

Audit and Accounting Review (AAR)

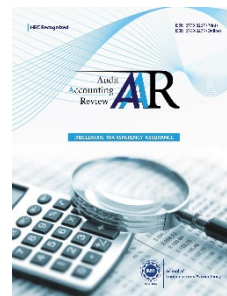
Volume 5 Issue 1, Spring 2025

ISSN(P): 2790-8267 ISSN(E): 2790-8275

Homepage: <https://journals.umt.edu.pk/index.php/aar>



Article QR



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Author (s): Ghulam Mustafa and Snober Javid

Affiliation (s): University of Central Punjab, Lahore, Pakistan

DOI: <https://doi.org/10.32350/aar.51.05>

History: Received: January 10, 2025, Revised: June 19, 2025, Accepted: June 20, 2025, Published: June 27, 2025

Citation: Mustafa, G., & Javid, S. (2025). Volatility transmission of oil and gas sector stocks returns with stock futures and commodity futures. *Audit and Accounting Review*, 5(1), 103–128. <https://doi.org/10.32350/aar.51.05>

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Conflict of Interest: Author(s) declared no conflict of interest



A publication of
The School of Commerce and Accountancy
University of Management and Technology, Lahore, Pakistan

Volatility Transmission of Oil and Gas Sector Stocks Returns with Stock Futures and Commodity Futures

Ghulam Mustafa* and Snober Javid

UCP Business School, Faculty of Management Studies, University of Central Punjab, Lahore, Pakistan

Abstract

Pakistan is a very volatile market in the eyes of both international and national investors. Market participants mostly use derivative instruments to protect their investments from price fluctuations. However, the use of a particular type of derivative in a trading strategy depends on the type of investors. Speculators and short-term profit seekers use stock futures, while portfolio managers use commodity futures to minimize their portfolio risk. Both types of traders need to develop strategies at the company level; therefore, this study aims to analyze volatility transmission between the stocks of oil and gas sector companies with stock futures and commodity futures (oil, gas, and gold). In this study, the relationship of selected companies in Pakistan's oil and gas sector (exploration and marketing) are studied on three levels: the relationship of stock with its stock futures at the first level, related commodity futures at the second level, and with unrelated commodity futures at the third level. BEKK-GARCH was used to examine volatility transmission and asymmetric stock linkage with each future. The spillover index was calculated for every stock, with stock futures and each commodity future to determine each pair's net transmitter or net receiver of volatility. The results determined that stock futures of all companies have no significant volatility transmission. In case of commodity futures, it was found that oil and gas have a natural relevance with the oil and gas sector; therefore, most companies from this sector have significant volatility transmission. Whereas, in case of gold as an unrelated instrument, it has no significant volatility transmission in most companies, thus proving itself to be an alternative investment option for portfolio managers.

Keywords: BEKK-GARCH, commodity futures, spillover index, portfolio managers, portfolio risk, stock futures, volatility transmission

*Corresponding Author: ghulammustafa270.gm@gmail.com

Introduction

The global financial landscape shows heightened volatility and complex interdependencies across markets, particularly in the wake of the COVID-19 pandemic and recent energy crises. Emerging markets, characterized by their developing financial infrastructure and vulnerability to external shocks, have been hit particularly hard. The oil and gas sector, a key component of these economies, has experienced significant price volatility, impacting both equity and commodity futures markets. Understanding volatility transmission, asymmetric linkages, and spillovers across these markets is critical for investors, policymakers, and stakeholders to navigate the complexities of the current economic environment.

Recent studies have delved into the dynamics of volatility spillovers in emerging markets (Qadir et al., [2023](#)). For instance, recent research has highlighted the strong connection between global uncertainties and sectoral indices in Pakistan, emphasizing the role of the energy sector as both a receiver and transmitter of shocks during crises, such as the global financial crisis and the COVID-19 pandemic (Khan et al., [2022](#)). Furthermore, the application of quantile VAR network models has provided critical insights into the interconnectedness of global crude oil prices, economic policy uncertainties, and sector-specific indices in Pakistan, revealing varying degrees of connection across different quantiles. These findings underscore the asymmetric nature of volatility transmission, where negative shocks often have more pronounced effects than positive ones (Rezitis et al., [2023](#); Zaidi et al., [2023](#)).

Volatility transmission among different classes of assets in any market increases systematic risk, which needs to be monitored by policymakers in order to reduce the risk level of the market and by investors to formulate investment strategies (Aziz et al., [2020](#); Fousekis & Grigoriadis, [2019](#)). For local and foreign investors, the level of connectedness within the financial market of any country is a sensitive factor for portfolio building (Liow et al., [2021](#)). The level of connectedness leads to the financialization of commodity futures including oil and gold, which needs to be understood by fund managers for portfolio diversification (Nguyen et al., [2020](#)). Another aspect of volatility transmission between stock and commodity futures is its asymmetric nature which may restrict investors from obtaining the expected diversification benefits and rewards of their trading strategies (Naeem et al., [2022](#)).

