Bulletin of Business and Economics, 12(4), 238-253
https://bbejournal.com
https://doi.org/10.61506/01.00108

Non-Financial Markets and Interconnectedness between US and Emerging Financial Economies: Evidence from Covid-19 Financial Crisis

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Abstract
During times of financial turmoil, when traditional assets experience significant volatility, commodity markets provide diversification benefits to investors. The objective is to investigate the factors influencing financial contagion between the United States and emerging Asian equity markets (China and India). The study analyzes the influential impact of the volatility index, gold, oil, and USD index on financial contagion among the markets. The dynamic conditional correlation analysis is utilized to explore the correlations during the US subprime and Covid-19 crises, and quantile regression analysis is conducted at different levels of time-varying correlations. The study's results suggest that financial contagion becomes more pronounced during periods of financial turmoil, and global financial crises contribute to alterations in the dependence structure between financial contagion among equity markets and global macroeconomic risk factors. The effect of financial contagion can be abridged through altering portfolio reallocation strategies according to investors' risk appetite during high market volatility.
Keywords: financial contagion, emerging financial markets, financial econometrics, macroeconomic global risk factors

1. Introduction

The global commodity markets have become increasingly interconnected, serving as vital conduits for trade and economic growth across nations. Among these markets, the United States (US) plays a pivotal role as both a major consumer and producer of commodities, while emerging economies have emerged as significant players, driving demand and supply dynamics. The intricate web of interactions between the US and emerging economies in commodity markets has garnered considerable attention from researchers and policymakers alike. Developed markets being robust and mature capital markets provide innovative investment products, trading platforms and broaden market participation. Developing economies being risky economies often offer higher growth rates and investment returns compared to developed economies (Mensi, Hammoudeh, & Kang, 2017; Audi et al., 2023). When there is severe disruption in the functioning of financial system, significant decline in the value of financial assets and a loss of confidence in financial institutions occur, resulting in financial distress (Bandt & Hartmann, 2000; Ali, 2022). Global equity markets are interconnected through financial institutions. Investors often hold portfolios that include equities from various countries. Financial crisis often spread through interconnected financial system and there create a financial contagion among global equity markets. When a financial crisis occurs in one country, its shocks transmit in other country (Balcilar, Elsayed, & Hammoudeh, 2023). In this interconnected world, news and information travel rapidly, and negative developments in one market can quickly spread to others. News of financial distress in one country can erode investor confidence globally. Recent events in financial markets have revealed that, in addition to advanced economies, emerging economies in the Asian region play a significant role in transmitting financial shocks globally (Buchanan, English, & Gordon, 2011; Ali, 2022).

Contagion is the spread of financial shocks from one country to other countries. It may be cross-country transmissions of shocks or cross-country spillover effects. Contagion is also the detection of stress transmissions. In the markets where contagion exists, correlations dynamically move on increasing trend and co-integration across markets significantly increases. According to Longin & Solnik, (1995); Forbes & Rigobon, (2001); Chiang, Jeon, & Li, (2007) and Dooley & Hutchison, (2009) speculators, investors, global market players and policy makers consider very important to financial contagion among markets. Intermarket connectedness plays a significant role in transmission of systematic risk across markets or institutions and spread of contagion is linked by systematic risk (Balcilar, Elsayed, & Hammoudeh, 2023).

There are two possible theories of contagion among countries. One is the fundamental contagion and other is the pure (investor-based) contagion (Forbes & Rigobon, 2001). Fundamental contagion theory posits that cross-market linkages undergo a significant increase following a shock to a country, driven by fundamental factors like the flow of goods, services, and capital. In contrast investor-based contagion does not attribute the transmission of stress to changes in fundamentals. According to pure contagion theory, a shock in one country leads to stress transmission in another country due to investors lacking anticipation, which stems from incomplete information. After a shock to a country, investors' risk appetite or aversion to risk undergoes changes, resulting in a notable increase in cross-market interconnectedness. A decrease in investors' risk appetite results in a reduction in their exposure to risky assets in the international market, leading to a decline in the prices of these assets and vice versa. This form of contagion is driven by changes in the portfolio structure of global investors rather than the inherent characteristics of the market (Kumar & Persaud, 2001). This risk reassessment is called Wake up call. It increases the relative importance of domestic fundamentals in the transmission of stress during period of turmoil. The "wake-up call" theory of contagion can provide insights into how commodity market returns impact the interconnectedness between the United States (US) and emerging financial economies. According to this theory, a shock or event in one market can serve as a wake-up call, leading market participants to reassess their risk exposures and causing contagion effects to spread across interconnected markets.

The interconnection among global financial markets undergoes fluctuations during crisis periods, with non-financial markets exerting a significant influence on the integration of global financial markets. The literature has shown a particular interest in understanding the impact of commodity market returns on the interconnectedness between the United States (US) and emerging financial economies. Dahlqvist (2018) explores information transmission among countries, investigating the role of commodity

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markets as an indirect channel of information transmission. Junttila, Pesonen, & Raatikainen (2018) scrutinize the correlation between commodity markets and equity markets during financial crises. Additionally, Kocaarslan, Soytas, Sari, & Ugurlu (2018) inquire the impact of gold price, oil price, and financial stress on financial contagion between the US and BRIC markets, concluding that global financial crises have altered the dependence structure among equity markets and non-financial markets.

Gold is often considered a safe-haven asset and its price movements can influence investor behavior and risk perceptions, thereby potentially affecting the transmission of shocks and contagion effects between these economies. Oil prices play a significant role in global markets and their fluctuations can have far-reaching effects on financial systems and economies. Oil is a critical input in various industries and has a direct impact on production costs and consumer prices. Changes in oil prices can create transmission channels for contagion effects, as economic shocks in one country can spill over to others through trade and financial linkages. Currency returns reflect the relative strength or weakness of a currency and can significantly influence cross-border trade, capital flows, and financial market dynamics. Variations in currency returns have the potential to impact the competitiveness of exports and imports, thereby affecting trade balances and overall economic performance.

This research contributes to the existing literature by addressing the influence of volatility index and non-financial markets (gold, oil and currency) returns on the interconnectedness between the US and emerging financial economies. It examines how shocks and changes in commodity market returns act as wake-up calls, triggering reassessments of risk exposures and potential contagion effects in interconnected markets. The study also identified the impact of commodity markets returns on the financial contagion among Asian emerging economies and US economy before and after US-subprime crisis and Covid-19 crisis.

