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ASYMMETRIC AND VOLATILITY SPILLOVER EFFECTS BETWEEN GOLD, EXCHANGE RATE AND SECTORAL STOCK RETURNS IN PAKISTAN

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ABSTRACT

In this paper, the asymmetric and spillover effects among gold, exchange rate, and sectoral stock returns of Pakistan have been examined. Using the Threshold GARCH model, we found that the volatilities in both gold and exchange rate transmit to each sectoral stock return in the overall sample period. The variations in gold returns lead to variation in the exchange rate and contrariwise. The gold and exchange rate spillover effect on sectoral stock returns is notably higher in times of pre-Asian financial crisis than other sub-periods along with the bidirectional mechanism of volatility contagion between gold and exchange rate. Further, the asymmetric response of most sectoral returns to shocks and a switch in direction of volatilities through the post-global crisis as compared to pre-crisis periods have also been noted. Our findings provide frail evidence on volatility spread between gold and exchange rate in the course of post-global financial crisis phase. These findings have important implications for portfolio managers and institutional investors.

Keywords: *Threshold GARCH; Volatility Contagion; Asymmetric Effect; Exchange Rate; Gold Prices.*

INTRODUCTION

The recent years have witnessed a dramatic increase in the demand of gold mainly due to dollar depreciations, economic downturns and inflation (Do, Mcaleer, & Sriboonchitta, 2009). The increased gold demand has led to a remarkable increase in the gold prices by 26% in 2011 compared to 2010 (World Gold Council, 2012). The fluctuations in gold prices are highly affected by its consumption, saving, and reprocessing activities. Besides gold reserves, gold prices are also influenced by oil prices, exchange rate, and financial calamities (Gil-Alana, Yaya, & Awe, 2017; Yaya, Tumala, & Udomboso, 2016). Contrary to gold, there was an adverse impact of the financial crisis on the world stock markets that are at present

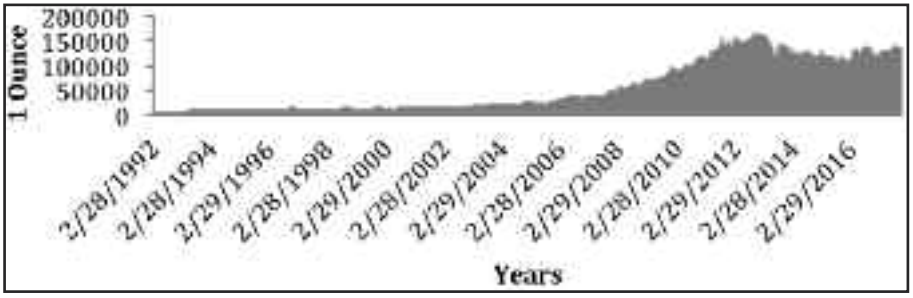
viewed as highly volatile markets for investment motives. In particular, stock markets of emerging economies have faced constant distress (Cardoso & Leal, 2010; Yao & Luo, 2009). In retrospect, several studies have investigated gold-stock prices relationship (Sumner, Johnson, & Soenen, 2011; Baur & Lucey, 2010; Lawrence, 2003; Jaffe, 1989), and noted that gold is a safe haven, an efficient portfolio investment and diversifier, and a good predictor for stock returns (Mishra, Das, & Mishra, 2010). Several studies examined the correlation and spillover pattern between gold and stock returns using correlation and dynamic VAR techniques. For instance, Lawrence (2003); Chua, Sick, and Woodward (1990), noted that the correlation tends to weaken between both assets over time, thus, the role of portfolio diversification seems to dwindle. Sumner et al. (2011), found low spillover of gold returns to stock returns in the case of the US stock market. Several other studies found no impact of gold on stocks (Akgün, Şahin, & Yilmaz, 2013; Hood & Malik, 2013; Özdemir & Yeşilyurt, 2013; Hillier, Draper, & Faff, 2006). Most of the studies in empirical literature have considered the relationship of gold with stock returns of the market as a whole. In this vein, Ratner and Klein (2015), suggested that the influence of gold towards stock returns of the industrial and corporate sector differ. They noted that gold possesses little influence on US stocks. However, in the context of industrial effects, gold exerts the strongest, positive and negative influence on the technology and telecommunication sectors respectively. Liao and Chen (2008), examined the effect of gold on Taiwan stock indices and reported volatility spillover of previous gold returns on most of the industries.

Recently, the value of the currency has become one of the critical factors with the expansion of movements in world trading and especially in relation to gold and stock prices. The exchange rate movements significantly affect stock prices and profitability of businesses (Kim, 2003). Several studies have empirically examined the link between exchange rate and stock prices, thus yielded mixed findings. For instance, Chkili and Nguyen (2014), noted that the exchange rate has no significant impact over the stock prices for BRICS. Similar results have been obtained in the study of Caporale, Hunter, and Ali (2014), which focused on the volatility linkage of both variables. On the contrary, some studies noted fluctuations in the exchange rates which positively affect stock prices (Inci & Lee, 2014; Yang, Tu, & Zeng, 2014; Sharma & Mahendru, 2010; Pan, Fok, & Liu, 2007; Kurihara & Nezu, 2006; Phylaktis & Ravazzolo, 2005; Chen, Naylor, & Lu, 2004), while Moore and Wang (2014),

noted negative correlation between exchange rate and stock prices in Asian markets. Of particular importance, Inci and Lee (2014), argue that the exchange rate link to the industrial stocks is justifiable because of the relevant exposure and industrial differentiations. Al-Shboul and Anwar (2014), confirm Canadian industries exposure to the exchange rate. Similarly, Miao, Zhou, Nie, and Zhang (2013), examined the responsiveness of Chinese sectoral stock returns to the exchange rate. The findings revealed evidence of the exposure for some industries. The study also found perceptible asymmetric effects for manufacturing, mining, wholesale, and retail industries in China.

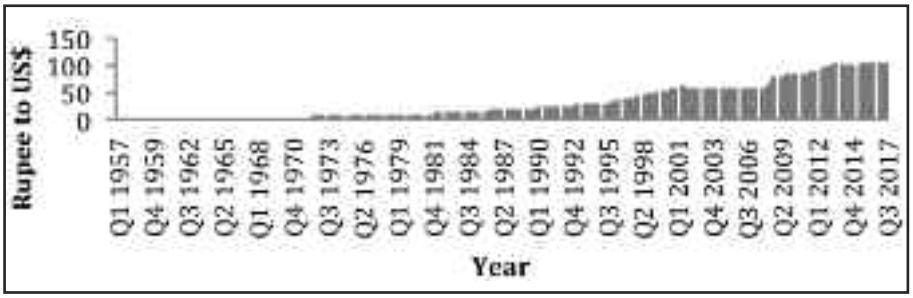
The financial calamity in the present world economy has brought attention to the increased importance of gold. Gold investment in the Pakistan stock market is considered as a safe investment during unfavorable economic situations. Recent times have witnessed a consistent increase in the gold demand in different parts of the world as a result of economic uncertainty (Khan, 2013; Ismail, Yahya, & Shabri, 2009). Due to an increase in gold prices since February 2012 (Nadeem, Zakaria, & Kayani, 2014), investors prefer investing in gold as it offers higher returns comparative to other surrogate investments. Nadeem et al. (2014), explain that the rise in gold price from Rs.6280/*Tola* in 2002 to Rs**.**62,600/*Tola* in 2012 provided 897% of the gold returns to investors during the earlier period. Rush in gold investment has been observed successive to uncertainty in Rupee. Figure 1 explains the gold price increases in PKR over the period of 1992-2017. Importance of gold is also realized by the fact that the government of Pakistan keeps enough gold reserves for future refuge. The gold possession has recently ascended to 1339.25 tons and Pakistan is the fifth greatest gold holding country in the world (Baig, Shahbaz, Imran, Jabbar, & Ain, 2013). In addition, gold futures are seen to be greatly traded in the Pakistan Mercantile Exchange (PMEX) (Shahbaz, Tahir, Ali, & Rehman, 2014).

Figure 1. Gold Prices (Ounce) 1992-2017



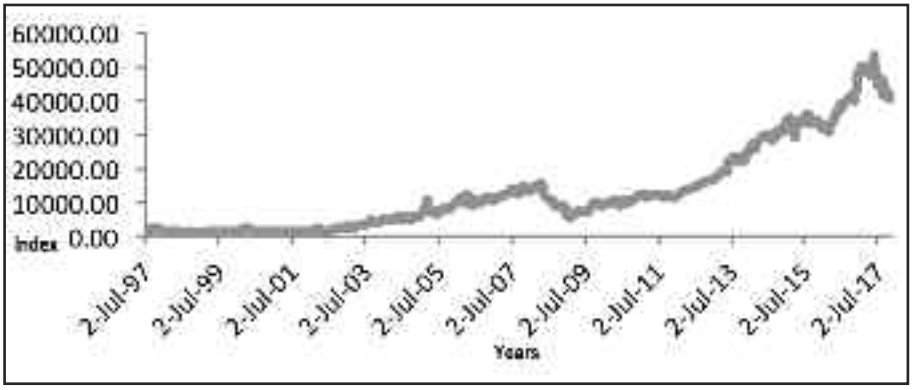
Source: State Bank of Pakistan

Figure 2. USD/PKR Exchange rate 1957-2017



Source: International Financial Statistics

Figure 3. Karachi Stock Exchange 100-Price Index 1997-2017



Source: Bloomberg

Table 1. Sector-wise Net FDI flows in Million US$

	2012	2013	2014	2015	2016
Sector	**NET FDI**				
Food	13.5	493.7	83.3	- 2.0	- 56.0
Food Packaging	2.0	39.0	0.0	0.0	0.6
Beverages	27.8	20.0	23.0	96.6	41.9
Tobacco & Cigarettes	-3.3	0.4	34.2	11.2	35.8
Sugar	0.6	4.8	15.1	3.1	4.4
Textiles	30.3	13.9	- 0.2	43.9	20.0
Leather & Leather Products	8.7	4.5	5.0	0.3	2.6
Rubber & Rubber Products	1.7	1.4	- 0.3	4.4	1.7
Chemicals	96.2	- 47.1	94.9	55.3	88.5
Petroleum Refining	14.7	106.8	2.7	- 14.8	20.3
Mining & Quarrying	7.3	2.0	- 23.2	- 2.0	0.7
Oil & gas Explorations	629.4	559.8	502.0	299.0	248.9
Pharmaceuticals & OTC Products	2.0	14.0	15.7	- 48.8	3.3
Cement	-11.0	8.1	36.6	- 185.2	33.4
Basic Metals	3.8	1.3	5.2	1.5	3.1