Stock futures comprise a hedging instrument that the stock market offers primarily for hedging purposes. Stock futures mainly come in two forms: stock index futures and single stock futures (SSF). The latter is considered as an alternative to short selling and has several advantages over the spot market. Factors due to which SSF is superior to the spot market mainly include the transaction cost and leverage facility (Curran et al., [2020](#); Dungore et al., [2022](#); Jiang et al., [2020](#); Woo & Kim, [2021](#)).

Despite the growing literature, a significant gap persists in the comprehensive analysis of the impact of volatility on the oil and gas sectors and equity and commodity futures in Pakistan. While previous studies have examined the impact of global uncertainties on sectoral indices, there is a lack of research focused on asymmetric linkages and impact indices specific to Pakistans oil and gas sector. This gap is particularly significant given Pakistans status as a net oil importer and the strategic importance of its energy sector for economic development (Hoque & Zaidi, [2020](#); Imran et al., [2024](#)).

Pakistans stock market is considered as the most volatile since it has seen the crashes of 2005 and 2008. This forces local and international investor to adopt investment strategies that lead to a portfolio with minimum risk. Hence, investors and portfolio managers look for other assets that can be used as a hedging instrument (Lei et al., [2023](#)). In previous studies, the overall relationship of the countrys stock market with different commodities has been examined. Such information may show an overall picture of the relationship between the stock market and various commodities including oil, gold, and natural gas. However, at the sector level and the company level, the relationship may differ from that of the market. Investors and portfolio managers, while adding different commodities to their portfolio, may be interested more in the relationship of a particular company with different commodities. Hence, it may be possible that the relationship of a particular company's stock is not the same as that of the overall market relationship.

In the Pakistan Stock Market (PSX), SSF is an option available for traders and investors. Indeed, studies have shown that the behavior of stock futures and the underlying stock remains not the same across the market. Moreover, it has been reported in different studies that stock futures are mostly used by speculators to gain advantage from the price difference between stock futures and the underlying stock. So, there is a need to

investigate whether commodity futures and stock futures provide hedging opportunities or arbitrage opportunities to market participants. Another aspect that needs to be investigated is which asset has led to transmitting volatility to other assets. For example, in single stock futures and underlying stock, whether stock futures are net transmitters or net receivers of volatility?

Addressing this research gap is imperative for several reasons. Firstly, a detailed understanding of volatility transmission mechanisms can facilitate the development of effective hedging strategies, mitigating potential risks associated with price fluctuations. Secondly, the knowledge of asymmetric linkages can inform policy decisions aimed at improving market resilience (Sánchez-García, & Rambaud, [2023](#)). Finally, quantifying spillover indices can provide a clearer view of the interdependencies between markets, facilitating more informed investment decisions.

In light of the above, this study seeks to explore volatility transmission, asymmetric linkages, and spillover effects between Pakistans oil and gas sector and its equity and commodity futures market. By employing BEKK-GARCH model and leveraging recent data, the research seeks to fill the existing gap in the literature and contribute to a more complete understanding of market dynamics in emerging economies during periods of heightened uncertainty (Ameet et al., [2024](#)).

Literature Review

Stock Returns and Commodity Futures Market

Commodities, especially gold and oil, are assets which have a low correlation with stock market and can be used for hedging purposes. Various studies have reported different results regarding their mutual relationship and volatility transmission. Several studies found that stock had a bi-directional relationship with stock and gold. They also revealed that the level of connectedness of stock market was also very strong with gold and oil and moderate with natural gas. Stock was found to be superior in transmitting volatility to commodities market (Farid et al., [2021](#)). Energy futures including crude oil and natural gas were found to have a positive and uni-directional volatility transmission with stock. This means that these alternative asset classes cannot be used for hedging purposes because of their positive correlation with the stock market (Ahmed & Huo, [2020](#); Maitra & Dawar, [2018](#)). However, in certain cases, both gold and crude oil

were found to have a bi-directional volatility transmission with stock. It revealed that both these commodity futures were not an option for traders while formulating hedging strategies (Ajmi et al., [2021](#); Kang & Yoon, [2019a](#); Soni & Nandan, [2022](#)). In African countries, a strong dependency was found between commodity futures and stock. Commodities included energy and precious metals like gold. Studies found that gold's effectiveness as a hedging instrument was greater as compared to other commodities (Boako et al., [2020](#); Morema & Lumengo, [2020](#)).