The focus of this study is to derive the determinants of financial contagion among economies. For that purpose, the dynamic conditional correlations (DCC) series among Asian emerging economies and US economy are derived from DCC-GARCH model. Further, quantile regression model is applied to identify the driving factors of intermarket connectedness. Volatility index, gold prices, oil prices and USD index are the explanatory variables. The analysis is performed by considering specific quantiles (low, moderate, high) of the dynamic conditional correlations series. Quantile regression technique allows the researchers to compare different episodes of the financial contagion. The results indicate that the roles of financial and non-financial markets have been altered during both the US subprime and Covid-19 crises. Post-global financial crises, an uptick in gold prices is associated with a reduction in correlations between Asian emerging economies and the US. This suggests that investors tend to liquidate holdings in risky assets, turning toward safe-haven assets like gold and the USD index. Regarding the impact of oil prices on interconnectedness, following global financial crises, an increase in oil prices prompts investors to readjust their global portfolios to manage oil price risk. Consequently, it influences the interconnectedness between Asian emerging and US economies. Countries' specific characteristics and macroeconomic policies are also influence the financial contagion among economies.

The paper proceeds as follows. The second section provides literature review. The data sources and preliminary analysis are discussed in third section. In the fourth section, methodology and empirical results are presented. Discussion on the findings is covered in fifth section. Conclusions are coved in sixth and last section.

2. Literature Review and Asian Emerging Economies

Asian emerging stock markets play a crucial role in the region's economy and global financial landscape. Emerging markets became important for global investors after 2008 global financial crisis (Kocaarslan, Sari, Gormus, & Soytas, 2017). Trends and events in any financial or non-financial market influence the price movement of another market. Changes in the prices of non-financial markets' products create a trickle-down effect that eventually influences the prices of financial market instruments. As commodities of non-financial markets are extracted, refined, drilled, and produced by organizations listed on different financial markets (Domanski & Heath, 2007). So, the decision and behavior of investors in financial market can influence the prices and accessibility of commodities throughout the economy.

A financial crisis negatively affects the behavior of financial and non-financial markets, and short-term investors face major consequences, while this behavior is well for long-term investors (Cheng & Xiong, 2014). During covid-19 crisis, stock exchanges have fallen by more than 30 percent. Implied instability in stock and oil prices has reached crisis levels. Credit extents on non-investment-grade obligation have broadened quickly as investors downgrade risks (OECD, 2020). As the correlation coefficient between financial and nonfinancial markets increases during a crisis period, and behavior of both markets rapidly changes with the change in investors' decisions. A global financial crisis can increase commodity prices, which can lead to recession, a decrease in stock prices, and the devaluation of currencies (Nagle, 2020). When stock and commodity prices reach bottom levels, long-term investors begin to invest more. This is why every recession is followed by a rapid recovery in the financial markets (Ayadi, Gana, Goutte, & Guesmi , 2021).

Contagion is the expansion of a fiscal crisis from the market of one region to the market of another region and may be either domestic or globally (Morris, 2000). Contagion may be situated because many similar services and goods, particularly capital goods and labor, can be used in many various markets and because practically all markets are linked by financial and monetary systems (Bae, 2003). Contagion impacts describe the likelihood of spreading of financial crisis boom up to throughout the countries or districts.

In modern financial markets, the required information is gathered around the clock for investors. The availability of relevant information increases interconnectedness and spillover between the US market and emerging Asian markets (Dogah & Premaratne, 2023). Contagion and interconnectedness are relevant in the emerging and developed economies. The notable work of Dogah (2021) showed that the US sustains the role as the most systematic and fundamental financial market in the long run, while other financial markets rarely took the central role as leading markets. This is why Asian markets have strong interconnectedness with the US

market. It indicated that stock exchanges are more dynamic during trading periods and US markets provide more relevant information which increases spillovers or contagion between emerging Asian markets and developed US markets.

During the last decades as globalization increases, a great interest has attracted by the correlations between the countries' risks, global factors and the performances of stock markets (Forbes & Rigobon, 2001; Abad, Chuliá, & Gómez-Puig, 2010). The globalization of financial markets has a significant influence on the performance of international portfolios and risk management. International diversification of risk is highly valued and sought after by investors. However, during periods of crisis when international diversification is most needed, the opportunity for such diversification diminishes. Understanding the linkages between markets is of particular importance for financial market regulators, given the perceived increase in contagion among global financial markets (Ahlgren & Antell, 2010).

The notable work of Gunay & Can (2022) has explored global financial crisis and spillover or contagion between developed and emerging markets. Gunay & Can (2022) has used the ICSS test and Diebold-Yilmaz interconnectedness analysis for the empirical investigation of the financial interconnectedness of developed and emerging markets. The results of the study show that although the outbreak region of Covid-19 was in China, the financial markets of the United States were the source of financial spillovers and interconnectedness during the epidemic, just as it was during Subprime Mortgage Crisis. The spread of negative impacts was much higher among developed markets than among emerging financial markets.

US Subprime Mortgage Crisis 2007-2008, and Covid-19 crisis created a prominent financial spillover between developed and emerging markets (Dogah & Premaratne, 2023). The role of stock markets in determining the value of real equity values makes them important for countries around the world. In addition, stock markets are vital indicators for the financial position of countries as equity prices can integrate expectancies of several markets' participants (Gunay & Can, 2022). Chang, McAleer, & Wang (2020) elucidated that spillovers and contagion exhibit time-varying patterns, peaking during the global financial crisis. The authors' empirical evidence showed that during the financial crisis of Covid-19, asymmetric effects of Chinese and US markets have been observed in other emerging Asian markets. Gunay & Can's (2022) research findings suggested that the epicenter of the financial crisis and its cross-market interconnectedness were not dependent. Despite the initial outbreak of Covid-19 in China, it was revealed that the United States exerted a dominant influence on global financial markets in terms of spillovers and interconnectedness during this crisis. It is evident from the prior researches that global financial crisis has created high uncertainty in equity markets globally that resulted in increased interdependency across equity markets globally.

Contagion effect largely depends upon characteristics of economies, trade and stock market activities. Strong economies have capacity to buffer the economic shocks while week or developing economies may have magnifying effects of shocks. Trade characteristics of China, India and US economies are presented in Table 1. In panel A, both China and India have almost same trade to GDP, export to GDP and total reserves in USD to GDP ratios but China is exporting manufactured products more than India. Indian equity market is more open for international investors. The economies with highest reserve ratio has capacity to absorb shocks compared to economies with lowest reserve to GDP ratio. Panel B provides information about the global rankings of the markets. Global ranking of countries also plays a significant role in contagion effects. Global ranking in this study has been measured through different index including financial development index, Index of economic freedom, ease of doing business, global competitiveness index, and the GDP growth index. Index of economic freedom indicates the degree to economic freedom in countries is supported by policies and institutions of countries. Economic freedom index evaluates the nations' degree of economic independence (Dialga & Vallée, 2021). Countries with larger economic freedom score have stronger economy with greater individual GDP. The ease of doing business index shows how favorable the regulatory environment is for business operations (Babatunde, et al., 2021). Global competitiveness index captures micro-economic and macroeconomic foundations of a nation's competitiveness. It depicts the level of productivity of a country that is affected by various institutions, policies, and factors. China is leading India globally according to all above mentioned global rankings. GDP (Gross Domestic Product) and exchange rate index measures the inflation in the prices of goods and services and devaluation of currency. According to the World Bank, India and China are leading countries among Asian emerging economies as their GDP growth index is 8.7 and 8.1 respectively. The financial characteristics of both economies are presented in Panel C. turnover ratios indicate that China has more liquidity than India. It also indicate that stock market size relative to GDP has also increased across years for China. The differences in the characteristics arise some questions that how dynamic correlations are derived through global economic factors, is there any impact of global economic crisis on dynamic correlations among Us, India and China.