Metal Products	18.8	3.2	8.6	- 55.2	0.8
Machinery other than Electrical	-5.2	2.6	1.0	0.0	0.1
Electronics	22.8	20.8	18.2	- 0.3	33.7
I) Consumer/Household	5.4	14.9	15.1	8.7	33.1
II) Industrial	17.4	5.9	3.1	- 9.0	0.6
Transport Equipment (Automobiles)	31.6	25.1	53.1	64.3	46.2
I) Motorcycles	0.0	-	11.9	25.9	0.0
II) Cars	21.6	21.6	27.7	27.3	32.4
III) Buses, Trucks, Vans & Trail	10.1	3.4	13.5	11.1	13.8
Power	-84.9	26.8	71.4	219.3	751.9
I) Thermal	-96.2	- 19.5	62.7	45.0	324.5
II) Hydel	11.3	45.7	8.7	166.2	137.0
III) Coal	0.0	0.6	-	8.1	290.4
Construction	72.1	47.7	28.8	53.5	46.7
Trade	25.3	5.1	- 3.2	50.0	26.8
Transport	0.0	44.2	2.7	6.2	70.2
Storage Facilities	0.2	13.9	- 4.9	- 0.2	1.4
Communications	-315.2	- 381.7	434.2	45.1	236.7
Telecommunications	-361.3	- 404.1	429.9	65.7	246.8
I) Software Development	16.7	7.7	3.0	9.2	4.2
II) Hardware Development	1.0	1.1	0.8	0.4	1.8
Financial Business	64.4	314.0	192.8	256.4	289.0
Social Services	3.6	7.3	0.1	0.3	1.3
Personal Services	21.2	18.4	102.2	36.4	44.0
Others	97.7	62.4	6.9	- 18.1	42.2

Source: www.sbp.org.pk

Pakistan's exchange rate, on the other hand, is consistently fluctuating since long. Figure 2 shows the quarterly exchange rate (USD/PKR) from 1957-2017. Furthermore, the main equity market in Pakistan is the Pakistan stock exchange (PSX) which was the top leading market in 2002 (Bloomberg Business Week, 2002). Prior to 2007, PSX also achieved a focal position in world emerging markets (Shahzadi & Chohan, 2012). Currently, it has been devastated with acute sell-off situations due to frail financial and economic conditions in Pakistan. Thus, it has created an uncertain situation for investors with respect to expected outcomes. This is one of the reasons for investors to deflect themselves and switch towards gold investment. Figure 3 exhibits the Karachi stock exchange indices from 1997-2017.

The foreign direct investment (FDI) scenario in multiple sectors of Pakistan during the last few years, cannot be ignored. As FDI improves economic growth of a country, enhances productivity and competition, and creates employment opportunities which is the reason that government of

Pakistan has successfully attracted FDI in different sectors (Awan, Khan, & uz Zaman, 2011). Recently, the FDI inflows have revealed an increasing trend in all the sectors. The FDI in the services sector has a massive contribution to GDP. It is greatly focused on the telecommunication, Oil & Gas, and finance sectors. The liberalization and privatization in these sectors have increased the foreign capital flows in the country. Awan et al. (2011), stated that there is an attractive environment for foreign investment in services and telecommunication industries of Pakistan. The Government of Pakistan has eased off the investment policies and has widely opened almost all sectors for foreign investments. The opportunities for investment have been exposed to both the home and host countries. Table 1 shows the net FDI flows of diverse sectors from the year 2012 till the present.

The worse situation and perceived volatility have not only influenced the whole economy but also particular sectors and industries. Butt, ur Rehman, Khan, and Safwan (2010), found that the stock returns of industry are sensitive to higher fluctuations of economic variables in Pakistan. For example, the Chemicals industry sector which accounts for major shares in the stock market has experienced high instability in stock prices. The high volatility pattern is also observed in other industries including Insurance, Automobiles, and Food & Beverages. Hence, it is crucial to study the impact of gold-exchange rate volatility on stock prices of sectors in Pakistan as limited research is carried and seen in this regard.

The research intent of this study is to examine the spillover effects among gold, exchange rate and sectoral returns particularly gold and exchange rate volatility transmission to sectoral returns. The study departs from earlier studies in the many ways; contrary to the earlier studies on the associations among exchange rate, gold, and stock returns of the stock markets at the macro level, this study examines the sectoral stock returns. We extend the work of Liao and Chen (2008), and include the exchange rate in examining spillover effects on stock indices. We also consider the structural sectoral returns analysis. Our findings supplement the findings of Liao and Chen (2008), on analyzing concurrently gold and exchange rate volatility effects to sectoral returns with the addition of subsample analysis. The analysis is not confined to full sample only but is segregated to pre and post-crisis to have a better understanding of the spillover effects. We also take into account the analysis of asymmetric volatility influence. Thus, the study contributes by investigating the return spillovers among gold, exchange rate, and sectoral stock returns. In addition, the

study attempts to identify the volatility impact between gold and exchange rate. We use the TGARCH model for analyzing spillover dynamics which has an additional advantage over the GARCH model in capturing asymmetric effects. Due to the recent financial crisis, it is relevant to explore the gold and exchange rate relationship with different sectors. As the risk hedging property of gold intrigues investors in replacing their stocks and acquiring gold, thus, this ultimately decreases demand for stocks and its volatility correspondingly. Therefore, a better understanding of both gold and exchange rate influence on sectoral returns will be helpful for firms and investors in the diversification of portfolio risks.

The findings suggest that the gold and exchange rate shocks spread to all the sectoral returns for the full sample. Both gold and exchange rate variations spillover to each other. The volatility persistence in all the variables is confirmed although the likewise results are not apparent in specific periods before and after the crisis. The pre-Asian crisis period is found to have a noticeable volatility impact on sectoral returns in particular. Prominent industries including Automobile, Consumer service, Oil & Gas, Food and Beverage, Health care, Insurance, Telecommunication and Utilities are affected by exchange rate volatility in post-Asian/pre-global crisis. The asymmetric effects are apparent for the post-global crisis period and transition in volatilities is observed for this period in comparison to the pre-period.

The remainder of the paper is structured as follows. Section two summarizes literature review on the relationship between gold, exchange rate, and stock returns of the stock market and industries. Section three provides a description of data and methodology. Section four discusses empirical results followed by the conclusion and implications in section five.

LITERATURE REVIEW

Numerous studies have investigated the concurrent relationship between gold, exchange rate, and stock prices (Ingalhalli & Reddy, 2016; Jain & Biswal, 2016; Badshah, Frijns, & Tourani-Rad, 2013; Ciner, Gurdgiev, & Lucey, 2013; Samanta & Zadeh, 2012; Sujit & Kumar, 2011; Tully & Lucey, 2007). Tully and Lucey (2007), confirmed the gold's hedging property against equity and identified higher gold prices during stock market strikes. Further, the study found the dollar exchange rate and equity influences on gold. These results contradict with Samanta and Zadeh (2012), which find no exchange rate impact on gold and stock prices however the reverse effect cannot be ignored.

Moreover, Sujit and Kumar (2011), reported the influence of changes in gold price and stock returns to exchange rate, while the stock market returns contribute less in affecting the exchange rates that is dollar and euro. In contrast, Christner, Dicle, and Levendis (2013), found evidence for the greater impact of stock market changes on the dollar exchange rate. Further, they found equity to exchange rate causalities is observed with instant feedback and negative correlations.

The linkage between gold, equity index and the exchange rate has also been tested in Southeast Asian countries. Fahami, Haris, and Mutalib (2014), find the existence of dynamic correlation between financial variables and commodities. The study reveals the presence of feedback relation of the exchange rate and stock index.

Furthermore, in the context of the Indian economy, Singh (2014), analyzed the macroeconomic variables influence on India's stock market performance. The results notify that gold prices adversely affect the stock market which reflects investor's interest in gold. Likewise, the exchange rate negatively affects the stock market throughout the sample period. The dollar appreciation in the international market leads to the depreciation of Indian rupee. This decrease in the value of Indian currency causes the stock market to decline. In addition, Shiva and Sethi (2015), determine the causal relation of the exchange rate, gold prices and stock prices in India. The findings confirm unidirectional causality gold prices to stock prices and from gold prices to exchange rate.