Volatility Transmission Asymmetric Linkages

The intricate relationship between the oil and gas sector and the broader financial market has garnered considerable attention from academics and practitioners alike, particularly in the context of volatility transmission, asymmetric linkages, and spillover effects (Lang & Auer, [2020](#)). A thorough understanding of these dynamics is not merely an academic exercise; it is imperative for investors seeking to optimize portfolio allocations, policymakers striving to ensure energy security and market stability, and energy companies aiming to strategically manage risks and capitalize on emerging opportunities within the global energy landscape (Gurbuz & Sahbaz, [2022](#)). Understanding the intricate relationship between the oil and gas sector and the broader financial market is crucial, especially considering factors such as shareholder interests and equity market volatility (Ali et al., [2019](#); Coskun, [2023](#)).

The existing literature extensively describes the association of energy markets with stock prices, revealing how shocks and fluctuations in one market can rapidly propagate to others, thereby impacting asset prices, investment strategies, and overall economic stability (Huang et al., [2023](#)). Studies focusing on volatility transmission mechanisms within energy futures markets have demonstrated the significant influence of crude oil futures on the volatility of other energy commodities, such as gas oil and natural gas (Hou & Li, [2020](#)). These findings suggest that crude oil acts as a bellwether for the energy complex, with its price fluctuations exerting a disproportionate impact on the volatility of related energy assets (Rastogi & Agarwal, [2020](#)).

In view of the above, the current study postulates the following hypotheses.

H1: There is significant volatility transmission between oil and gas sector stock returns and crude oil futures.

H2: There is significant volatility transmission between oil and gas sector stock returns and natural gas futures.

H3: There is significant volatility transmission between oil and gas sector stock returns and gold futures.

Stock Futures and Underlying Stock

A significant impact of futures on the volatility of the underlying stock confirmed that informed investors prefer to use futures in spot market (Singh et al., [2020](#)). Another stream of studies found that the introduction of stock futures reduces the volatility of spot market and improves its efficiency, which lends support to other arguments about stock futures, such as the stabilize hypothesis of stock futures. This shows that the introduction of futures brings stability in spot market because it creates more options for investors and traders to implement varied investing strategies (Cimen, [2018](#); Magweva et al., [2021](#); Malik et al., [2019](#); Shah & Khan, [2019](#)). Hence, the current study hypothesizes that

H4: There is significant volatility transmission between stock futures and the underlying stock of companies in the oil and gas sector.

To summarize, the relationship of stock with stock futures and commodity futures (oil, gas, and gold) is not conclusive. Most of the studies have been conducted either on the aggregate market or on any particular sector. Whereas any work on the level of an individual company needs to be carried out. This is important for investors and portfolio managers as they must decide about any commodity based upon its level of integration with the individual stock of the company. Similarly, in the context of Pakistan, the relationship between stock futures and its underlying stock needs to examine. This is because previous studies have been conducted mostly to see the pre and post effect of stock futures on the volatility of PSX. Secondly, a comparison needs to be made on the hedging capabilities of stock futures and commodity futures.

Methodology

Data was collected from 1st December, 2013 to 31st December, 2022. Daily prices of each company stock and stock futures were collected from the

official website of PSX. Whereas, the prices of commodity futures were observed from the PMEX website.

Table 1

List of Companies and Commodity Futures

Sector	Name of Companies	Symbol
Oil and Gas Exploration	Oil and Gas Development Company Ltd.	OGDC
	Pakistan Oil Fields	POL
	Pakistan Petroleum Limited	PPL
	Pakistan State Oil Co. Ltd.	PSO
	Shell Pakistan Ltd.	SHEL
Oil and Gas Marketing	Sui Nothern Gas Pipeline Ltd.	SNGP
	Sui Sourthern Gas Co. Ltd	SSGC
Commodity Futures	Crude Oil Futures	
	Natural Gas Futures	
	Gold Futures	

The return of each series was calculated using the following formula:

$$\frac{(P_t - P_{t-1})}{P_{t-1}}$$

To understand the dynamics of conditional volatility between two or more markets, Multivariate GARCH models are widely used. The most popular MGARCH models include VECM GARCH, DCC GARCH, CCC GARCH, BEKK GARCH, and diagonal BEKK GARCH. MGARCH models have the capability to forecast future volatility by incorporating the time varying nature of covariance between two or more time series. In this study, volatility transmission between different time series was examined using the BEKK-GARCH model, as it has been applied in a number of studies for the same type of time series (Ahmed & Huo, [2020](#); Ajmi et al., [2021](#))

BEKK-GARCH is superior to other M GARCH models in terms of positive definite of conditional covariance, which is an important element of variance and covariance matrices in finance. Another benefit of using the BEKK-GARCH model is simplicity and easy interpretation of parameters, which is lacking in other M GARCH models. Moreover, the model uses

fewer parameters. Furthermore, it allows flexible interaction between time series of different times. It allows capturing the volatility within and across markets and enables us to know the impact of good and bad news across markets.