Data shows the global rank for each market. Financial development index (2016, 2020) is sourced from International Monetary Fund (IMF). Index of economic freedom (2018, 2020), Ease of doing business (2016, 2020) and GDP growth 2021 are sourced from World Bank. The global competitiveness index is sourced from "The Global Competitiveness Report 2019" from World Economic Forum.

3. Data Sources and Preliminary Analysis

Daily closing prices for both US and emerging Asian markets (China and India) have been acquired from the Wall Street Journal. Volatility index data originates from the Chicago Board Options Exchange (CBOE). The Volatility Index (VIX) holds significant value in the trading and investment realms, offering a quantifiable measure of market risk and investor sentiments in real time. Daily gold price data is sourced from the data repository of Deutsche Bundesbank, known for providing reliable, accurate, and regularly updated information. Oil price data is obtained from the Energy Information Administration, specifically focusing on West Texas Intermediate (WTI) daily figures. The USD index data is derived from the Wall Street Journal, offering historical daily data. The

sample period spans from January 1, 2000, to April 30, 2023, encompassing both pre-crisis and post-crisis periods. The dataset comprises 8,521 observations for each series.

The study has used first differences of logarithmic equity market prices as equity market returns. Considering the local inflation factor and systematic risk of the countries, market indices are expressed in US dollars because global investors are more concerned about dollar dominated profits.

Table 1: Trade and Financial Characteristics

Panel A: Trade characteristics and total reserves of stock markets

Markets	Trade to GDP ratio (%)	Export to GDP ratio (%)	Exports of manufactures (% of merchandise exports)	Market openness	Total reserves in USD / GDP (%)
	2020	2020	2020	(2018)	2020
US	23.38	10.13	55	27.61	0.688
China	35	18.6	94	37.57	22.858
India	38	18.7	71	43.62	22.125

Panel B: Global rankings of equity markets

Markets	Financial development index (IMF)		Index of economic freedom (World Bank)		Ease of doing business (World bank) Score out of 100		The global competitiveness index	GDP Growth (average prices & exchange rate) (World Bank index)
	2016	2020	2018	2020	2016	2020	2019	2021
US	0.9	0.91	75.1	76.6	63.1	84	83.7	5.7
China	0.63	0.78	57.4	59.5	83.6	77.9	73.9	8.1
India	0.42	0.52	52.6	56.5	54.5	71	61.4	8.7

Panel C: Financial characteristics

Markets	Market capitalization of listed companies (% of GDP)	Market capitalization of listed companies (% of GDP)	Market capitalization of listed companies (% of GDP)	Stocks traded turnover ratio of domestic shares (%)	Stocks traded turnover ratio of domestic shares (%)	Stocks traded turnover ratio of domestic shares (%)
	2010	2015	2020	2010	2015	2020
US	114.8	137.7	193.3	208.4	94.7	108.5
China	66.2	74.0	83.2	205.0	249.9	258.6
India	105.2	83.0	97.3	60.2	46.3	75

Note: Data shows the trade characteristics for each market. The data is sourced from World Bank. Financial characteristics for all economies are sourced from World Bank.

Descriptive statistics for all indices, volatility index (VIX), gold prices (GP), oil prices (OP) and USD index (USDX) are presented in table 2. The standard deviation of both Chinese and Indian markets is almost same which shows that risk of both markets is same. The Jarque-Bera value for all the variables is extremely high which indicates that the data is not normally distributed. It is also clear form the kurtosis that all the variables except GP, Op and USDX have the value of kurtosis more than 3 which means the distribution is leptokurtic i.e. it is more peaked and has heavier tails than a normal distribution. Therefore, in this study GARCH models are applied to adjust the presence of leptokurtosis. Table 3 shows the unit root test results of all variables. The study has used Augmented Dickey and Fuller (1979) (ADF) and Philips and Perron (1988) (PP) tests. The findings of ADF and PP demonstrate that all the variables are stationary except GP, OP and USD index as the values are highly negative which strongly evident against the null hypothesis. Natural log transformations of gold, oil and USD index are employed for quantile regression analysis. Figure 1 shows the evolution of equity market indices returns over the sample period. The graphs represent a clear presence of heteroscedasticity and volatility clustering. The researcher can observe sudden spikes or drops in the variance, this may indicate heteroscedasticity. The study has also identified volatility clustering in the sample data as there is period of high volatility followed by a period of low volatility, followed by another period of high volatility. These results instigate the researcher to make use of GARCH models to examine the correlation among markets.

Table 2: Descriptive statistics of all indices, volatility index, gold prices, oil prices and USD index

	DLUS	DLCH	DLIN	VIX	GP	OP	USDX
Mean	0.0000605	.000082	.0001539	20.17649	1059.136	62.73681	91.7258
Maximum	.098326	.094032	.080302	82.69	2061.5	145.31	120.92
Minimum	-0.141942	-0.139309	-0.172586	9.14	256.7	-36.98	71.33
Standard deviation	0.0094558	0.0111803	0.0120649	8.628317	527.706	26.04172	11.32082
Standard Error	0.0001024	0.0001211	0.0001307	0.0934993	5.718396	.2821966	.1226762
Skewness	-1.000773	-.6762883	-.870655	2.108209	-.1052261	.3165499	.4862932
Kurtosis	24.78417	14.87032	17.52974	10.40839	1.742619	2.303492	2.554257
Jarque-Bera	1.7e+05	5.1e+04	7.6e+04	2.6e+04	576.7	314.4	406.1
Probability	0	0	0	0	6.e-126	5.5e-69	6.4e-89
Observations	8,521	8,521	8,521	8,521	8,521	8,521	8,521

Note: Table 2 represents descriptive statistics of market returns of US, China, India, volatility index, gold prices, oil prices and USD index. DLUS, DLCH, DLIN are the daily market returns of US, China and India respectively. VIX, GP, OP and USDX are volatility index, gold prices, oil prices and USD index respectively.

