias in the data. There is a negative distortion in the data related to this industry because the value of sugar and related products is 2.426726 units below the essential value of 3.

Table 1

	AUTOMOBILE	CEMENT	CHEMICAL	FOOD	SUGAR_	TEXTILE
Value of Mean	0.0355	0.0182	0.0172	0.0199	0.0099	0.0123
Value of Median	0.0183	0.0088	0.0001	0.0079	0.0002	-0.0123
Maximum	0.199	0.2899	0.3200	0.2599	0.2600	0.2799

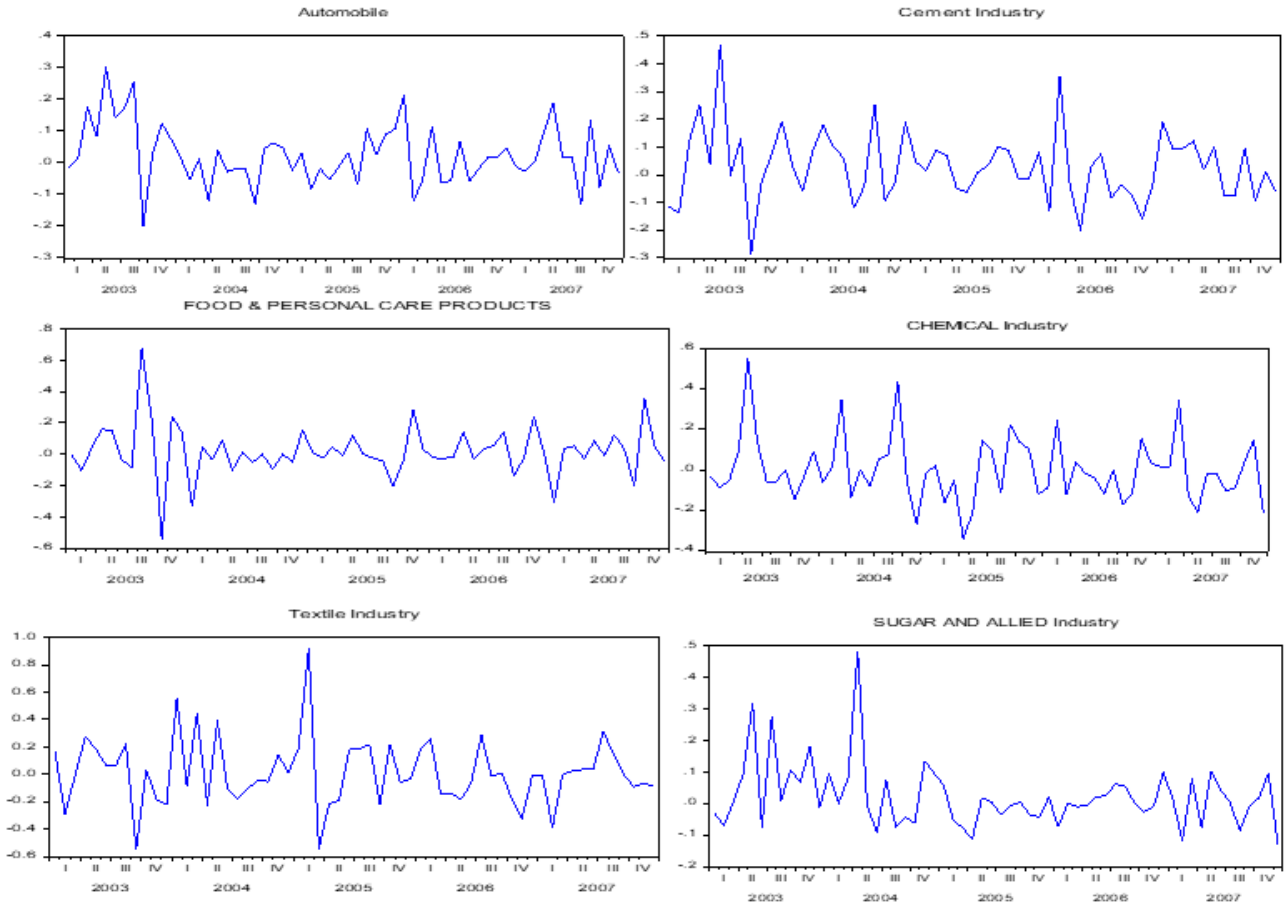
Value						
Minimum Value	-0.1934	-0.2300	-0.1999	-0.1599	-0.2087	-0.2195
Standard Deviation (S.D)	0.1322	0.1400	0.1309	0.1124	0.1309	0.1299
Skewness	0.1399	0.1309	0.4709	0.4799	0.1499	0.3500
Kurtosis	2.518935	2.221776	2.811753	3.262204	2.426726	2.711854
Jarque-Bera (J.B)	8.0912	14.0240	21.1234	25.0098	6.9908	14.9012
Probability	0.0300	0.0020	0.0012	0.0013	0.0200	0.0015
Sum	16.0987	9.9876	11.0098	14.0098	4.9987	6.0987
Sum Sq. Dev.	8.0015	12.7230	9.9876	5.9934	9.0023	11.0320
Observations	599	599	599	599	599	599
ADF Test	-39.8036***	-41.1621***	-31.0945***	-40.5822***	-26.7539***	-32.3603***
PP Test	-40.2451***	-39.3073***	-35.863***	-39.6572***	-30.3325***	-31.3276***
Arch Test	17.654***	30.1096***	335.765***	141.7482***	150.2573***	155.2783***