This model also considers the interdependencies of conditional volatility among variables which other models ignore. The conditional variance and covariance equation of BEKK-GARCH for time series or variables is given below.

$$H_t = CC' + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1} \quad (1)$$

The equation below comprises an asymmetric term to know the impact of bad and good news (Grier et al., 2004; Kroner & Ng, 1998).

$$H_t = CC' + \hat{A}\varepsilon_{t-1}\varepsilon'_{t-1}A + \hat{B}H_{t-1}B + \hat{D}\varepsilon_{t-1}\varepsilon'_{t-1}D \quad (2)$$

Equation (2) is bi variate BEKK-GARCH model in which H is 2x1 matrix of conditional variance and covariance, whereas A, B, and D are 2x2 matrices. The elements of matrix A represent the impact of past shocks on conditional variance. The elements of matrix B represent the impact of past conditional volatility on conditional variance. Matrix D includes asymmetric terms through which the impact of bad or good news on conditional variance is determined. Only the off-diagonal elements of matrices B and D are presented in the results section because these coefficients are relevant to our study.

In this study, the volatility spillover developed by Diebold and Yilmaz (2012) is used to determine the level of connectedness among stocks and both stock and commodity futures. Total spillover from stock to any future instrument is calculated as shown below in equation (3).

$$S^g_{f \leftarrow s(H)} = \frac{\sum_{s=1, s \neq f}^n \theta^g_{sf}}{N} \quad (3)$$

Table 2
Descriptive Statistics – Oil and Gas Exploration

	OGDC		POL		PPL	
	St	Fut	St	Fut	St	Fut
Min.	-0.07498	-0.10523	-0.211	-0.09648	-0.19754	-0.19213
Max	0.59529	0.61091	0.2012	0.2101	0.63653	0.65526
Mean	-0.000394	-0.000372	-3.172e-5	-4.381e-5	-0.000425	-0.000409

	OGDC		POL		PPL	
	St	Fut	St	Fut	St	Fut
Median	-0.001311	-0.001459	-5.895e-4	-1.349e-3	-0.001923	-0.002222
SD	0.02230	0.02261	0.02152	0.02052	0.025584	0.025627
Jarque	5460373	6031878	14879	7851.30	3717802	4585273
Bera						
ADF	-13.5***	-13.4***	-9.3***	-9.3***	-12.2***	-12.3***

Total spillover from any futures to the stock of a particular company is calculated as shown in equation (4) below.

$$S^g_{f \rightarrow s(H)} = \frac{\sum_{s=1, s \neq f}^n f^{(H)} \theta^g_{fs}}{N} \quad (4)$$

The difference between equations (6) and (7) determines in each pair the ‘net receiver’ and ‘net transmitter’ of volatility.

Results and Discussion

Table 2 and Table 3 provide descriptive statistics and stationary results of oil and gas exploration and oil and gas marketing, respectively. From the above results, it can be observed that stock and future series of all selected companies remain stationary at 1% level of significance. The average return of stock is greater than the average return of futures in case of four companies, namely OGDC, PPL, PSO, and SSGC.

Table 3

Descriptive Statistics – Oil and Gas Marketing

	PSO		Shel		SNGPL		SSGC	
	St	Fut	St	Fut	St	Fut	St	Fut
Min.	-0.2394	-0.2378	-0.056	-0.057	-0.4366	-0.4265	-0.08319	-0.1286
Max	0.3897	0.4081	0.0737	0.0726	4.35853	4.3795	0.35424	0.3608
Mean	0.0000	0.0000	0.0007	0.0007	0.00262	0.0026	0.00006	0.0000
Median	-0.00130	-0.00115	-0.00125	-0.00147	-0.00196	-0.00140	-0.002096	-0.00189
SD	0.02364	0.02344	0.0182	0.0186	0.11474	0.1152	0.02562	0.0268
Jarque	187704	22842	29.209	15.35	118376387	117611785	33024	30321
Bera								
ADF	-12.29***	-12.33***	-7.33***	-7.43***	-11.34***	-11.4***	-11.97***	-12.0***

Note. *, **, *** indicate 10%, 5%, and 1% significance level respectively

Table 4

Descriptive Statistics – Commodity Futures

	Crude Oil	Natural Gas	Gold
Min.	-0.40627	-0.17164	-0.08890

	Crude Oil	Natural Gas	Gold
Max	0.32985	0.37799	0.06677
Mean	0.000558	0.001142	0.000199
Median	0.000199	-0.000354	0.00020
SD	0.032559	0.037176	0.011296
Jarque Bera	122141	5719.7	4346.8
ADF	-13.951***	-11.341***	-15.34***

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 4 provides the descriptive statistics and stationary results of the returns of selected commodity futures. The results show that all such returns are stationary at level. In terms of average return, natural gas has the highest average return of three commodity futures, whereas gold has the lowest average return.