Table 3: Unit root test results for Stock Market Indices, VIX, GP, OP and USD index

	ADF Statistics	P-Value	PP Statistics	P-Value
USA	-89.007 ***	0.000	-88.990***	0.000
China	-84.932***	0.000	-85.341***	0.000
India	-79.121***	0.000	-79.201***	0.000
VIX	-7.161***	0.000	-6.571***	0.000
GP	-0.553	0.8813	-0.615	0.8676
OP	-2.535	0.1071	-2.451	0.1278
USDX	-1.425	0.5704	-1.501	0.5331

Note: Table 3 presents Augmented Dickey and Fuller and Philips and Perron tests. *, **, *** shows significant at the 10%, 5% and 1% level. DLUS, DLCH and DLIN are the daily returns of USA, China and India. VIX, GP, OP and USDX are volatility index, gold prices, oil prices and USD index respectively.

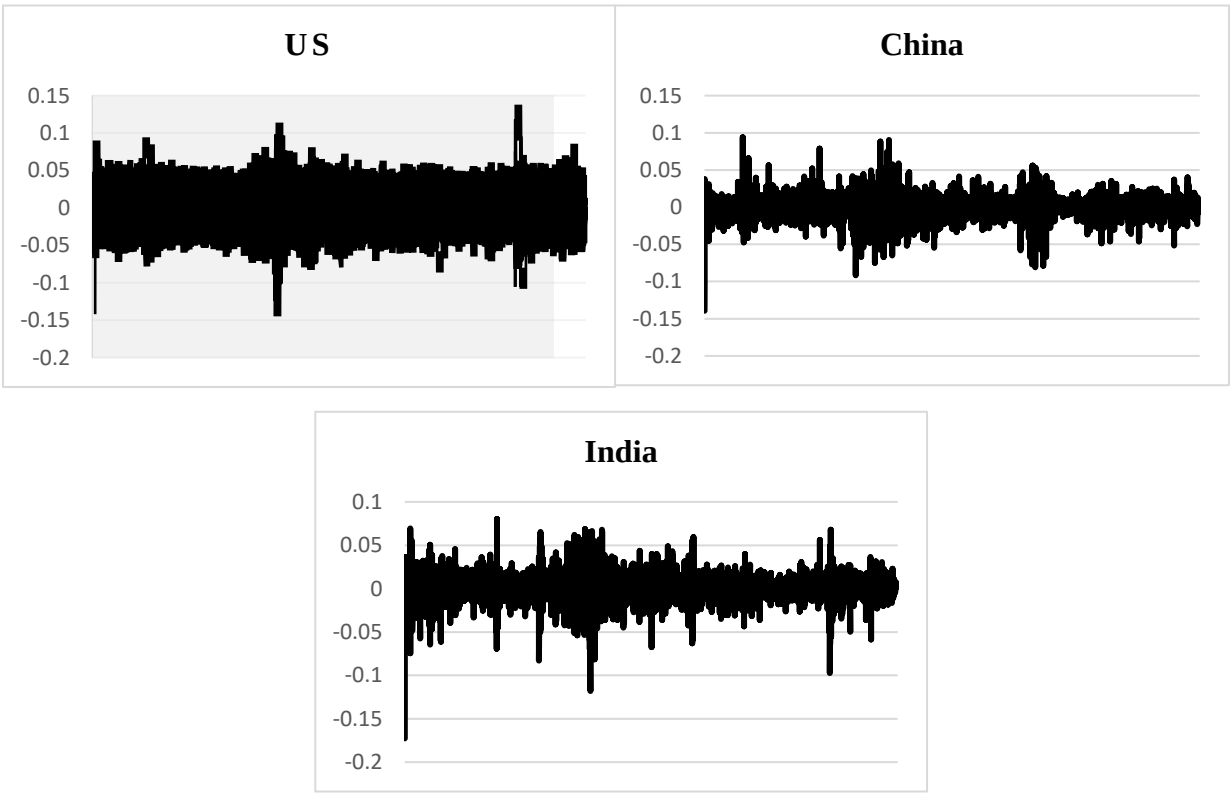

Figure 1: Evolution of market returns

4. Methodology and Empirical Findings

The empirical analysis is divided into two parts. In the first part DCC (Dynamic Conditional Correlations) model is applied to determine the correlation series between US and emerging Asian equity markets and in the second part quantile regression model is applied to determine the driving factors of financial contagion between equity markets.

In the first part, the study has developed and estimated a vector autoregressive (VAR) model by considering the linear relationship between China, India and the US equity markets in the mean equation. The mean equation 1 is indicated as follows;

$$Y_t = \varphi_0 + \sum_{i=1}^{n} \varphi_i Y_{t-i} + \varepsilon_t \qquad 1$$

In the above equation 1, Y_t represents three variable vector containing the US, Chinese and Indian markets. The VAR framework is used to control the serial correlation and non-synchronous trading hours over the globe. The non-synchronous trading hours are also controlled by taking closed-to-closed indices prices over the sample period.

The study has used five lags length as it enables the researcher to consider within week variation in trading patterns (Forbes and Rigobon, 2002). The optimal selection of lags length is also based on Log-Likelihood ratio, Akaike Information Criterion (AIC) and Hannan-Quinn information Criterion (HQIC). To identify the best-fitting univariate GARCH model, various members of the GARCH family are compared. These include the exponential GARCH (EGARCH) model proposed by Nelson (1991), the Glosten-Jagannathan-Runkle GARCH (GJR-GARCH) model introduced by Glosten, Jagannathan, & Runkle (1993) and Zakoian (1994).

The researcher applied the Threshold GARCH (1, 1) model, also recognized as the GJR-GARCH model. This model accommodates distinct dynamics in periods of high and low volatility. It formulates the conditional variance of a time series by considering both previous variances and past squared errors, incorporating a threshold variable that reflects the market's state. In the TGARCH model, the threshold variable is usually represented by a dummy variable, taking the value of 1 when the observed volatility surpasses a specific threshold and 0 when it falls below that threshold. The threshold can be set to capture a specific market condition or event that may affect volatility. In the context of stock returns, the threshold can be set to capture periods of market crashes or high volatility. The equation 2 represent TGARCH model.

$$\sigma_t^2 = \omega + \alpha\left(\varepsilon_{(t-1)}^2 - \gamma\sigma_{(t-1)}^2\right) + \beta\sigma_{(t-1)}^2 + \delta I_{(t-1)}\left(\varepsilon_{(t-1)}^2 - \gamma\sigma_{(t-1)}^2\right) \qquad 2$$

Where σ_t^2 is the conditional variance of the time series at time t, ε_t is the error term at time t, ω is the intercept,α,β, and δ are parameters to be estimated, γ is the threshold, and I_t is the threshold dummy variable that takes the value of 1 when $\varepsilon_{(t-1)}^2 > \gamma\sigma_{(t-1)}^2$ and 0 when $\varepsilon_{(t-1)}^2 < \gamma\sigma_{(t-1)}^2$.