Recently, Bukowski (2016), identified the dollar to euro exchange rate and S&P 500 returns as the main factors in determining the price of gold in the international marketplace. Further, the relationship is found statistically negative. Regarding the potential of gold as an effective diversifier, Ciner et al. (2013); and Kiohos and Sariannidis (2010), emphasized the underlying hedging and portfolio diversification attributes of gold. Besides, Kiohos and Sariannidis (2010), conclude the negative exchange rate and equity impact on the gold market. They observed that the volatility exertion of the exchange rate on gold is significant. The results also signify volatility perseverance and short-run asymmetry in gold. The findings on the complementary asymmetry of the gold market corroborate with the study of Miyazaki, Toyoshima, and Hamori (2012). Additionally, they notice that asymmetry also exists for the exchange rate. Furthermore, the study found gold as a safe haven for the stock market,

however, the effect is restricted in the long run. On the contrary, Ingalhalli and Reddy (2016), stated a positive high correlation between the stock index and gold, thus safe haven role of gold is not proved. Thus, using correlation and Granger causality test the study affirms positively relation between stock index and gold. Further, the findings indicate unidirectional causality among stock index, gold, and exchange rate.

The gold's role in the diversification of stock portfolios is also stressed in the study conducted by Lean and Wong (2015). They assessed the significance of gold for French stock portfolios by using the stochastic dominance approach. The results demonstrate that the stock portfolios comprising gold are stochastically dominating those excluding gold at second and third orders, hence, emphasized the role of gold in stock portfolios for maximization of their estimated utilities. However, the case for bond portfolios is dissimilar, in which portfolios exclusive of gold clearly dominates the one with gold.

Badshah et al. (2013), assess the relationship between stock indices, gold, and exchange rate in the context of volatility spillovers. Using traditional VAR and SVAR, a bi-directional volatility spillover between gold and exchange rate was noted. The study further noted a uni-directional spillover in case of stock indices to gold. More recently, Jain and Biswal (2016), estimated DCC GARCH model and proved that gold price decrease causes the stock index and exchange rate value to decline in the case of India. They identified bidirectional gold and stock index relation. Moreover, Sugimoto, Matsuki, and Yoshida (2014), examined the spillover effects of regional and global markets, commodity and nominal effective exchange rate, of African countries during European sovereign debt crisis and US subprime crisis. The study found that the African stock markets are modestly affected by currency and commodity markets.

Apergis, Christou, and Payne (2014), found the degree of spillovers in gold, silver, stock markets, and macroeconomic indicators in G7 countries. The study found significant price transmissions across all variables. The results, in particular, signify the contribution of macroeconomic surroundings in elucidating the performance of gold and silver returns. However, the stock market performance contribution is found negligible. Concerning conditional volatility spill out, Liow (2015), explored the conditional volatility spread among various asset classes including stock and currency market. The study analyzed the transmissions locally and internationally across G7 countries. The findings show that the magnitude of cross spillover is low within countries. Interestingly, the domestic asset markets exhibit volatility persistence. Further,

the study concludes that the major contributing factor in volatility spillovers is equity portfolio, and the spillover cycle of business cycle variations and asset market return is correlated. Bouri, Jain, Biswal, and Roubaud (2017), utilized the implied volatility indices to explore nonlinear causality and cointegration between the Indian stock market, International gold, and crude oil. The results confirm the cointegration and nonlinear positive influence of implied volatility of gold on the implied volatility of the stock market. These findings are in line with Jain and Biswal (2016), however, the reverse case is not evident.

Previous empirical literature focuses on examining gold and exchange rate inter-link with stock prices of the stock market, however, limited research has explored the gold and exchange rate relationship with prices of sectors. Liao and Chen (2008), analyzed the volatility spill out of gold and oil returns in Taiwan industrial sub-indices estimating TGARCH model. They found that Chemical, Cement, Automobile, Food and Textile indices are affected by gold returns volatility. Similarly, Ratner and Klein (2015), studied gold price behavior and assessed correlation of gold return with the US stock market index and stock of sectors. The findings revealed that the Technology sector is affected positively while the negative effect is evident for the Telecommunication sector.

Similarly, Few studies explored the exchange rate volatility effects on sectoral stocks (Al-Shboul & Anwar, 2014; Olugbode, El-Masry, & Pointon, 2014; Miao et al., 2013). Olugbode et al. (2014), examined the UK industries exposure to exchange rate volatility using the EGARCH model and found that the competitive industries are greatly influenced by higher perceived volatilities relative to other industries. In addition, the volatility persistence is also evident for some industries. Miao et al. (2013), investigated the sensitivity of sixteen Chinese sectoral stock returns to the exchange rate by using the Random effect Tobit regression model. Their study noted that the asymmetric effects are evident for Manufacturing, Mining, Wholesale, and Retail.

Moreover, Al-Shboul and Anwar (2014), provide an analysis of pricing for the exchange rate in the Canadian equity market. The empirical results of firms in Canada indicate that the risks including currency, local and world market are priced in the Canadian equity market. However, the prices of these risks are time-varying. Aabo and Brodin (2014), contend that firm-specific exposure of exchange rate is extremely sensitive to simple modifications in the study methodology, these alterations, for example include, change in the frequency of observation and market index. Further, it is observed that the sensitivity is of a general character.

Alenezi (2015), stressed the oil price fluctuations, interest rate risk, and exchange rate risk effects on market values of listed firms in Gulf Cooperation Council countries. The findings draw attention to the fact that the stock returns of firms are highly exposed to exchange rate risk and the effect of exchange rate risk on the firm values is positive. The extent of the effects of risk also differed country wise and among financial and non-financial firms. In any case, the return volatility was noticed to increase more by positive news than by negative news in many countries. Chou, Lin, Hung, and Lin (2017), studied the impact of trading partner currencies of the US on values of MNC's. They identified the asymmetric effects and investigated increased and decreased economic exposure of MNC's on the US stock exchange. The findings reveal that the effect of exchange rate variations on stock returns differ extremely for various currencies. MNC's are benefited modestly with the appreciation of the dollar against trade partner currencies.

RESEARCH METHODOLOGY

Data

Daily data of gold prices (PKR per ounce), exchange rate (PKR per unit of foreign currency) and sectoral sub-indices over the period of July 1992 - July 2016 was used. Fourteen (14) sectoral stock indices were considered for the analyses including the Automobile; Chemicals; Construction & Material; Consumer Service; Electronic Equipment; Financial Services; Food and Beverage; Industrial Goods & Services; Health Care; Oil & Gas; Pharmaceuticals; Insurance; Telecommunication; and Utilities. However, the data for Electronic Equipment is taken from July 1992 to July 2009 due to the data non-accessibility. Other sub-indices are excluded due to their complex constitution and data availability. Gold price, exchange rate, and sectoral stock indices data were gathered from Datastream. The sample period was divided into pre and post-Asian and Global financial crisis considering the recent crisis in financial markets, however, the period as a whole has also been analyzed. The three subsample groups are Pre-Asian financial crisis 1/2/1992-1/31/1997, Post-Asian financial/Pre-global financial crisis 10/1/1998-7/31/2007 and Post-global financial crisis 1/31/2010-12/31/2015[1]. Since the explicit effects of the global financial crisis were recognized in August 2007, the end period of the pre-global financial crisis is July 2007. This subsample segregation is based on the analysis conducted by previous literature[2].

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[1]The analysis of Electronic equipment is excluded from the subsample of the post-global financial crisis.
[2](Qureshi, Ismail, & Gee Chan, 2017; Khan, Ahmad, & Gee, 2016; Rehman, Mahdzan, & Zainudin, 2016; Wong & Kok, 2005).

Table 2. Descriptive Statistics

	Mean	Std.dev	Skewness	Kurtosis	Jarque-Bera	Q (12) ARCH
Gold	0.0005	0.0108	0.4968	13.4091	28914.99***	9.1694(0.000)
Ex Rate	0.0002	0.0040	5.9964	127.8193	4159570***	71.601(0.000)
Automobile	0.0006	0.0250	0.3013	9.1091	9797.774***	13.445(0.000)
Chemicals	0.0004	0.0191	-0.4143	156.9537	6162630***.	14.615(0.000)
Construction & Material	0.0004	0.0283	-0.0351	11.9164	18680.77***	3.7307(0.053)
Consumer service	-0.0007	0.0387	0.5139	15.6989	42134.84***	6.4213(0.011)
Electronic equipment	0.0002	0.0675	-7.4848	1013.680	27846.18***	0.0109(0.917)
Financial services	0.0005	0.0220	-1.0446	230.1862	13420666***	9.4264(0.002)
Food & Beverage	0.0008	0.0170	0.0754	29.3096	179976.4***	6.9218(0.009)
Industrial goods & services	0.0002	0.0222	-0.1479	21.8695	92598.19***	9.5781(0.002)
Health care	0.0004	0.0191	-4.5307	138.6361	4804607***	66.305(0.000)
Oil & Gas	0.0004	0.0183	-0.3540	16.9634	50824.16***	50.815(0.000)
Pharmaceuticals	0.0004	0.0165	0.0278	11.6790	19585.21***	62.869(0.000)
Insurance	0.0007	0.0297	0.4678	14.9783	31258.88***	12.234(0.000)
Telecommunication	-0.0002	0.0247	-0.1844	10.3962	12866.73***	14.914(0.000)
Utilities	0.0002	0.0239	0.1317	41.1304	378039.7***	5.7278(0.017)

Note: The table reports the summary statistics of Gold returns, Rupee-dollar exchange rate returns and sectoral returns. Ljung-Box test for checking serial correlation with 12 lags in the return series. ARCH refers to autoregressive conditional heteroskedasticity.