BEKK-GARCH

Table 5

Stock Features—Oil and Gas Exploration

Coef	OGDC		POL		PPL	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	-0.18072	-1.531134	0.173365	-1.44289	-0.13222	-0.413628
B21	0.205484	1.231988	0.008506	0.132899	0.013085	-0.022308
G12	-0.04049	-4.3668***	-0.147	-5.285***	-0.04185	-4.1787***
G21	0.036579	2.2516**	0.034774	2.5983**	0.041203	0.73328

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 6

Stock Features—Oil and Gas Marketing

coef	PSO		SHEL		SNGPL		SSGC	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	-0.129	-2.357***	0.0514	0.1604	0.3096	-0.1741	0.38379	-2.35***
B21	-0.014	0.08269	-0.1491	-0.224	0.3096	0.16619	-0.0805	-0.807
G12	-0.06	-3.659***	-0.0442	-1.0752	-0.0788	-1.45419	-0.0361	-3.49***
G21	0.080	4.2198***	0.02929	0.3026	0.01224	0.25525	0.02567	2.414***

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 7*Crude Oil–Oil and Gas Exploration*

coef	OGDC		POL		PPL	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	-0.20583	-11.3917***	-0.01394	-0.66645	-0.21750	-8.94603***
B21	0.29157	7.20584***	0.06496	1.40629	0.19650	5.88317***
G12	0.02143	5.57387	0.01269	3.95407***	0.03960	8.20869***
G21	-0.00754	-0.56261	0.04658	3.9866***	-0.06513	-3.4152***

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 8*Crude Oil–Oil and Gas Marketing*

coef	PSO		SHEL		SNGPL		SSGC	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	0.00914	0.45017	0.0046	0.1938	-0.0634	-1.6483*	-0.0728	-1.2318
B21	0.0380	1.40872	0.0338	1.3549	0.0108	0.31391	-0.0225	-0.1889
G12	-0.00012	-0.06104	-0.0022	-0.5268	-0.0002	-0.03532	-0.0132	-0.8514
G21	-0.00076	-0.12975	-0.0028	-0.3841	-0.0417	-4.4662***	0.07094	1.98**

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 9*Natural Gas–Oil and Gas Exploration*

coef	OGDC		POL		PPL	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	-0.09826	-3.1283***	-0.16343	-7.0449***	-0.08394	-2.096**
B21	-0.20460	-2.598***	-0.15959	-1.9707**	-0.29220	-3.7903***
G12	-0.00283	-0.65861	-0.00462	-0.84034	-0.01880	-3.53674***
G21	0.04775	3.13980***	0.06513	3.46807***	0.08539	6.01613***

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 10*Natural Gas–Oil and Gas Marketing*

coef	PSO		SHEL		SNGPL		SSGC	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	-0.0425	-0.50419	-0.036	-0.34924	-0.055	-2.2071**	-0.114	-1.2747
B21	-0.2490	-3.28***	-0.189	-2.103**	-0.206	-3.36***	-0.186	-2.36***
G12	-0.00269	-0.3411	-0.0052	-0.68653	-0.025	-1.810*	-0.024	-2.65***
G21	0.07789	4.111***	0.04457	2.63***	0.0777	3.008***	0.060	2.01**

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 11
Gold–Oil and Gas Exploration

coef	OGDC		POL		PPL	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	0.00781	0.14430	0.07874	1.51548	5.87e-5	0.00050
B21	0.03821	-1.650*	-0.03875	-1.830*	-0.02458	-0.93722
G12	-0.00748	-0.84379	-0.01552	-1.43885	-0.04437	-4.5699***
G21	-0.00303	-0.57548	-0.00255	-0.41161	-0.01108	-1.645*

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 12
Gold–Oil and Gas Marketing

coef	PSO		SHEL		SNGPL		SSGC	
	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>	Value	<i>t</i>
B12	-0.0302	-0.3657	-0.1686	-1.0645	-0.2971	-3.936***	0.0256	0.3433
B21	0.0061	0.1447	-0.0196	-0.8728	0.0693	1.2502	-0.0283	-2.900***
G12	-0.0024	-0.3205	-0.0016	-0.0824	0.0294	2.08**	-0.0043	-0.2023
G21	0.0029	0.9739	0.0006	0.090	0.0037	0.6712	0.0016	0.3902

Note. *, **, *** indicate 10%, 5%, and 1% significance level, respectively.