The TGARCH model allows for asymmetry in the volatility response to positive and negative shocks, as well as for non-linear relationships between past variances and past squared errors.

Table 4: Mean equation findings

Mean Equation Findings

	Dependent variables		
Independent Variables	DLUS	DLCH	DLIN
DLUS(-1)	0.029844***	0.1581***	0.253218***
DLUS(-2)	0.019525	0.01018	0.063976***
DLUS(-3)	-0.01138	0.020552	0.051382***
DLUS(-4)	-0.03394**	0.002017	-0.0039
DLUS(-5)	-0.00197	0.001146	0.018997
DLCH(-1)	0.014091**	0.042812***	-0.02458***
DLCH(-2)	-0.00525	0.070614***	-0.00018
DLCH(-3)	-0.00102	0.015757	0.001296
DLCH(-4)	-0.00142	-0.02924**	-0.01075
DLCH(-5)	-0.00499	0.000712	0.011316
DLIN(-1)	-0.00297	-0.00062	0.073095***
DLIN(-2)	0.014345*	-0.00818	0.018803
DLIN(-3)	0.007931	0.005126	0.001365
DLIN(-4)	0.003977	0.01297	-0.00082
DLIN(-5)	-0.00893	0.001439	0.002182

Note: Table 4 displays the estimated coefficients in the mean equations for market returns. The dependent variables are the returns of stock market indices, and the independent variables consist of lagged returns of market indices. Significance levels are denoted by *, **, and ***, indicating significance at the 10%, 5%, and 1% levels, respectively. DLUS, DLCH, and DLIN represent the daily market returns of emerging Asian equity markets (China and India) and the US equity market.

Table 4 presents the mean equation findings and it is evident that all markets are affected by their own lags. Both Asian equity markets' returns (China and India) are strongly predicted by lagged US market returns. Lagged Chinese market returns influence Indian market returns.

Table 5 presents the variance equation findings from the univariate GARCH (1, 1) model. All parameters are statistically significant, indicating the presence of conditional heteroscedasticity. The ARCH and GARCH parameters are denoted by α and β, respectively. The results highlight higher GARCH values compared to ARCH values, suggesting that long-run volatility has a more pronounced influence than short-run volatility. Asymmetry in volatility, measured by the δ parameter representing leverage, is found to have a highly significant effect on all equity market indices. The consistently negative and highly significant values of the leverage effect reveal that adverse and negative news and shocks exert a stronger influence on the volatilities of equity markets than positive news and shocks. Additionally, all β values are statistically significant, emphasizing the potential significance of conditional heteroscedasticity and indicating the market momentum across all equity indices.

Table 5: Variance equation results

		Variance Equation Findings				
Market Returns	Model Selected	Constant ω	ARCH α	Leverage δ	GARCH β	Log Likelihood
DLUS	TGARCH (1, 1)	7.49E-07***	0.104778***	-0.10305***	0.934138***	30019.27
DLCH	TGARCH (1, 1)	5.82E-07***	0.051225***	-0.01716***	0.953348***	27585.57
DLIN	TGARCH (1, 1)	1.88E-06***	0.115249***	-0.08999***	0.914863***	27516.11

Note: The coefficients in the variance equations for the TGARCH (1, 1) model are estimated, where *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. DLUS, DLCH, and DLIN denote the daily returns of the US and emerging Asian markets (China and India). In the model, ω, α, δ, and β correspond to the constant, ARCH, leverage, and GARCH parameters, respectively.

Further, Multivariate DCC GARCH model proposed by Engle R. (2002) is applied to estimate dynamic conditional correlation series. In the dynamic conditional correlation model, the correlation between the residuals of the different assets is modeled as a function of their past correlations. The equation 3 for the DCC (p, q) model is as follows:

$$H_t = D_t R_t D_t \qquad 4$$

WhereH_t, the correlation matrix at time t is, D_t is a diagonal matrix of the square roots of the conditional variances, and R_t is the conditional correlation matrix. The conditional correlation matrix is modeled as equation 4.

$$R_t = \omega + \alpha_1 \varepsilon_{(t-1)} \varepsilon'_{(t-1)} + \cdots \alpha_p \varepsilon_{(t-p)} \varepsilon'_{(t-p)} + \beta_1 R_{(t-1)} + \cdots + \beta_q R_{(t-q)} \qquad 4$$

Whereε_t , a vector of residuals at time t and α_1 ... α_p and β_1 ... $\beta_q$are the parameters of the model.

The dynamic conditional correlation DCC-MGARCH model is estimated using maximum likelihood estimation. The model is typically estimated using an iterative procedure such as the Quasi-Newton method which involves repeatedly estimating the parameters until convergence is achieved.

Table 6: Estimation results of DCC model

Model	A	β	Log likelihood	AIC	BIC
DCC-MGARCH (1,1)	0.005769***	0.988067***	85366.91	-170616	-170200
P value	0.000	0.000			

Note: The estimation of coefficients of DCC model. α is the impact of past standardized shocks on current dynamics, β is the impact of lagged dynamics on the current dynamics. AIC and BIC represent Akaike's information criterion and Bayesian information criterion, respectively.

The findings presented in Table 6 suggest that the DCC-MGARCH (1, 1) model provides the best fit. This conclusion is supported by the highly negative values of Akaike's information criterion (AIC) and Bayesian information criterion (BIC), along with a very high log likelihood value, indicating the model's strong fit. The dynamic and time-varying nature of the obtained estimators is reflected in the α and β parameters of DCC. DCC-α gauges the short-term volatility impact, capturing the spillover and transmission of information between markets in the short run, while DCC-β measures the enduring effect of a shock on conditional correlations, representing the long-term spillover and information transmission. The sum of DCC-α and DCC-β, totaling less than 1 (0.005769 + 0.988067 = 0.993836), underscores that conditional correlations in the model are not constant over time; instead, they exhibit dynamism. Consequently, dynamic conditional correlation series are derived from the DCC-MGARCH model.

The graph in figure shows the dynamic correlations among equity markets. The dynamic correlations among equity markets are showing an upward movement after the financial crisis 2007 and Covid-19 crisis which reveals a robust impact of global financial crisis on correlation dynamics among equity markets. The descriptive statistics of correlation series are presented in table 7. The findings indicate that China is less correlated with the US market than India over the sample period. Jarque-Bera values for all the correlation series are very high which indicate that the correlation series are not normal. There are 8516 observations for dynamic correlations series because the study has used 5 lags.