Note: The tests of stationarity are known by their respective acronyms: the enhanced Dickey and Fuller test (ADF) and the Phillips Perron test (PP). A data set's potential for including the ARCH effect can be ascertained using the Arch test. Before the crisis, which began on January 1, 2003, and ended on December 31, 2007, there was a post-crisis period that ended on December 31, 2015. Significance at 1% is indicated by ***.

4.1.2. Unit Root Test (URT)

The Unit Root is utilized in order to assess the stationarity of data. Utilizing the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests, the stationarity of continuous compounding returns prior to the crisis was examined. Both the 5% and 10% significance levels for the t-statistic values show statistical significance, according to the table that is shown. Because the values are all less than 0.05 in each example, the probabilities of both tests are considered extremely significant. The car data series is therefore shown to be stationary and free of unit roots, thereby rejecting the null hypothesis of both tests.

Figure 1



4.2. Post Crisis Analysis

4.2.1. Descriptive analysis

Monthly return series in the pre-crises period

Table 2

	AUTOMOBILE	CEMENT	CHEMICAL	FOOD	SUGAR_	TEXTILE
Value of Mean	0.0038	0.0032	0.0055	0.0067	0.0076	-0.0023
Value of Median	0.0065	0.0032	-0.0088	0.0001	0.0090	0.0021
Maximum value	3.0987	0.8902	0.9609	2.0007	0.9708	1.9980
Minimum value	-1.9987	-2.0098	-0.7890	-3.009	-0.6623	-0.7986
Standard deviation (S.D)	0.1700	0.1680	0.1987	0.2134	0.1399	0.1702
Skewness	-0.1299	-0.1209	0.2399	-3.9990	0.2511	-0.1234
Kurtosis	69.30902	8.817856	7.970685	38.74716	7.812429	2.382533
Jarque-Bera	16999.6	1301.876	900.876	5609.123	834.098	1200.09
Probability	0.0002	0.0002	0.0001	0.0003	0.0002	0.0001
Sum	6.9987	5.2345	5.6789	5.8765	6.0987	2.3456
Sum Sq. Dev.	28.0091	25.5240	30.0086	40.1234	21.3456	27.8901
Observations	1010	1010	1010	1010	1010	1010
ADF Test	-42.3267***	-40.2512***	-39.2178***	-21.873***	-34.0854***	-30.3256***
PP Test	-41.4376***	-42.2693***	-35.5738***	-36.4628***	-31.9738***	-36.5835***
Arch Test	49.9043***	229.4761***	13.5487***	86.2784***	57.276***	54.549***