Table 3. Unit Root Testing

	ADF Unit Root Test*	ADF Unit Root Test*	KPSS Unit Root Test	
	Intercept	Intercept	Intercept	Intercept and Trend
Gold	-82.0616***	-82.0616***	0.5341	0.3162
Ex Rate	-87.9379***	-87.9379***	1.4429	0.0838
Automobile	-75.3943***	-75.3943***	2.0389	0.1314
Chemicals	-82.8992***	-82.8992***	1.5472	0.0583
Construction & Material	-73.1722***	-73.1722***	2.0385	0.0334
Consumer service	-81.4861***	-81.4861***	1.5475	0.7846
Electronic equipment	-20.3530***	-20.3530***	2.0396	0.5563
Financial services	-82.0883***	-82.0883***	1.5467	0.4966
Food & Beverage	-76.3920***	-76.3920***	1.3621	1.4523
Industrial goods & services	-75.9442***	-75.9442***	2.0331	2.7245
Health care	-71.2112***	-71.2112***	0.1765	0.9262
Oil & Gas	-51.1947***	-51.1947***	0.1826	0.2274

Pharmaceuticals	-71.4111***	-71.4111***	0.3167	0.2503
Insurance	-68.7918***	-68.7918***	0.0841	1.5517
Telecommunication	-71.2434***	-71.2434***	0.3617	0.4211
Utilities	-81.4004***	-81.4004***	0.0849	2.7554

*Note: The ADF unit root test for variables is displayed. Subscripts ***, ** and * show the significant at 1%, 5% and 10% level, respectively. The table also reports Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) unit root test for variables. The null hypothesis of the test is variable is stationary.*

Preliminary Statistics

Returns of all series are computed using the log of first difference based on continuous compounding. Table 2 displays the summary statistics for returns of all the variables. In the table the gold and sectoral returns exhibit higher volatility in comparison with the exchange rate. Moreover, the coefficients of skewness for Chemicals, Construction & Material, Electronic Equipment, Financial Services, Industrial Goods & Services, Health Care, Oil & Gas and Telecommunication returns exhibit negative skewness while rest of other variables are positively skewed. The positive skewness for gold and exchange rate explain that the occurrence of high positive changes is frequent than the negative changes. The kurtosis coefficients verify the existence of higher leptokurtic distribution property in all the variables. Further, the normality of the series is rejected for all the variables as indicated by Jarque Bera test statistics. The Ljung Box Q test statistic rejects the hypothesis of autocorrelation suggesting the presence of ARCH effects in all the variables except Electronic equipment. In order to check the stationarity of the variables, Augmented Dickey-Fuller test (ADF) has been applied with Intercept and Trend is displayed in table 2. The result demonstrates that the hypothesis of unit root is rejected for the series at level. Further, the KPSS unit root test is used for cross-check analysis as shown in table 3. The non-rejection of the null hypothesis indicates that the variables are stationary.

Figure 4 displays gold volatility returns for the period of 1992 to 2016. The intense high period of volatilities persists for the overall period specifically spiked volatile return is seen in 2008 which shows the influence of global financial crisis and sudden inclination of investors to the safe-haven asset. Compared to gold returns, the fluctuation range of exchange rate returns is lower. The higher period of volatility is evident until 1998 and reappeared in 2008. High volatility is followed by prolonged high volatility whereas; a lower period of volatility has continuously followed lower volatility period.

Figures 6-19 presents volatility trends in sectoral returns. It is noticed that there are considerable increases for some periods and decreases for other periods for all sectoral indices except Chemical, Electronic Equipment, Health care and Financial Services, thus, confirming volatility clustering in returns. The observed volatility pattern in the time of Asian and pre-Asian financial crisis for Consumer service, Construction & Material, Industrial Goods & Services and Pharmaceuticals is quite similar since the higher spread is followed by a decrease in swings. The volatilities pattern in the pre-Asian crisis may be due to the investor's predictive reactions. In addition, a wide range of volatility is also exhibited throughout the time of global financial crisis; however, Food and Beverage, Oil, and Gas, Pharmaceutical, Chemicals, Electronic Equipment, Health care, Financial Services, Insurance and Utilities showed lower volatility during this crisis period. It is also observed that the volatility returns for Chemicals, Electronic Equipment, Financial Services, and Health care fall within a certain range suggesting constant or negligible volatility.