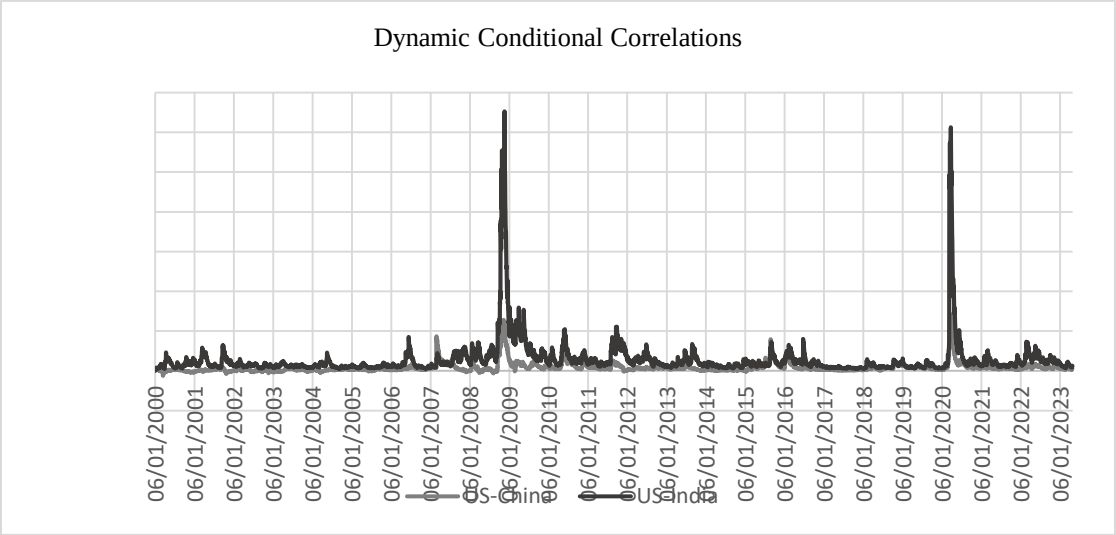

Figure 2: Dynamic Conditional Correlation series

Note: The dynamic correlation series, obtained from the DCC model, encompasses pair-wise correlations between two interconnected markets, namely, US-China and US-India.

Table 7: Descriptive Statistics for Dynamic Conditional Correlation series

	US-CH	**US-IN**
Mean	0.00000782	0.000028
Maximum	0.0001425	0.0006525
Minimum	-0.0000125	1.92e-07
Standard deviation	0.0000128	0.000049
Standard Error	1.38e-07	5.31e-07
Skewness	4.861689	7.513747
Kurtosis	34.58278	69.84797
Jarque-Bera	3.9e+05	1.7e+06
Probability	0	0
Observations	8516	8516

Note: The descriptive statistics of dynamic correlation series derived from DCC-MGARCH (1, 1) model. US-CH and US-IN are pair-wise correlations of US with China and India markets, respectively.

4.1. Quantile Regression

Within this section, we explore the influence of financial and non-financial markets on correlations among equity markets. The examination involves investigating the impact of conditional variables (volatility index, gold prices, oil prices, and the USD index) on the dependent variable (financial contagion) across various quantiles. The quantile regression function is employed to model this relationship, taking into account periods before and after the global crisis marked by a substantial reduction in oil prices. The sample period is further divided into two segments to assess the impact during the US subprime crisis and the Covid-19 crisis.

Dummy variable for the global financial crisis in the studied quantile regression model captures Pre and post crisis differences. The sharp reduction in oil price in July, 2008 and March 2020 became the base to select the break date for US subprime and Covid-19 crisis, respectively. From January 2000 to June 2008 is considered as pre-crisis period for US subprime crisis and from July 2008 to December 2015 is considered as post-crisis period for US subprime crisis. From January 2016 to February 2020 is considered as pre-crisis period for Covid-19 crisis and from March 2020 to April 2023 is considered as post-crisis period for Covid-19 crisis. It can be witnessed from the figure 3.

Examining the impact of shifts in global financial and non-financial markets on the dynamic correlations between Asian Emerging and US markets involves investigating low-correlation (lower quantiles), moderate-correlation (intermediate quantiles), and high-correlation (upper quantiles) periods. Key global economic factors, namely the volatility index, gold prices, oil prices, and the USD index, are employed as conditional variables. This analytical approach enables researchers to discern how the effects of commodity and financial markets on cross-market linkages vary across different quantiles.

The results of quantile regression are presented in table 8 and in addition, the empirical findings are summarized in Table 8-12 to show the impact of volatility index, gold prices, oil prices and USD index on the dynamic correlation series respectively.

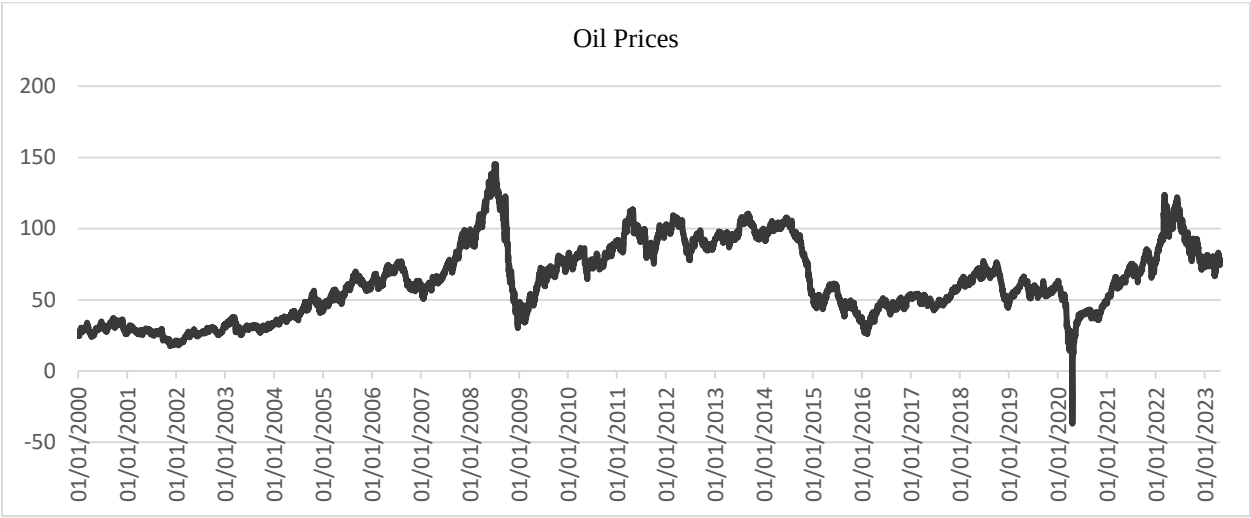

Figure 3: Oil price progression over the period

The impact of volatility index on financial contagion between US and China and US and India is strong and significantly positive in pre and post US Subprime crisis and Covid-19 crisis periods except for all quantiles of pre- US Subprime crisis period and lower quantiles of post Covid-19 crisis periods for the dynamic correlation series between US and Chinese equity markets.