Table 13
Results Summary

	Bi Directional	Uni Directional (Stock to Future)	Uni Directional (Future to Stock)
Stock Future		2	
Crude Oil Future	2		
Natural Gas Future	4	2	
Gold Future		1	1

Table 5 and Table 6 depict that two companies showed volatility spillover with stock futures. These two companies were Pakistan State Oil (PSO) and Sui Southern Gas Co. (SSGC), with volatility spillover coefficients B (1,2) as significant at 1% level of confidence. However, the sign of relationship is not the same since it is positive for SSGC and negative for PSO. As in most companies of oil and gas sector, stock futures and underlying stock have no linkage. This shows that stock futures of this sector are primarily used for hedging purposes. Asymmetric coefficient G (1,2) is also significant and negative. This indicates that there is no leverage effect in the relationship between these two instruments. So, any good and

bad news from stock futures have the same effect on its underlying stock. These results are different from the results of other studies (Ali et al., [2019](#); Gurbuz & Sahbaz, [2022](#); Siddique & Roy, [2020](#)).

On the other hand, companies in which volatility transmission existed between their stock and stock futures included PSO and SSGC. The existence of volatility for these two companies may be due to the fact that these companies are government owned and investors may perceive them as 'too big to fail'. Both these companies have a major role in energy supply, so any news may cause disturbance in their returns, providing an opportunity to market players to use these movements in their favour.

Table 7 and Table 8 depict the results of volatility transmission between the stock of selected oil and gas sector companies with crude oil futures. Oil and Gas Development Company (OGDC) and Pakistan Petroleum Limited (PPL) were found to have a bi-directional volatility transmission between their stock and crude futures at 1% level of significance. For both these companies, the sign of transmission is positive when its flow is from stock to futures with symmetric nature, as coefficient of G21 in asymmetric term is negative. In case of volatility transmission flow from crude oil futures to stock, it becomes negative, and the relationship remains asymmetric in nature. These results are similar to the findings of other studies (Kang & Yoon, [2019b](#); Soni & Nandan, [2022](#)).

Moreover, there is a uni-directional volatility transmission from stock to futures of Sui Northern Gas Co. (SNGC), with a negative sign and symmetric nature. Overall, these results show that crude oil futures can be used by portfolio managers for diversification purposes, although they remain less attractive for speculators. There may be a lack of interlinkages because of recent developments in the financial market of Pakistan aimed to minimize the speculative element of the market. Furthermore, OGDC, PPL, and SNGC were found to have volatility transmission with crude oil which may be because of their dependence on oil. These companies are from the oil and gas exploration sector; therefore, it is quite evident that crude oil impacts their stock. Policymakers also need to look into this fact that crude oil futures have a significant impact on government owned companies which may, in turn, impact the financial stability of the country. As in the case of stock futures, the study observed that speculators mostly eye these big companies for their speculative purposes.

Table 9 and Table 10 show the results of volatility transmission between stock and natural gas futures. Four companies namely OGDC, POL, PPL, and SNGPL have a bi-directional volatility transmission with gas futures. In all these four companies, the sign of transmission for both sides remain negative. Whereas, the nature of transmission remains symmetric, as coefficient $G(1,2)$ is significant and negative. This is so when transmission flow is from futures to stock and asymmetric when transmission flow is from stock to gas futures, since the coefficient $G(2,1)$ is significant and positive.

The reason of bi-directional volatility between the stock of these companies and their futures may be due to the fact that oil and gas are alternative energy sources and, in most cases, the rise of one causes the fall of other. This may also be the reason that these oil and gas exploration companies have a bi-directional volatility with natural gas futures. Another notable fact is that the nature of transmission remains asymmetric and transmission flow is from stock to futures. This may be due to the reason that these companies are major suppliers of energy in the country and any major development in the energy sector impacts them, which may result in panic activities by traders. The current findings are somewhat different from other studies which found that natural gas had no volatility transmission with their related sector's stock return (Borg et al., [2022](#); Umar et al., [2020](#)).