Figure 4. Gold return volatility (in %) 1992-2016

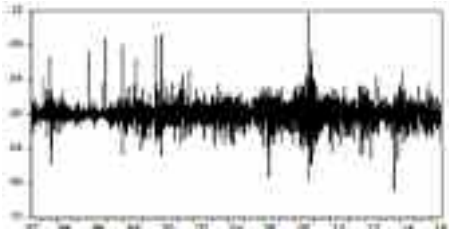

Figure 5. Exchange rate return volatility (in %) 1992-2016

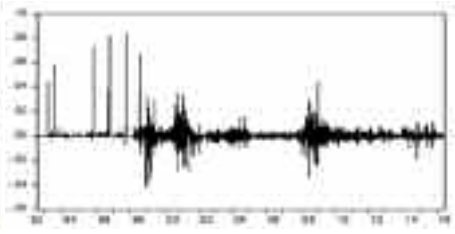

Figure 6. Automobile volatility Indices 1992-2016

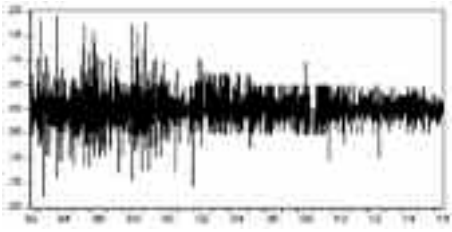

Figure 7. Construction & Material volatility Indices 1996-2016

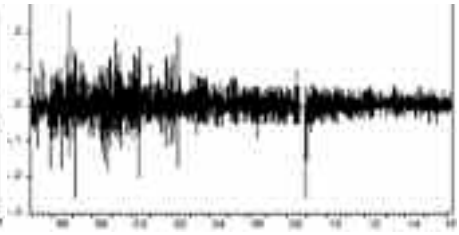

Figure 8. Consumer service volatility Indices 1992-2016

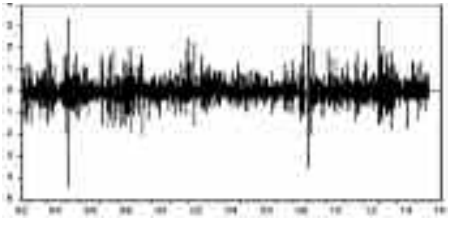

Figure 9. Food & Beverage volatility Indices 1992-2016

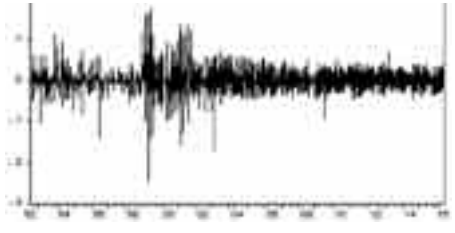

Figure 10. Industrial goods & service volatility Indices 1992-2016

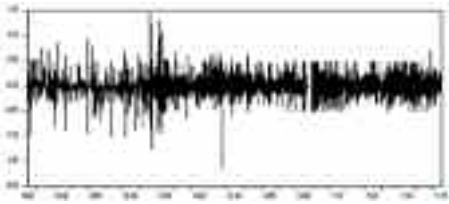

Figure 11. Oil & gas volatility Indices 1992-2016

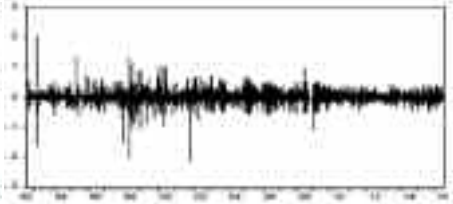

Figure 12. Pharmaceutical volatility Indices 1992-2016

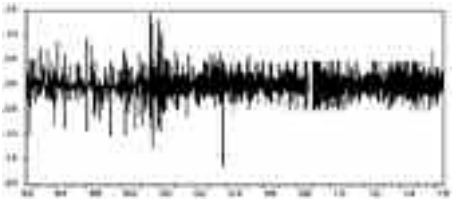

Figure 13. Chemical volatility Indices 1992-2016

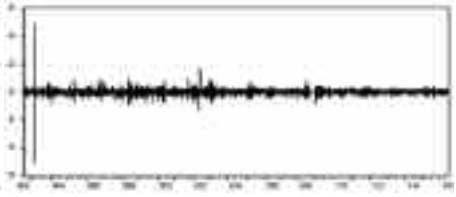

Figure 14. Telecom volatility Indices 1996-2016

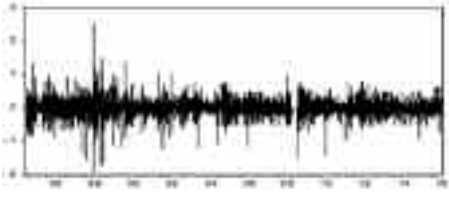

Figure 15. Utilities volatility Indices 1992-2016

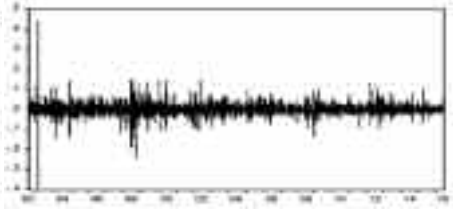

Figure 16. Electronic equipment volatility Indices 1992-2016

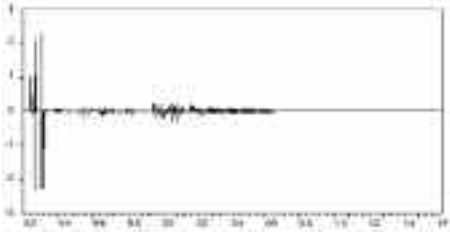

Figure 17. Financial Services volatility Indices 1992-2016

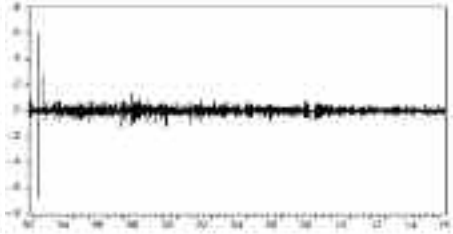

Figure 18. Health care volatility Indices 1992-2016

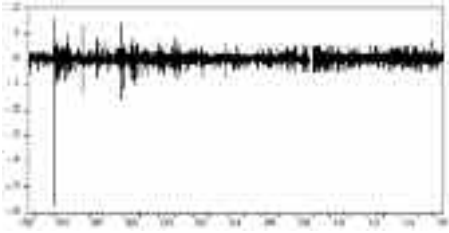

Figure 19. Insurance volatility Indices 1996-2016

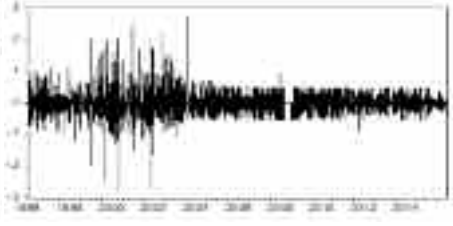

Table 4. Volatility of Returns Summary: Gold, Exchange Rates and Sectoral Returns

Returns	High Volatility (Period)	Low Volatility (Period)	Volatility clustering	Volatility during Asian and Global crisis
Gold	1992-2000	2002-2005	Existent	High
Exchange Rate	1992-1999	2002-2007	Existent	High and Low
Automobile	1992-2002	2003-2008; 2013-2016	Less Evident	High and Low
Construction & Material	1992-2002; 2008	2003-2007; 2009-2016	Existent	High
Consumer service	1994; 2008	1995-2007; 2014-2016	Existent	Low and High
Food and Beverage	1998-2002; 1996	2003-2016	Existent	High and Low
Industrial Goods & Services	1993-2000; 2008	2009-2016	Existent	High
Oil & Gas	1997-2002; 1992	2003-2016	Existent	High and Low
Pharmaceutical	1992-2003	2004-2016	Existent	High and Low
Chemical	1992	1993-2016	Less Evident	Low
Telecom	1997-2006; 2008-2010	2011-2016	Existent	High
Utilities	1992; 1998	1993-1996; 1999-2016	Less Evident	Low
Electronic equipment	1992	1994-2006	Less Evident	Low
Financial Services	1993	1994-2016	Less Evident	Low
Health care	1994	1994-2016	Less Evident	Low
Insurance	1999-2004	2005-2015	Less Evident	Low

Note: The table reports the summary of Gold, Exchange rate and Sectoral returns volatilities and the respective volatility trends before and after crisis periods

Moreover, the increased volatility for Oil & Gas returns is short-lived and continues to proceed with lesser volatility periods. Finally, the fluctuations in the Insurance sector are perceived to be highly sensitive in the post-Asian crisis and tend to be stable during the global crisis period and thereafter. Table 4 summarizes the returns volatilities of gold, exchange rate, and sectoral indices throughout the sample period.

GARCH Model

The GARCH model was applied to measure and forecast volatility and assess associated downside risks. The Auto Regressive Conditional Heteroskedasticity (ARCH) developed by Engle (1982), accounts for the previous error term influence on the current term's conditional variance.

Bollerslev, Chou, and Kroner (1992), later extended this model and proposed Generalized Auto Regressive Conditional Heteroskedasticity (GARCH). The concept was broadened to both previous error term and conditional variance effects on current conditional variance. GARCH explains and estimate instability in financial markets by volatility modeling and forecasting. It concurrently approximates mean and variance equations, therefore GARCH model is used in various empirical literature to understand financial and economic variables relationship with stock returns (See, for instance, Olugbode et al., 2014; Liao & Chen, 2008; Tully & Lucey, 2007). Few of the most common discerned features of equity returns include fat tail leptokurtic distributions (Fama, 1965); the leverage effect which is owing to asymmetries phenomenon (Christie, 1982; Black, 1976); the volatility clusters that constitutes the larger fluctuations followed by larger fluctuation trends and smaller fluctuations to be followed by smaller changes (Kyle, 1985), and presence of autocorrelation in the daily return series, evidence of which substantiates the volatility persistence over the period (Akgiray, 1989). The ARCH and GARCH (1, 1) specification widely describe fat tail distributions through the application of autoregressive formation on the conditional variance. The models are also able to capture volatility clustering of the distributions.

According to the assertion of efficient market hypothesis, stock price movements are random therefore there is no possibility for profitable opportunities. The fundamental model that is a random walk with no drift is commonly used in different studies. It is basically the AR (1) model consisting of a unit coefficient, yet, the daily stock returns usually have drift given the positive anticipations for returns in the long run. Hence, a stochastic trend possibility including drift should be allowed. The model is then given as

$$\gamma_t = \mu + \epsilon_t \qquad (1)$$

Where the mean of the returns is shown as , which is expectedly zero. is the zero-mean error term and is not eventually autocorrelated. The other model allows for constituting the lag dependence of returns and is estimated as

$$\gamma_t = \mu + \alpha\gamma_{t-1} + \epsilon_t \qquad (2)$$

Equation (2) is the mean equation, further, it is also relevant to estimate the volatility varying overtime and the conditional returns variance is modeled. The GARCH (1,1) specification is approximated and is given as the equations below

$$\gamma_t = \mu + \alpha\gamma_{t-1} + \epsilon_t$$
$$\epsilon_t = Z_t\sigma_t$$
$$\sigma_t^2 = \alpha + b\,\epsilon_{t-1}^2 + c\sigma_{t-1}^2 + w_t \quad (3)$$

The Z_t possesses a standard normal distribution and it is a stochastic variable with no autocorrelation in time. The returns conditional variance is represented by σ_t^2 and the random component with white noise properties is symbolized by w_t.

However, GARCH modeling has few limitations since they divulge the issue of explaining asymmetry volatility effects (Black, 1976). Volatility responses are accounted as positive and negative shocks in a symmetric manner. To overcome this issue, Threshold GARCH and Exponential GARCH models were suggested by Nelson (1991) and Glosten, Jagannathan, and Runkle (1993), because these models allow asymmetric reactions in volatility. Further, TGARCH model is suitable comparatively to GARCH model in capturing the leverage effects of financial market volatility (Miralles-Marcelo, Miralles-Quiros, & Miralles-Quiros, 2010; Sabiruzzaman, Huq, Beg, & Anwar, 2010; Liao & Chen, 2008; Girard & Biswas, 2007; Wong & Kok, 2005; Rabemananjara & Zakoian, 1993). The asymmetry can also be captured using the EGARCH model, but it is detected that it implies the variability of the conditional variance to a higher extent. Therefore, the study uses the TGARCH model following Jaleel and Samarakoon (2009); Hughes, Smith, and Winters (2007); and Chan-Lau and Ivaschenko (2003).

TGARCH Model

We leverage on the TGARCH model which is specified as

$$\gamma_t = \mu + \alpha\gamma_{t-1} + \epsilon_t$$
$$\epsilon_t = Z_t\sigma_t$$
$$\sigma_t^2 = \alpha + b\,\epsilon_{t-1}^2 + c\,\epsilon_{t-1}^2\varepsilon_{t-1} + d\sigma_{t-1}^2 + w_t \quad (4)$$

The model is based on the postulation that sudden changes in the returns are articulated as ϵ_t having a differing influence on the return's conditional variance. The good news is linked to an unexpected increase and coefficient b contributes to the variance. The bad news is constituted by unexpected fall and stimulates volatility increase through (b+c) coefficient. The coefficient c if non-zero implies that the returns are of asymmetric nature. While a positive value indicates the leverage effect existence.

The normal GARCH model is extended in order to allow asymmetric effects by the inclusion of the dummy variable ε_{t-1}. The value is 1 in case of negative ϵ_{t-1} or else zero. Moreover, $\epsilon_{t-1} > 0$ and $\epsilon_{t-1} < 0$ is the good and bad news respectively and has different repercussions in the conditional variance. The term $b\,\epsilon^2_{t-1}$ has an impact on good news while $c\,\epsilon^2_{t-1}\varepsilon_{t-1}$ affects the bad news with a greater impact that being the case the leverage effect exists in the model if $\epsilon_{t-1} > 0$ and if its statistical significance is confirmed. Conversely, if $\epsilon_{t-1} < 0$ then the asymmetric effect is inverted that is good news has a greater impact.