Gold prices have significant, positive and strong impact on the interconnectedness between US and Chinese market and US and Indian market in pre- US Subprime crisis period. Whereas in post- US Subprime crisis period both correlation series (US-China and US-India) have negatively influenced by the changes in gold prices across all quantiles i.e. lower, medium and upper quantiles. Furthermore, the impact of gold prices on correlations between US and China; and US and India is negative in both pre Covid-19 crisis and post Covid-19 crisis periods.

Oil prices exert a substantial, adverse, and robust influence on the interconnectedness between the US and Chinese equity markets during the pre-US Subprime crisis era and in the lower quantiles of the post-US Subprime crisis period. Conversely, in the upper quantiles of the post-US Subprime crisis period, the effect of oil prices becomes notably positive. Additionally, during the upper quantile periods of the pre-Covid-19 crisis, the impact of oil prices is significantly negative, while it turns significantly positive in the upper quantile periods of the post-Covid-19 crisis. Furthermore, concerning financial contagion between the US and India, the influence of oil prices is consistently positive and significant throughout the US Subprime crisis and post-Covid-19 crisis periods. In contrast, in the pre-Covid-19 crisis period, the impact of oil prices is negative and significant.

The impact of USD index is strong, significant and positive on the interconnectedness between US and Chinese equity market in pre- US Subprime crisis period and pre Covid-19 crisis period. Further, it changes to significantly negative in lower quantiles of post- US Subprime crisis period and in upper quantiles of post Covid-19 crisis period. The impact of USD index on the dynamic correlations between US and India remains positively significant in pre and post US Subprime crisis periods across all quantiles. Moreover, the impact remains negatively significant in pre and post Covid-19 crisis periods.

It is evident from the findings of quantile regression analysis that global investors should revise their asset allocation structures in their portfolios on arrival of new information about global market conditions. Because the flow of information changes the level of dynamic correlations between the markets.

5. Discussion

Markets correlations have increased as a result of recent worldwide developments. Consequently, it became more challenging for international investors to locate alternative economies with low correlations to diversify which poses new challenges for global portfolio diversification. As the dependencies are time varying, it is important to explore the dynamic strategies. Another important issue is how cross-market rebalancing channel affects the pattern of time-varying correlations. The global investor must have an insight on the factors that have a significant effect on these dynamics in order to predict correctly. To enjoy maximum diversification in equity portfolio, a global investor should rationally decide least correlated equity markets. This study endeavors to reveal the dynamic nature of dependencies between developed and emerging markets.

The results indicate a lower correlation of finished product exports-oriented country that is China with the US economy which means this market will be less affected by the worldwide risks. For investors, there exists relatively more diversification benefits in Chinese market. Whereas, Indian market is relatively more open for global investors than Chinese market while both have almost same total reserves to GDP ratio. This may be because Indian market is relatively more correlated with US market than Chinese market. Chinese market is maintaining high total USD reserves to GDP ratio and it has limited policy for global investors to access its market may protect it from global risks.

Table 8: Quantile Regression Estimations for Dynamic series obtained from DCC model

Quantiles	Ω	M	β_{vix}	Y_{vix}	β_{gp}	Y_{gp}	β_{op}	Y_{op}	β_{USDX}	Y_{USDX}	Pseudo R^2
Panel A: Quantile regression estimations for US-China dynamic correlation series before and after US subprime crisis											
Q(0.05)	-0.0000153***	0.000054***	-4.11E-07***	4.06E-07***	1.73E-08***	-1.38E-08***	-5.05E-08***	-7.26E-08***	1.68E-07***	-5.50E-07***	0.1665
Q(0.10)	-6.28E-06***	0.0000308***	-3.06E-07***	4.38E-07***	1.26E-08***	-9.42E-09***	-4.50E-08***	-8.28E-08***	8.22E-08***	-2.97E-07***	0.1769
Q(0.25)	1.19E-06	0.0000129*	-1.85E-07***	4.69E-07***	7.68E-09***	-3.23E-09	-2.46E-08	-1.03E-07***	9.16E-09	-1.33E-07**	0.2039
Q(0.50)	-1.26E-06***	-0.0000243	-1.49E-07***	8.38E-07***	1.44E-08***	-1.05E-08***	-4.82E-08***	-1.40E-09	2.64E-08***	2.05E-07***	0.2731
Q(0.75)	-5.70E-06***	-0.0000801***	-1.53E-07***	1.48E-06***	3.20E-08***	-3.09E-08***	-1.14E-07***	1.50E-07***	4.90E-08***	7.89E-07***	0.3964
Q(0.90)	-0.0000217***	-0.000108***	-6.79E-08*	1.84E-06***	6.88E-08***	-6.76E-08***	-2.42E-07***	3.44E-07***	1.31E-07***	1.12E-06***	0.5274
Q(0.95)	-0.0000303***	-0.0001256***	5.31E-08	1.94E-06***	8.28E-08***	-8.21E-08***	-2.47E-07***	3.67E-07***	1.55E-07***	1.39E-06***	0.5947
Panel B: Quantile regression estimations for US-India dynamic correlation series before and after US subprime crisis											
Q(0.05)	-0.0000146***	-0.0000107	9.13E-08***	1.50E-06***	7.97E-09***	-1.42E-08***	9.31E-08***	-5.30E-09	1.31E-07***	5.69E-09	0.2181
Q(0.10)	-0.0000159***	-0.0000229***	1.88E-07***	1.65E-06***	1.25E-08***	-1.94E-08***	7.21E-08***	5.37E-08**	1.27E-07***	1.09E-07*	0.2507
Q(0.25)	-0.0000205***	-0.000047***	3.61E-07***	2.02E-06***	2.47E-08***	-3.07E-08***	1.96E-08*	1.39E-07***	1.36E-07***	3.27E-07***	0.3156
Q(0.50)	-0.0000261***	-0.0001008***	8.05E-07***	2.44E-06***	3.32E-08***	-3.97E-08***	3.17E-08***	2.80E-07***	1.02E-07***	8.13E-07***	0.4096
Q(0.75)	-0.0000301***	-0.0001838***	1.45E-06***	3.09E-06***	3.79E-08***	-4.67E-08***	7.54E-08***	4.71E-07***	2.64E-08	1.55E-06***	0.5117
Q(0.90)	-0.0000372***	-0.0004166***	1.86E-06***	5.76E-06***	4.48E-08***	-5.34E-08***	8.84E-08*	1.05E-06***	3.61E-08	3.36E-06***	0.6248
Q(0.95)	-0.0000453***	-0.0005698***	2.04E-06***	7.66E-06***	5.93E-08***	-6.45E-08***	4.55E-09	1.50E-06***	1.05E-07**	4.50E-06***	0.7088
Panel C: Quantile regression estimations for US-China dynamic correlation series before and after Covid 19 crisis											
Q(0.05)	-0.0000124***	0.0000164	2.14E-07***	-5.60E-08	4.28E-09***	-6.11E-09***	-1.39E-08	-1.16E-08	6.50E-08**	-4.89E-08	0.1784
Q(0.10)	-6.76E-06***	0.0000217***	3.51E-07***	-1.85E-07***	7.19E-10	-5.58E-09***	1.52E-08	-5.29E-08***	2.69E-08	-5.00E-08	0.2135
Q(0.25)	-6.97E-06***	0.0000202***	5.56E-07***	-1.36E-07***	-1.19E-09*	-3.64E-09***	2.21E-08**	-5.59E-08***	3.16E-08**	-8.47E-08***	0.2511