Table 11 and Table 12 depict the results of stock with gold futures. The tables depict that three companies SSGC, POL and OGDC have a uni-directional volatility transmission with gold futures at 10% level of significance. In SSGC and ODGC, the flow of transmission is from stock to gold futures with a negative sign for SSGC and a positive sign for OGDC. For SNGP, the flow of transmission is from gold futures to stock with a negative sign. Again, in case of gold, futures have a linkage with companies owned by the government. This again reveals that market players use these companies for speculative activities. This is an important finding for policymakers to look into and also for the portfolio managers who mostly believe that gold is an instrument for effective diversification strategies. This may be due to the reason that gold does not have any natural relevance with oil and gas sector and any movement in their stocks may not translate into changes in the volatility of gold futures.

Spillover Index**Table 14***Stock Future – Oil and Gas Exploration*

	OGDC				POL				PPL		
	Futures	Stock	From		Futures	Stock	From		Futures	Stock	From
Futures	83.90	16.1	8.05	Futures	97.23	2.77	1.38	Futures	95.50	4.50	2.25
Stock	0.46	99.54	0.23	Stock	0.22	99.78	0.11	Stock	3.80	96.20	1.90
To	0.23	8.05	8.28	To	0.11	1.38	1.49	To	1.90	2.25	4.15

Table 15*Stock Futures – Oil and Gas Marketing*

	PSO				SHEL				SNGPL				SSGC		
	Fut	St	From		Fut	St	From		Fut	St	From		Fut	St	From
Fut	97.6	2.4	1.19	Fut	91.83	8.2	4.08	Fut	79.0	20.9	10.48	Fut	72.68	27.32	13.66
St	0.9	99.1	0.46	St	0.88	99.1	0.44	St	15.3	84.7	7.64	St	0.25	99.75	0.13
To	0.5	1.19	1.65	To	0.44	4.1	4.52	To	7.6	10.5	18.11	To	0.13	13.66	13.79

Table 16*Crude Oil – Oil and Gas Exploration*

	OGDC				POL				PPL		
	Crude	Stock	From		Crude	Stock	From		Crude	Stock	From
Crude	95.70	4.30	2.15	Crude	95.90	4.10	2.05	Crude	96.69	3.31	1.65
Stock	4.54	95.46	2.27	Stock	4.50	95.50	2.25	Stock	3.45	96.55	1.72
To	2.27	2.15	4.42	To	2.25	2.05	4.30	To	1.72	1.65	3.37

Table 17**Crude Oil – Oil and Gas Marketing**

	PSO				SHEL				SNGPL				SSGC		
	Crude	Stock	From		Crude	Stock	From		Crude	Stock	From		Crude	Stock	From
Crude	99.3	0.68	0.34	Crude	99.6	0.44	0.22	Crude	99.91	0.09	0.04	Crude	99.9	0.07	0.03
Stock	0.71	99.3	0.36	Stock	0.42	99.6	0.21	Stock	0.02	99.9	0.01	Stock	0.08	99.9	0.04
To	0.36	0.34	0.70	To	0.21	0.22	0.43	To	0.01	0.04	0.05	To	0.04	0.03	0.07

Table 18**Natural Gas – Oil and Gas Exploration**

	OGDC				POL				PPL		
	Gas	Stock	From		Gas	Stock	From		Gas	Stock	From
Gas	99.81	0.19	0.09	Gas	99.94	0.06	0.03	Gas	99.80	0.20	0.10
Stock	0.03	99.97	0.02	Stock	0.12	99.88	0.06	Stock	0.27	99.73	0.13
To	0.02	0.09	0.11	To	0.06	0.03	0.09	To	0.13	0.10	0.23

Table 19**Natural Gas – Oil and Gas Marketing**

	PSO				SHEL				SNGPL				SSGC		
	Gas	Stock	From		Gas	Stock	From		Gas	Stock	From		Gas	Stock	From
Gas	99.93	0.07	0.04	Gas	99.99	0.01	0.01	Gas	99.66	0.34	0.17	Gas	99.47	0.53	0.27
Stock	0.02	99.98	0.01	Stock	0.26	99.74	0.13	Stock	0.02	99.98	0.01	Stock	0.32	99.68	0.16
To	0.01	0.04	0.05	To	0.13	0.01	0.14	To	0.01	0.17	0.18	To	0.16	0.27	0.43

Table 20*Gold- Oil and Gas Exploration*

OGDC				POL				PPL			
	Gold	Stock	From		Gold	Stock	From		Gold	Stock	From
Gold	99.98	0.02	0.01	Gold	99.73	0.27	0.13	Gold	99.97	0.03	0.01
Stock	0.03	99.97	0.02	Stock	0.04	99.96	0.02	Stock	0.06	99.94	0.03
To	0.02	0.01	0.03	To	0.02	0.13	0.15	To	0.03	0.01	0.04