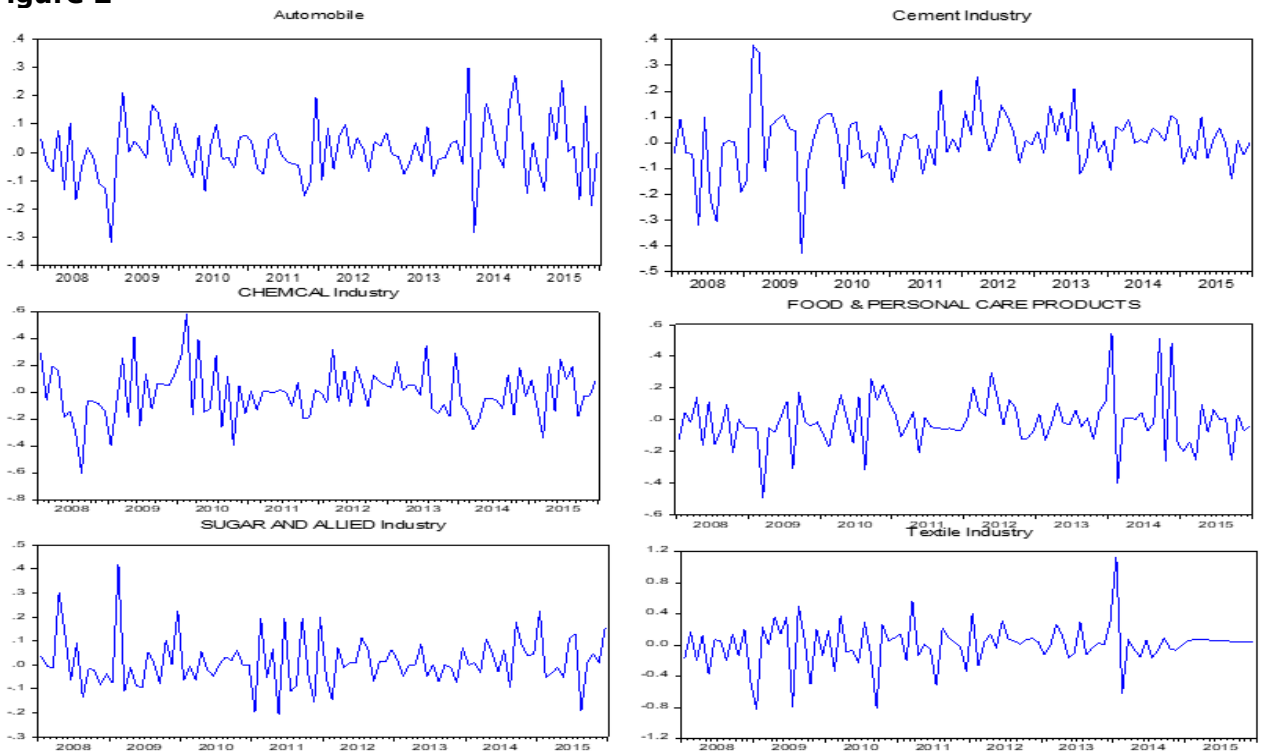
Note; Data stationarity can be measured using the enhanced Dickey and Fuller test (ADF) or the Phillips Perron test (PP). A data set's potential for including the ARCH effect can be ascertained using the Arch test. Both the pre-crisis (January 1, 2003 – December 31, 2007) and post-crisis (December 31, 2015) eras are being discussed. Significance at 1% is indicated by ***.

The data in the automotive industry is highly positively skewed, as indicated by the kurtosis value in the descriptive statistics of the sector following the crisis being larger than 3. For post-crisis data in the cement business, the kurtosis value is larger than 3, indicating a positive bias in the data. The chemical industry's kurtosis value is 7.970685, which is higher than 3, indicating a positively skewed set of data. The textile industry's kurtosis score is 2.382533, which is less than 3, suggesting that the data may be skewed negatively.

4.2.2 Test of Unit Root

Prior to initiating the unit root test, the data's stationarity was verified. We then employed the (PP) Phillips Perron test and the (ADF) Augmented Dickey Fuller test to examine the stationarity of continuous compounding returns using post-crisis data. The table displays the t-statistic values, which indicate statistical significance at both the 5% and 10% level of significance. The values in each case are less than 0.05, indicating that the probabilities of both tests are deemed extremely significant. Consequently, the null hypothesis of both tests is refuted, demonstrating that the car data series has a unit root and stationary issue.