The TGARCH (1, 1)[3] model setting for the gold and exchange rate return effects on sectoral indices returns is expressed as

$$\gamma_{s,t} = \mu + \alpha_{s,1}\gamma_{s,t-1} + \epsilon_{s,t}$$

$$\sigma^2_t = \alpha_{s,0} + b_s\,\epsilon^2_{t-1} + c_s\epsilon^2_{t-1}\varepsilon_{t-1} + d\sigma^2_{t-1} + b_{s,g}\,\epsilon^2_{g,t-1} + b_{s,ex}\,\epsilon^2_{ex,t-1} \quad (4.1)$$

And the TGARCH model estimations for gold and exchange rate respectively is stated as

$$\gamma_{g,t} = \mu + \alpha_{g,1}\gamma_{g,t-1} + \epsilon_{g,t}$$

$$\sigma^2_t = \alpha_{g,0} + b_g\,\epsilon^2_{t-1} + c_g\epsilon^2_{t-1}\varepsilon_{t-1} + d\sigma^2_{t-1} + b_{g,ex}\,\epsilon^2_{ex,t-1} \quad (4.2)$$

$$\gamma_{ex,t} = \mu + \alpha_{ex,1}\gamma_{ex,t-1} + \epsilon_{ex,t}$$

$$\sigma^2_t = \alpha_{ex,0} + b_{ex}\,\epsilon^2_{t-1} + c_{ex}\epsilon^2_{t-1}\varepsilon_{t-1} + d\sigma^2_{t-1} + b_{ex,g}\,\epsilon^2_{g,t-1} \quad (4.3)$$

The first part in equation (4.1) analyzes previous sectoral returns impact on current sectoral returns where s is the sectoral return. In addition, the influence of one period lagged gold and exchange rate squared return volatility is also analyzed in the second part of the equation where 'g' and 'ex' represent gold and exchange rate, respectively.

RESULTS AND DISCUSSION

Overall Sample Results

The estimated coefficients of the TGARCH model for mean equation are reported in t table 5. The coefficients signify that most of the sectoral indices returns have self-spillover effects to the returns of the current period which implies that the past returns significantly transmit information and influences the current period returns. All the positive coefficient estimates reveal that the sectoral returns under react to previous shocks. Similarly, the findings of the mean equations 4.2 and 4.3 also suggest the self- spillovers of gold and exchange rate, respectively. The negative sign of coefficients indicate overreaction to the previous returns. Further, the volatility parameters in the

[3]*The optimal lag length is 1 based on AIC, BIC, and HQ information criterion.*

second part of equations 4.1, 4.2 and 4.3 express that all β are significantly different from zero which confirms the GARCH properties for all the sectoral returns, gold, and exchange rate. These findings corroborate with the previous empirical work of Liao & Chen (2008); Liu & Pan (1997); Bollerslev et al. (1992); Nelson (1991); and Engle (1982).

It is also noted that that the value of β is greater α than for all the variables thus suggesting that the GARCH impact on conditional variance is greater than the ARCH. The significance and positive values of γ_s stipulate that the influence of negative returns and bad news have a greater influence on the future volatilities of Automobile, Construction & Material, Chemical, Pharmaceuticals and Utilities. Concerning the volatility spillovers, as shown in table 5, it is found that volatility transmissions of gold returns to all stock returns are evident except Industrial Goods & Services. This result is consistent with Liao and Chen (2008), for Automobile, Chemical and Food Industries. Hence, an investor may include stocks of these industries in his portfolio in order to avoid losses arising from gold price increases or inflation. Moreover, we observed that the overall magnitude of spillover is weak. The negative coefficients show that the Chemical, Electronic Equipment, Financial Services, Food and Beverage, Health care, Oil & Gas returns overreact to the previous conditional volatility of gold. This behavior is consistent with findings of Fung, Mok, and Lam (2000), and Miralles-Marcelo et al. (2010). Additionally, the exchange rate spillover to sectoral returns is consequential and the magnitude is strong for Consumer service and Electronic Equipment and Insurance. We observed that most of the industries overreact to previous period exchange rate volatilities, this return swing may be due to the immediate reaction of the stocks as a result of an immoderate pessimistic or optimistic response to the news and information.[4] The substantiation of volatility spillovers implies that gold and exchange rate can be used for prediction of stock returns of these industries. Regarding the volatility spillover between gold and exchange rate, the effects are confirmed. This impact of gold to exchange rate volatility and the inverse points out the fact that investors may analyze the movements of both by predicting and monitoring the volatilities of each other. Thus, there is an existence of bidirectional spillover between both. These findings are in accordance with Badshah et al. (2013). Subsequently, Table 7 presents the volatility spillover summary findings of all the variables.

[4](Spyrou, Kassimatis, & Galariotis, 2007; Lo & MacKinlay, 1990).

Table 5. Estimates of the TGARCH Model for Sectoral Stock, Gold, and Exchange Rate Returns

Return Series	Mean Equation		Variance Equation					
	$\alpha_{s,0}$	$\alpha_{s,1}$	$\alpha_{s,0}$	α_s	γ_s	β_s	$b_{s,g}$	$b_{s,ex}$
Automobile	0.0005	0.0588***	0.0000***	0.1344***	0.0318***	0.8004***	0.0018***	-0.0027***
Chemicals	0.0036***	0.0172	0.0003***	0.0650***	0.4619***	0.0624***	-0.0033***	0.0029***
Construction & Material	0.0002	0.0583***	0.0000***	0.0684***	0.0939***	0.8823***	0.0008***	-0.0010**
Consumer service	-0.0004	-0.0322**	0.0003***	0.1126***	0.007	0.6710***	0.0091***	-0.0233***
Electronic equipment	-0.0008	-0.0097	0.0045***	0.1528**	0.0559	0.5974***	-0.0166**	-0.1180***
Financial services	0.0007***	0.1184***	0.0004***	0.0555***	-0.0693***	0.5351***	-0.0058***	-0.0053***
Food & Beverage	0.0010***	0.0294	0.0001***	0.1273***	-0.0635***	0.6372***	-0.0014***	-0.0021***
Industrial goods & services	0.0001	0.0398	0.0004***	0.1073***	0.0202	0.5378***	-0.0014	-0.0095***
Health care	0.0003	0.0010**	0.0003***	0.1204***	0.0275	0.5862***	-0.0064***	-0.0036***
Oil & gas	0.0010**	0.0905***	0.0002***	0.1427***	0.0513	0.5578***	-0.0039***	-0.0016**
Pharmaceuticals	0.0002	0.0977***	0.0977***	0.1586***	0.0325**	0.4559***	0.0009***	-0.0036***
Insurance	0.0011	0.0617**	0.0006***	0.1291***	0.0111	0.5208***	0.0074***	0.0207***
Telecom	-0.0002	0.0380***	0.0000***	0.0839***	0.0065	0.8845***	0.0005***	0.0026***
Utilities	0.0003	0.0157	0.0000***	0.0633***	0.0429***	0.8465***	0.0006***	-0.0013***
Gold	$\alpha_{g,0}$ 0.0004***	$\alpha_{g,1}$ -0.0400***	$\alpha_{g,0}$ 0.0000***	α_g 0.0498***	γ_g -0.0194***	β_g 0.9451***	$b_{g,ex}$ 0.0006***	
Exchange Rate	$\alpha_{ex,0}$ -0.0004**	$\alpha_{ex,1}$ -0.1071***	$\alpha_{ex,0}$ 0.0000***	α_{ex} 0.1500***	γ_{ex} 0.05	β_{ex} 0.5998***	$b_{ex,g}$ -0.0003***	

*Note: The table displays TGARCH estimation results for Gold, Exchange rate and Sectoral returns for the overall sample. The α, β and γ represents the ARCH, GARCH and TGARCH terms respectively. Term $b_{s,g}$ represents the volatility spillover of gold to sectoral returns and $b_{s,ex}$ is volatility spillover of the exchange rate to sectoral returns. **, *** denote 5% and 1% level of significance respectively*

Table 6. Diagnostic tests of the TGARCH Model for Sectoral Stock, Gold, and Exchange Rate Returns

	R^2	F Statistic (p-value)	ARCH-LM (p-value)	LL	AIC	Breush-Godfrey LM stat	Durbin-Watson stat
Automobile	0.0522	0.0081	0.9624	11241.66	-4.020	52.122***	1.75
Chemicals	0.2699	0.0001	0.8891	11120.01	-4.623	36.984***	2.08
Construction & Material	0.3223	0.0000	0.4262	10900.13	-3.721	1.5721	1.95
Consumer service	0.0829	0.0004	0.7374	10541.12	-3.717	6.2311**	2.90
Electronic equipment	0.0093	0.9970	0.9762	10713.93	-3.095	3.8911	2.02
Financial services	0.0635	0.0006	0.9923	10406.23	-4.072	42.183**	2.65
Food & Beverage	0.6065	0.0000	0.8843	10317.32	-4.675	22.367***	2.82
Industrial goods & services	0.0144	0.0001	0.9991	10259.94	-3.771	22.658***	2.19
Health care	0.0379	0.0003	0.2704	10195.6	-3.768	23.499**	2.64
Oil & Gas	0.0167	0.0001	0.1512	10129.88	-3.147	17.642***	3.95
Pharmaceuticals	0.0694	0.9968	0.5816	10027.18	-4.706	3.4922	4.46
Insurance	0.0487	0.0039	0.9981	9989.237	-4.707	20.802***	2.77
Telecom	0.2416	0.0061	0.6312	9960.82	-4.712	20.503***	2.98
Utilities	0.0211	0.9984	0.6363	10334.76	-4.758	18.482***	1.12
Gold	0.0042	0.0013	0.3162	25459.7	-3.185	9.1694**	1.97
Exchange rate	-0.0162	0.0011	0.5671	11224.13	-2.661	10.357**	2.89

Note: The table displays TGARCH diagnostic test results for Gold, Exchange rate and Sectoral returns

*for the overall sample. The F-statistic is for testing the significance of the model. ARCH-LM refers to the Engle (1982) LM test for the presence of ARCH effects. LL is the Log-likelihood statistic. The optimal lag order for the model is selected using the AIC information criteria. Serial correlation is tested using Breusch Godfrey LM statistics and Durbin Watson tests. *, **, and *** denote significance levels of 10%, 5% and 1%, respectively*