Table 21*Gold – Oil and Gas Marketing*

PSO			SHEL			SNGPL			SSGC		
	Gold	Stock	From		Gold	Stock	From		Gold	Stock	From
Gold	99.91	0.09	0.04	Gold	99.98	0.02	0.01	Gold	99.99	0.01	0.01
Stock	0.02	99.98	0.01	Stock	0.06	99.94	0.03	Stock	0.06	99.94	0.03
To	0.01	0.04	0.05	To	0.03	0.01	0.04	To	0.03	0.01	0.04

Table 14 and Table 15 show the results of the spillover index between stock and stock futures. The results show that the stock of SSGC makes the highest contribution in the volatility of its stock futures (13.60%), followed by SNGPL with 10.48% and OGDC with 8.05%. The share of stock futures in the volatility of underlying stock is high in SNGPL with 15.27%, whereas stock futures of most companies have a very nominal share in the volatility of underlying stock. Tables 16 and 17 depict the spillover indices between stock and crude oil futures. The values in the tables show that the magnitude of the share in the volatility of each instrument is not very high. The stock of all companies was found to be the net receiver of volatility and crude oil futures remain the net transmitter of volatility. However, a directional volatility spillover shows that the difference between the volatility transmitted and received is not very high.

Table 18 and Table 19 show the spillover index results with natural gas futures. Like crude oil futures, the level of connectedness between stock and natural gas futures is very low. However, in terms of net receiver and net transmitter, the results are mixed. In four companies namely OGDC, PSO, SNGPL, and SSGC, natural gas was found to be the net receiver of volatility, while the stock of these companies remains the net transmitter of volatility.

Table 20 and Table 21 show the results of spillover index with gold futures. The tables clearly show that the level of spillover index remains low in all companies of the oil and gas sector. This again confirms that gold can be used as a hedging instrument.

The results of this study advocate different trading strategies for different market players. In the first case, the results of stock futures show that stock futures of this sector are mostly used by market players for hedging purposes, which is the ultimate goal of policymakers behind introducing stock futures in the market. This would encourage them to leverage the policy of introducing the stock futures of other companies as well. Similarly, a low level of volatility transmission with gold futures provides the opportunity for portfolio managers to add gold futures in their portfolio for investment made in the stock of this sector. Further, speculation may occur for trading in oil, gas futures, and stock of these companies. This also demands the attention of policymakers to regulate the movement of capital between stock market and commodity market.

Conclusion

The study attempted to make a comparison of the relationship of stock with stock futures, related futures, and unrelated futures. The results of this study confirmed that in the oil and gas sector, either stock futures have lead in transmitting volatility to underlying stock or no significant volatility transmission between stock and single stock futures occurs. The results of BEKK-GARCH revealed that POL, PSO, and SSGC had uni volatility transmission from stock futures to underlying stock. In PSO, stock futures had a negative impact on the volatility of underlying stock, which indicates that stock futures can be used for hedging purposes. Only in OGDC, stock and stock futures had a bi directional volatility transmission.

Crude oil and natural gas futures were also found to be the net transmitter of volatility to stocks of some of the companies of these two sectors. The results with gold futures also confirmed that gold showed a very low level of volatility transmission with selected companies, which confirmed that it can be used for diversification purposes. The findings of this study would be helpful for policymakers in terms of understanding the behaviour of stock and commodity futures in the financial market.

Implications

Policymakers can use these findings of this study in two ways. The first is to figure out the exact role of stock futures in the oil and gas sector, since the main purpose of introducing stock futures was to reduce speculative activities in the stock market of the country. Moreover, they can introduce customize policies for the oil and gas sector based on the findings of this study. Based on this, studies on other sectors can also be carried out to clarify the role of stock futures in the stock market. The second is to determine the role of selected commodity futures, that is, whether they have the properties of hedging or financialization behaviour. Traders can use commodity futures either as a diversifier or as an alternative asset for parallel investment.

Future Research Directions

Traders and portfolio managers can devise their strategies keeping in view the companies which are part of their portfolio, as the results have confirmed that the nature of the linkages of commodity futures is not the same across the sectors. For future studies, other sectors can also be examined for their time varying relationship with other commodity futures,

including agriculture futures, currency futures, and other metal futures. Similarly, the impact of stock futures can be further analyzed as stock futures of 84 companies from 22 different sectors are listed on PSX. So, in future studies, the relationship of stock futures and the underlying stock of other sectors can also be investigated. Specially, those sectors which have a major influence on market performance including commercial banks, textile, fertilizers, and technology and communication sector should be focused in future studies.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

The data associated with this study will be provided by the corresponding author upon request.

Funding Details

This research did not receive grant from any funding source or agency.

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