Figure 2



Monthly return series in the post-crisis period

4.3. Volatility spillover prior to a crisis

Table 3

Coefficients	AUTOMOBILE	CEMENT	CHEMICAL	FOOD	SUGAR_	TEXTILE
ω_0	0.0234	0.0481*	0.0865***	0.1615***	0.0573***	0.0384***
	(0.0300)	(0.0233)	(0.0278)	(0.0240)	(0.0125)	(0.0272)
ω_1	- 0.0034	0.0358	0.1286***	0.0337*	0.2358***	0.3476***
	(0.0224)	(0.0168)	(0.0162)	(0.0205)	(0.0320)	(0.0263)
ψ _ Automobile		- 0.0051	- 0.0058	0.0091	0.0132	0.0118
		(0.0160)	(0.0166)	(0.0121)	(0.0117)	(0.0231)
ψ _ Cement	0.0123		- 0.0056	0.0769***	- 0.0198	- 0.0095
	(0.0116)		(0.0263)	(0.0350)	(0.0122)	(0.0036)
ψ _ Chemical	- 0.0215	0.0329*		0.0122	0.0165	0.0173
	(0.0219)	(0.0127)		(0.0181)	(0.0136)	(0.0120)
ψ _ Food & Personal Goods	- 0.0075	0.0043	0.0222		0.0248***	0.0365***
	(0.0173)	(0.0135)	(0.0134)		(0.0080)	(0.0020)
ψ _ Sugar & Allied Industry	0.0114	0.0220**	0.0278*	- 0.0115		0.0121
	(0.0275)	(0.0161)	(0.0006)	(0.0115)		(0.0110)
ψ _ Textile Industry	0.0352*	0.0120	0.0264***	0.1240***	0.0332*	
	(0.0101)	(0.0131)	(0.0080)	(0.0142)	(0.0252)	
γ_0	- 0.1040***	-	-	-	-	-
	(0.0075)	0.0621***	0.1678***	0.2109***	0.2640***	0.0652***
		(0.0124)	(0.0261)	(0.0156)	(0.0120)	(0.0113)
γ_1	0.1634***	0.0815***	0.2634***	0.3628***	0.5206***	0.4587***
	(0.0131)	(0.0153)	(0.0205)	(0.0234)	(0.0150)	(0.0120)
ϕ	0.0124***	- 0.0326**	-	-	- 0.0267*	- 0.0059*
	(0.0035)	(0.0124)	0.1135***	0.0531***	(0.0138)	(0.0116)
			(0.0222)	(0.0101)		
γ_2	0.9457***	0.9626***	0.9086***	0.8738***	0.9078***	0.8056***
	(0.0030)	(0.0045)	(0.0105)	(0.0119)	(0.0051)	(0.0045)
δ_ Automobile		0.0056	0.0166*	-	0.0026	0.0021
		(0.0027)	(0.0110)	0.0237***	(0.0165)	(0.0130)
				(0.0076)		
δ _ Cement	- 0.0115		-0.0787***	-0.0050	0.0024	0.0038
	(0.0129)		(0.0148)	(0.0121)	(0.0141)	(0.0188)
δ _ Chemical	0.0004	-		-	0.1105***	0.1236***
	(0.0085)	0.0361***		0.0532***	(0.0210)	(0.0131)
		(0.0121)		(0.0128)		
δ _ Food & Personal Goods	0.0042	-0.0028	-0.0323**		-	-
	(0.0060)	(0.0078)	(0.0172)		0.0305***	0.0307***
					(0.0118)	(0.0185s)
δ _ Sugar & Allied	0.0014	0.0204**	0.0218**	0.0012		0.0010
	(0.0073)	(0.0032)	(0.0120)	(0.0127)		(0.0120)
δ _ Textile Industry	0.0017	-	0.0875***	0.2640***	0.5264***	
	(0.0142)	0.0415***	(0.0137)	(0.0202)	(0.01470)	
		(0.0116)				

Notations: The metric δ indicates the volatility spillover from the complementary stock market. The residual return from that stock market is represented by the parameter ϱ. Its asymmetric influence is indicated by parameter 4. Before the crisis, the dates are January 1, 2003, through December 31, 2007. The figures with parameters show the standard errors. The 1%, 5%, and 10% are indicated by the symbols ***, **, and * and showing the significance level.