Table 7. Summary-Volatility Spillovers of Gold and Exchange Rate Returns to Sectoral Returns

Return Indices	Gold	Magnitude of volatility spillover	Indices reaction to volatility	Exchange Rate	Magnitude of volatility spillover	Indices reaction to volatility
Automobile	Rejected	Weak	Under reaction	Rejected	Weak	Overreaction
Chemical	Rejected	Weak	Overreaction	Rejected	Weak	Under reaction
Construction & Material	Rejected	Weak	Under reaction	Rejected	Weak	Overreaction
Consumer service	Rejected	Weak	Under reaction	Rejected	Moderate	Overreaction
Electronic equipment	Rejected	Moderate	Overreaction	Rejected	Strong	Overreaction
Financial services	Rejected	Weak	Overreaction	Rejected	Weak	Overreaction
Food and Beverage	Rejected	Weak	Overreaction	Rejected	Weak	Overreaction
Industrial Goods & Services	Accepted	Weak	Overreaction	Rejected	Weak	Overreaction
Oil & Gas	Rejected	Weak	Overreaction	Rejected	Weak	Overreaction
Health care	Rejected	Weak	Overreaction	Rejected	Weak	Overreaction
Pharmaceutical	Rejected	Weak	Under reaction	Rejected	Weak	Overreaction
Insurance	Rejected	Weak	Under reaction	Rejected	Moderate	Under reaction
Telecom	Rejected	Weak	Under reaction	Rejected	Weak	Under reaction
Utilities	Rejected	Weak	Under reaction	Rejected	Weak	Overreaction

Note: We test the absence of volatility Spillover effect. The overreaction is a negative response to previous returns and under reaction is the positive reaction to previous returns.

The entire sample diagnostic test results of the TGARCH model are reported in table 6. The tests depict inexistence of serial correlation and ARCH effects thus, the model is adequate in capturing the volatility spillover dynamics between the series. However, the Breusch-Godfrey LM test shows the presence of serial correlation in Electronic Equipment, Construction & Material, and Pharmaceutical sectors. The F-statistics confirm the joint significance of the model in most of the cases[5].

Sub-sample Analysis

We investigate whether the dynamics of spillover effects differ in the pre and post-crisis period. The sub-periods are segregated by considering the pre-Asian, post-Asian/pre-global and post-global crisis.

Pre-Asian Crisis

The results of TGARCH for sectoral returns, gold and exchange rate during the pre-Asian crisis are reported in Table 8. We noted some different and interesting results compared to the results of the whole sample. The mean

[5] *The diagnostic tests for the subsample analysis periods are not reported for the purpose of brevity. Results are available on request.*

equation findings for all the variables show that there is no significant past returns effect on all current return indices, gold, and exchange rate returns. The constant variation in returns due to the earlier period is also evinced, suggesting that the indices volatility persists over the period hence the shocks gradually assimilate to the stock market. We further noted evidence of inverted asymmetric reaction of returns for Consumer service, Health care, Oil & Gas, Pharmaceuticals, Telecom and Utilities which implies that the returns volatility is increased by positive shocks more than the negative shocks which is consistent with Ghazali and Lean (2015), for the gold market. In addition, the hypothesis for the impact of gold and exchange rate returns volatility cannot be rejected for most of the sectoral indices except a few. Furthermore, gold and exchange rate volatilities continue to affect each other with little magnitudes as depicted in table 8. It is obvious that gold overacts in response to exchange rate fluctuations, consequently, points the role of gold as a portfolio diversifier.

Post-Asian/Pre-Global Crisis

In this period, few sectoral returns including Automobile, Chemical, Financial Services, Food and Beverage, Health Care and Insurance are found to exert self-spillovers which were not identified in the pre-Asian crisis period. Construction & Material is still observed to possess leverage effect, results are presented in table 9. In addition, Financial Services, Utilities and Health care are also seen to have a greater impact of the bad news which was not noted earlier. In contrast to the period of before the Asian crisis, the exchange rate transmission of volatilities on a considerable number of industries is observed for this period. These findings support the claim of Inci and Lee (2014), that exchange rate and stock returns relation has become stronger in recent recessionary periods than before. This may also be due to the fact that the exchange rate in Pakistan has experienced a constant dismissal since the last decade (Aftab, Abbas, & Nawaz Kayani, 2012). Further, volatility in exchange rate returns does not spread into gold returns. While volatility in gold increases exchange rate volatility which implies the existence of unidirectional volatility transmission. The plausible reason could be the sudden surge in gold demand witnessed in Pakistan for this period as discussed above. Yet, this adverse impact is not perceived on sectoral stock indices to a great extent.

Post-Global Crisis

Table 10 reports the after-effects of the global financial crisis for all the variables. It is confirmed that all of the returns are positively affected by the previous period returns except Consumer service and Insurance which tend to respond negatively. It is clear that the mean return spillover behavior is not the same for the entire subsample span. Moreover, the volatility

feedback effect is noticeable for most of the industries during this period.

The considerable previous period volatility influences are also perceived correspondingly. The overall subsample findings regarding volatility spillover patterns of gold and exchange rates confirm the steady spillover of both on Automobile and Insurance sectors throughout the subsample analysis. Gold return volatilities spill out throughout the post-global crisis to Financial Services, Industrial Goods & Services and Insurance which were not affected during the pre-global crisis period. On the other side, it is apparent that the fluctuations in gold and exchange rate have no momentous influences on each other for this period which contradicts the previous sub-period findings. As a result, it can be deduced that the impact dissipates in the post-global crisis. Finally, it is perceived that the greater coefficients are found during the pre-Asian crisis amongst all sub-periods for that reason gold and exchange rate volatility impact is greater during the pre-Asian crisis. In general, it can be concluded that gold and exchange rate fluctuations possess a different degree of influences on individual sectoral indices for the whole and sub sample period.

CONCLUSION

We investigated the asymmetric and spillover reactions of gold, exchange rate, and sectoral stock returns in Pakistan stock market. While earlier studies examine gold and exchange rate influence on indices of stock markets, this study examines whether sectoral indices return are affected by gold-exchange rate volatility using the TGARCH model. The findings indicate that the volatilities in gold and exchange rate increase sectoral return volatilities for the entire sample period, however, the intensity is not found to be substantial. Further, the sectoral returns mostly overreact to the gold and exchange rate volatilities. These results imply that individual investors and portfolio managers may consider inclusion of sectoral returns in their portfolios for loss aversions arising due to the fluctuations in gold and exchange rate, respectively. Besides, gold and exchange rate may help in forecasting stock returns of these particular industries. Moreover, the evident spillover effects of gold and exchange rate on each other suggest that fluctuations in the exchange rate are affected by extreme fluctuations in gold prices and vice versa. Thus, it may assist participants of the financial market and speculators to forecast gold and exchange rate volatilities. The study further analyzes whether the relationship is stable during the pre and post-crisis period. The subsample analysis reveals that the associations among variables vary and sectoral returns react differently during these periods, it is thus identified that the mean spillover varies across all the sub-periods.

Table 8. Pre-Asian Crisis TGARCH Estimates for Sectoral Stock Indices, Gold, and Exchange Rate Returns

Return Series	Mean Equation		Variance Equation					
	$\alpha_{s,0}$	$\alpha_{s,1}$	$\alpha_{s,0}$	α_s	γ_s	β_s	$b_{s,g}$	$b_{s,ex}$
Automobile	-0.0004	0.0107	0.0004***	0.1777***	-0.0321	0.4918***	-0.0166***	0.0423**
Chemicals	0.0012	-0.2328	0.0006***	0.0954**	0.0181	0.5836***	-0.0076	-0.010
Construction & Material	-0.0023**	-0.0035	0.0000***	-0.0267***	0.0356***	0.9921***	-0.0087***	0.0422***
Consumer service	0.0033**	0.0777	0.0008***	0.2439***	-0.1045**	0.3820***	-0.002	-0.0163
Electronic equipment	-0.0054	0.0326	0.0201***	0.1552	0.0707	0.5949***	-0.1662	-0.4264
Financial services	0.0011	-0.1985	0.0010***	0.0880**	-0.0449	0.5915***	-0.0099	-0.0198
Food & Beverage	0.000	0.0764	0.0002***	0.1338***	0.0093	0.5559***	0.000	-0.0051**
Industrial goods &services	0.0006	-0.0985***	0.0004***	0.3291***	0.0934	0.2411***	0.0035	-0.0103***
Health care	-0.0047***	-0.0837	0.0005***	0.4144***	-0.4168***	0.5528***	-0.0268***	0.0161
Oil & gas	0.0013	0.0038	0.0002***	0.0365***	-0.0833***	0.5536***	-0.0017	-0.0034
Pharmaceuticals	0.0001	0.1625***	0.0001***	0.1123***	-0.1013***	0.6388***	-0.0005	-0.0015***
Insurance	-0.0016	-0.0281	0.0009***	-0.0846	0.0138	0.0468	-0.1458***	0.1472***
Telecom	-0.0006	0.0585	0.0001***	0.2304***	-0.2074***	0.6546***	-0.0083***	0.0145**
Utilities	0.0015	-0.0435	0.0008***	0.0543***	-0.1038***	0.5830***	-0.0068	-0.015
Gold	$\alpha_{g,0}$ 0.0006	$\alpha_{g,1}$ -0.0464	$\alpha_{g,0}$ 0.0000***	α_g 0.1416**	γ_g 0.0447	β_g 0.5958***	$b_{g,ex}$ -0.0073***	
Exchange Rate	$\alpha_{ex,0}$ 0.0004	$\alpha_{ex,1}$ -0.0099	$\alpha_{ex,0}$ 0.0000***	α_{ex} 0.1518	γ_{ex} 0.0505	β_{ex} 0.5976***	$b_{ex,g}$ 0.0005***	

*Note: The table shows TGARCH Pre Asian Crisis estimations of sectoral returns, gold, and exchange rate. The α, β and γ represents the ARCH, GARCH and TGARCH terms respectively. The term $b_{s,g}$ represents the volatility spillover of gold to sectoral returns and $b_{s,ex}$ is volatility spillover of the exchange rate to sectoral returns. **, *** denote 5% and 1% level of significance respectively.*

Table 9. Post Asian/Pre-global Crisis TGARCH estimates for all sectoral returns, Gold and Exchange rate

Return Series	Mean Equation		Variance Equation					
	$\alpha_{s,0}$	$\alpha_{s,1}$	$\alpha_{s,0}$	α_s	γ_s	β_s	$b_{s,g}$	$b_{s,ex}$
Automobile	0.0012***	0.0506***	0.0000***	0.0463***	-0.0121	0.9465***	0.0011***	-0.0054***
Chemicals	0.0010***	0.0612***	0.0000***	0.1653***	-0.0048	0.8110***	-0.0002	0.0003
Construction & Material	0.0015***	0.0186	0.0000***	0.0791***	0.0424***	0.8809***	0.0009	0.0002
Consumer service	-0.0002	-0.0435	0.0001***	0.0954***	0.005	0.8566***	0.0027***	-0.0082***
Electronic equipment	0.0008	-0.0207	0.0005***	0.0917***	-0.1071***	0.5446***	0.0034***	0.0242***
Financial services	0.0018***	0.0963***	0.0000***	0.0883***	0.0984***	0.7946***	0.000	0.002
Food & Beverage	0.0013**	-0.0606**	0.0002***	0.1304***	-0.1034***	0.5441***	-0.0044***	0.0161***
Industrial goods &services	0.0005	0.0271	0.0000***	0.0948***	-0.0057	0.8699***	0.0003	-0.0036***
Health care	0.0010***	0.0966***	0.0000***	0.0845***	0.0604***	0.8327***	-0.0001	-0.0002
Oil & gas	0.0007**	0.0418	0.0000***	0.1696***	-0.0054	0.8025***	0.0004	-0.0030***
Pharmaceuticals	0.0009***	0.0369	0.0000***	0.1160***	-0.0373***	0.8701***	-0.0001	-0.0023***
Insurance	0.0011	0.0744**	0.0010***	0.0919***	-0.0686**	0.5200***	0.0051	0.0442***
Telecom	0.0004	0.0179	0.0002***	0.1507***	0.033	0.5955***	-0.0037***	0.0121***

Utilities	0.0002	0.0157	0.0002***	0.0917***	0.0302***	0.8658***	-0.0007***	-0.0025**
Gold	$\alpha_{g,0}$ 0.0005***	$\alpha_{g,1}$ -0.0452***	$\alpha_{g,0}$ 0.0000***	α_{g} 0.0765***	γ_{g} -0.0552***	β_{g} 0.9173***	$b_{g,ex}$ 0.0002	
Exchange Rate	$\alpha_{ex,0}$ 0.0000	$\alpha_{ex,1}$ -0.1731***	$\alpha_{ex,0}$ 0.0000***	α_{ex} 0.1500***	γ_{ex} 0.0500	β_{ex} 0.5996***	$b_{ex,g}$ -0.0002***	

*Note: The table shows TGARCH Post Asian/Pre-global Crisis estimations of sectoral indices returns, gold and exchange rate. The α, β and γ represents the ARCH, GARCH and TGARCH terms respectively. The term $b_{s,g}$ represents the volatility spillover of gold to sectoral returns and $b_{s,ex}$ is volatility spillover of the exchange rate to sectoral returns. **, *** denote 5% and 1% level of significance respectively.*

Table 10. Post Global Crisis TGARCH estimates for all sectoral returns, gold, and exchange rate

Return Series	**Mean Equation**		**Variance Equation**					
	$\alpha_{s,0}$	$\alpha_{s,1}$	$\alpha_{s,0}$	α_{s}	γ_{s}	β_{s}	$b_{s,g}$	$b_{s,ex}$
Automobile	0.0008*	0.0847***	0.0001***	0.1762***	0.0611	0.4013***	0.0018***	-0.0105***
Chemicals	0.0005	0.0798***	0.0000***	0.0491***	0.1153***	0.7973***	0.0002	0.0010**
Construction & Material	0.0011***	0.0923***	0.0000***	0.0440***	0.0596***	0.8773***	0.0001	-0.0016
Consumer service	-0.0005	-0.1014***	0.0002***	0.1357***	0.2239***	0.6957***	0.0023	0.0182***
Electronic equipment	0.0004	0.1693***	0.0000***	0.0823***	0.1353***	0.7778***	0.0005***	0.0008
Financial services	0.0007**	0.0933***	0.0000***	0.1347***	-0.0639***	0.7916***	0.0007***	-0.0003
Food & Beverage	0.0004	0.1371***	0.0000***	0.0817***	0.0675***	0.7864***	0.0005**	-0.0042***
Industrial goods &services	0.0008**	0.1064***	0.0000***	0.1639***	-0.0228	0.7425***	0.0003	0.0006
Health care	0.0008*	0.0847***	0.0001***	0.1762***	0.0611	0.4013***	0.0018***	-0.0105***
Oil & gas	0.0003	0.0867***	0.0000***	0.0179**	0.0916***	0.8966***	-0.0001	-0.0022***
Pharmaceuticals	0.0008**	0.1064***	0.0000***	0.1638***	-0.0228	0.7426***	0.0003	0.0006
Insurance	0.0010***	-0.0782***	0.0000***	0.1326***	-0.0433**	0.8272***	0.0019***	0.0024***
Telecom	-0.0003	0.068***	0.0000***	0.0869***	-0.0258	0.8371***	0.0003	0.0062***
Utilities	0.0003	0.0196	0.0001***	0.0895***	0.0680***	0.8378***	0.0010***	-0.0009
Gold	$\alpha_{g,0}$ 0.0002	$\alpha_{g,1}$ -0.0273	$\alpha_{g,0}$ 0.0000***	α_{g} 0.0442***	γ_{g} 0.0404***	β_{g} 0.8725***	$b_{g,ex}$ 0.0007	
Exchange Rate	$\alpha_{ex,0}$ 0.0001***	$\alpha_{ex,1}$ -0.0837***	$\alpha_{ex,0}$ 0.0000***	α_{ex} 0.1877***	γ_{ex} 0.0475***	β_{ex} 0.7708***	$b_{ex,g}$ 0.0000***	

*Note: The table shows TGARCH Post Global Crisis estimations of sectoral returns, gold, and exchange rate. The α, β and γ represents the ARCH, GARCH and TGARCH terms respectively. The term $b_{s,g}$ represents the volatility spillover of gold to sectoral returns and $b_{s,ex}$ is volatility spillover of the exchange rate to sectoral returns. **, *** denote 5% and 1% level of significance respectively.*

Additionally, the findings suggest that the influential extent of gold and exchange rate on returns vary and appear to be significant during the pre-Asian crisis. There is a bidirectional volatility spill out between gold and exchange rate during the pre-Asian crisis, unidirectional spread running from gold to exchange rate for post-Asian/pre-global and no contagious volatility in the post-global period is recognized. The asymmetric sectoral returns reaction is discernible in post-global crisis for nearly all of the

industries. Furthermore, the persistence in volatilities is perceived to be significant in all the variables for all the periods. The brief sub-period outcomes for volatility transmissions on sectoral returns are

1. During the pre-Asian crisis, the gold returns volatility negatively influences the Automobile, Construction & Material, Health care, Insurance and Telecom. Whereas, exchange rate volatility has a positive impact on Construction & Material, Insurance and Telecom and a negative impact on Food and Beverage, Industrial Goods & Services, and Pharmaceutical.

2. During the post-Asian/pre-global crisis, fluctuations in gold returns affect Automobile, Construction & Material, Electronic equipment, Food and Beverage, Telecom and Utilities. Conversely, exchange rate fluctuations influence virtually all sectoral indices.

3. During the post-global crisis, shocks arising in gold returns affect the Automobile, Financial Services, Food and Beverage, Industrial Goods & Services, Insurance and Utilities. Moreover, correlations are found to be positive. The exchange rate volatilities, on the other hand, spread over to the indices of Automobile, Chemicals, Consumer service, Industrial Goods & Services, Oil & Gas, Insurance, and Telecom.

RESEARCH IMPLICATIONS

The findings provide crucial implications to the portfolio managers for devising an optimal portfolio by utilizing risk management strategies to the stocks of specific sectors which may help to alleviate the risks arising due to volatility shocks. The spillover existence highlights the predicting behavior of gold, exchange rate, and sectoral returns which also provide insights for effective trading strategies. Further, the negative gold and exchange rate volatility correlations imply that the increased volatilities lead to negative gold and exchange rate correlations with sectoral returns, hence, confirming the gold and exchange rate importance in hedging over the markets in the time of crisis. Further, due to differing return behavior of sectors in a similar period of time may guide investors in analyzing the industry characteristics prior to investment decision making. The differential gold and exchange rate influences on Pakistan's competitive and concentrated industries would be an interesting avenue to explore in the future.

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