4.4. Volatility spillover in after-crisis analysis

Table 4

Coefficients	AUTOMOBILE	CEMENT	CHEMICAL	FOOD	SUGAR_	TEXTILE
ω_0	-0.0301	0.0015	0.0006	0.0762***	0.0494***	0.0397***
	(0.0246)	(0.0321)	(0.0232)	(0.0106)	(0.0162)	(0.0121)
ω_1	0.0043	- 0.0363*	0.0529**	0.1253***	0.2531***	0.1543***
	(0.0189)	(0.0215)	(0.0192)	(0.0221)	(0.0250)	(0.0270)
ψ _ Automobile		-0.0432*	-0.0450***	-0.0038	-0.0037	-0.0043
		(0.0242)	(0.0308)	(0.0137)	(0.0103)	(0.0201)
ψ _ Cement	-0.0696**		0.0382	0.0171*	0.0106	0.0111
	(0.0302)		(0.0256)	(0.0099)	(0.0129)	(0.0179)
ψ _ Chemical	0.1497***	0.2090***		0.0044	-0.0096	0.0082
	(0.0281)	(0.0273)		(0.0146)	(0.0121)	(0.0131)
ψ _ Food & Personal Goods	0.0371	0.0111	0.0015		0.0237*	-0.0167*
	(0.0322)	(0.0293)	(0.0254)		(0.0129)	(0.0129)

ψ _ Sugar & Allied Industry	0.0670* (0.0402)	0.0327* (0.0279)	- 0.0127 (0.0246)	0.0052 (0.0221)		0.0032 (0.0128)
ψ _ Textile Industry	-0.0444* (0.0252)	- 0.0550*** (0.0208)	-0.0058 (0.0137)	0.0171* (0.0099)	0.1297*** (0.0281)	
γ_0	-0.0525*** (0.0070)	- 0.0299*** (0.0118)	-0.1553*** (0.0116)	- 0.2051*** (0.0172)	- 0.3306*** (0.0232)	- 0.0326*** (0.0050)
γ_1	0.0667*** (0.0099)	0.1258*** (0.0163)	0.1718*** (0.0153)	0.2729*** (0.0240)	0.3790*** (0.0266)	0.2490*** (0.0166)
ϕ	-0.0120** (0.0070)	- 0.0524*** (0.0142)	-0.0939*** (0.0166)	- 0.1788*** (0.0175)	- 0.0642*** (0.0160)	- 0.0622*** (0.0120)
γ_2	0.9942*** (0.0020)	0.9885*** (0.0026)	0.9903*** (0.0030)	0.9347*** (0.0069)	0.9106*** (0.0121)	0.8100*** (0.0142)
δ_ Automobile		0.0068 (0.0085)	0.0164* (0.0089)	0.0153* (0.0089)	0.0362*** (0.0100)	0.0242*** (0.0102)
δ _ Cement	-0.0172* (0.0094)		-0.0038 (0.0091)	-0.0126 (0.0130)	- 0.0761*** (0.0127)	- 0.0793*** (0.0131)
δ _ Chemical	- 0.0022 (0.0105)	- 0.0236*** (0.0084)		0.0644*** (0.0131)	0.0607*** (0.0075)	0.0619*** (0.0063)
δ _ Food & Personal Goods	0.0091 (0.0065)	0.0075 (0.0080)	0.0032 (0.0068)		- 0.0400*** (0.0135)	0.0300*** (0.0115)
δ _ Sugar & Allied	0.0071 (0.0068)	-0.0081 (0.0104)	0.0311*** (0.0071)	-0.0305* (0.0169)		0.0205* (0.0124)
δ _ Textile Industry	-0.0333* (0.0152)	- 0.0560*** (0.0108)	-0.0048 (0.0127)	0.2259*** (0.0130)	0.2740*** (0.0226)	

Notes: the parameter δ represents the volatility for each stock market. The degree to which returns from a particular stock market influence and bleed into other markets is reflected in the α statistic. The uneven influence of volatility is indicated by parameter 4. The era that followed the crisis began on January 1, 2008, and ended on December 30, 2015. The standard errors are indicated by values that are included in parentheses. The 1%, 5%, and 10% levels of statistical significance are indicated by the symbols ***, **, and *.

The parameter ϴ, which is significantly negative, will indicate whether volatility has an asymmetric influence. The results obtained from the EGARCH model are really interesting. In both sub-periods, the chemical, food & personal care goods, and sugar & related industries stock markets showed significant own-lagged return spillover, according to the data. However, the impact of own-lagged return spillover on the cement industry was only substantial during the period following the crisis. These results indicate that the financial crisis in Pakistan induced return spillover between sectors. In addition, the findings suggest that financial integration tends to escalate during times of crisis. According to the estimation outcomes of the EGARCH model, there is a substantial disparity in the volatility transfer between Pakistani sectors during the two sub-periods. Volatility contagion from the chosen indices to the automobile industry was not observed during the pre-crisis time. Volatility contagion from the chosen indices to the textile industry was not observed in the pre-crisis time. However, substantial volatility spillover from the cement industry to the automobile industry is observed during the period following the crisis. Likewise, substantial volatility spillover is evident between sectors of Pakistan during the post-crisis period, which was not present during the pre-crisis period. For instance, there is a spillover from the automobile industry to the sugar and allied industry, from the automobile industry to the textile industry, from cement to the automobile industry and sugar and allied industry, and from the sugar and allied industry to food and personal care products, respectively.

It predicts that there is a substantial financial crisis impact on interconnections among sectors in Pakistan, leading to a greater degree of integration among those sectors during the crisis. In contrast, volatility spillover from sectors of Pakistan to other sectors has been observed in the post-crisis era, whereas it was non-existent in the pre-crisis era. The industries that fall under this category include those that supply sugar and related goods to the cement industry, food and personal care products to the chemical industry, textile products to the chemical industry, and cement products to food and personal care products. The asymmetry

effect creates more volatility because of bad news, than good news, and significant for both occurrences and sub-periods. This finding supports the conclusion reached by Li and Giles (2015) that the negative news in emerging economies is more pronounced than the overall influence. Additionally, it is observed that the impact of previous volatility is exceedingly significant in every instance for both sub-periods. Moreover, in the pre-crisis era, we noticed reciprocal volatility spillover across the cement and chemical sectors as well as between the food and personal care sectors. Amid the crisis, there has been a two-way spillover of volatility in the food and personal business as well as the sugar and related industries. Conversely, in both sub-eras, bidirectional volatility spillover is perceived amongst the chemical then cement industries. Conversely, bidirectional volatility spillover is observed in the cement and textile industries in both sub eras. The integration of sectors in Pakistan was ultimately impacted by the financial crisis. Results propose to increase the correlation among sectors in Pakistan in the financial crisis. Moreover, cross-sector volatility contagion occurred in the majority of Pakistan's sectors in the financial crisis era. Overall, the results illuminate how sectoral integrations in Pakistan fluctuate during volatility era.

5. Conclusion

The study adds to the body of knowledge by offering sufficient evidence to close gaps in the literature for the years and including the financial crisis of 2007. A pre-crisis timeframe of January 1, 2003, to December 31, 2007, was defined for the sake of computing the results utilizing sectors in Pakistan. The post-crisis territory was operational from January 1, 2008, until December 31, 2015. The information was obtained monthly from the Pakistan Stock Exchange and additional sources. As previously explicated in preceding sections, the data were analyzed utilizing the statistical software EViews 9 and the applied unit roots test. The units roots test examines whether the data are stationary; if so, further statistical analyses can be conducted. Following this, the ARCH model was utilized to assess the GARCH and EGARCH models' viability and determined that the data presented statistically significant results. The researcher employed the GARCH and EGARCH models and generated substantial findings that support the hypothesis of a contagion effect in Pakistani sectors during the post-crisis period. Moreover, during the period of the financial crisis, cross-sector volatility contagion occurred in the majority of Pakistan's sectors. Overall, the results illuminate how sectoral integrations in Pakistan fluctuate during periods of stability and instability. In contrast, the results indicate that no significant vulnerabilities were discovered. Additional research could be conducted to examine the correlation by integrating additional variables that were not considered in this study due to limitations in time, resources, and manpower. The primary ramification of future deliberations could be the implementation of a yearly or daily study. It will increase confidence in the data and generate novel outcomes.

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