Quantiles	Ω	M	β_{vix}	Y_{vix}	β_{gp}	Y_{gp}	β_{op}	Y_{op}	β_{USDX}	Y_{USDX}	Pseudo R^2
Q(0.50)	-2.20E-06	0.0000213***	1.06E-06***	-3.51E-07***	-5.30E-09***	-4.57E-09***	-3.76E-10	-7.11E-08***	-3.11E-09	-3.51E-08	0.3001
Q(0.75)	-9.90E-06***	0.0000334***	1.47E-06***	-1.19E-07	-1.35E-08***	6.53E-10	-2.78E-08***	-8.45E-08***	1.73E-07***	-2.79E-07***	0.4196
Q(0.90)	-0.000013**	0.0000425***	1.55E-06***	5.86E-07***	-2.13E-08***	9.20E-09**	-8.53E-08***	-3.11E-08	3.58E-07***	-6.59E-07***	0.593
Q(0.95)	-0.0000119*	0.0000323***	1.75E-06***	8.61E-07***	-2.27E-08***	1.69E-08***	-1.12E-07***	3.33E-08	3.66E-07***	-7.95E-07***	0.7078
Panel D: Quantile regression estimations for US-India dynamic correlation series before and after Covid 19 crisis											
Q(0.05)	0.0000204***	0.0000432**	6.04E-07***	1.68E-07	-6.34E-09***	-2.95E-08***	-4.97E-08***	-6.25E-09	-1.09E-07***	1.11E-07	0.1692
Q(0.10)	0.0000235***	0.0000111	6.71E-07***	3.13E-07***	-7.73E-09***	-1.62E-08**	-7.57E-08***	7.51E-08	-1.11E-07***	1.21E-07	0.199
Q(0.25)	0.0000183***	1.80E-06	8.32E-07***	4.61E-07***	-7.62E-09***	-6.01E-09	-1.05E-07***	2.05E-07***	-5.16E-08**	-9.58E-08*	0.2482
Q(0.50)	0.0000335***	0.0000376***	1.18E-06***	1.15E-06***	-9.36E-09***	-2.46E-08**	-2.37E-07***	2.76E-07***	-1.36E-07***	-2.80E-07***	0.2816
Q(0.75)	0.000066***	0.0000217	1.66E-06***	2.92E-06***	-1.24E-08***	-3.18E-08	-4.51E-07***	3.61E-07***	-3.42E-07***	-3.60E-07**	0.3722
Q(0.90)	0.0000925***	0.000029	2.15E-06***	8.26E-06***	-1.66E-08***	-2.76E-08*	-5.57E-07***	4.88E-07**	-5.36E-07**	-1.53E-06***	0.5714
Q(0.95)	0.0001805***	-0.0001208***	2.15E-06***	9.94E-06***	-1.46E-08***	2.74E-08	-7.47E-07***	5.16E-07***	-1.33E-06***	-1.28E-06**	0.7075

Note: The dependence structure between global economic variables (VIX, GP, OP and USDX) and dynamic correlations among US and Emerging Asian markets. The predictors are VIX, GP, OP and USDX which are volatility index, gold prices, oil prices, and USD index respectively. Quantile of dynamic correlation series between the markets derived from the DCC model is the dependent variable. Each panel reports the estimates of coefficients. *, ** and *** represent the variable is significant at the 10%, 5% and 1% level. The parameters μ and Y are for post-crisis periods and ω and β are for pre-crisis period. These parameters are reflecting the impacts of the conditional variables (VIX, GP, OP and USDX) on the correlations among the markets.

Table 9: Summarized findings for the impact of VIX on dynamic correlations

Quantile	US Subprime Crisis 2007				Covid-19 Crisis			
	US-China		US-India		US-China		US-India	
	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis
Q(0.05)	-	+	+	+	+	NS	+	NS
Q(0.10)	-	+	+	+	+	-	+	+
Q(0.25)	-	+	+	+	+	-	+	+
Q(0.50)	-	+	+	+	+	-	+	+
Q(0.75)	-	+	+	+	+	NS	+	+
Q(0.90)	-	+	+	+	+	+	+	+
Q(0.95)	NS	+	+	+	+	+	+	+

Note: US-China and US-India, are pairwise correlations between two related markets. NS refers no significant impact of VIX on dynamic correlations among the markets. The + (−) signs show positive (negative) and statistically significant effect of VIX on dynamic correlations among markets for pre-crisis and post-crisis periods of both US subprime and Covid-19 crises.

Table 10: Summarized findings for the impact of Gold Prices on dynamic correlations

Quantile	US Subprime Crisis 2007				Covid-19 Crisis			
	US-China		US-India		US-China		US-India	
	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis
Q(0.05)	+	-	+	-		-	-	-
Q(0.10)	+	-	+	-	NS	-	-	-
Q(0.25)	+	NS	+	-	-	-	-	-
Q(0.50)	+	-	+	-	-	-	-	-
Q(0.75)	+	-	+	-	-	NS	-	-
Q(0.90)	+	-	+	-	-	+	-	-
Q(0.95)	+	-	+	-	-	+	-	NS

Note: US-China and US-India, are pairwise correlations between two related markets. NS refers no significant impact of gold prices on dynamic correlations among the markets. The + (−) signs show positive (negative) and statistically significant effect of VIX on dynamic correlations among markets for pre-crisis and post-crisis periods of both US subprime and Covid-19 crises.

Table 11: Summarized findings for the impact of Oil Prices on dynamic correlations

Quantile	US Subprime Crisis 2007				Covid-19 Crisis			
	US-China		US-India		US-China		US-India	
	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis
Q(0.05)	-	-	+	NS	NS	NS	-	NS
Q(0.10)	-	-	+	+	NS	-	-	NS
Q(0.25)	NS	-	+	+	+	-	-	+
Q(0.50)	-	NS	+	+	NS	-	-	+
`Q(0.75)	-	+	+	+	-	-	-	+
Q(0.90)	-	+	+	+	-	NS	-	+
Q(0.95)	-	+	NS	+	-	NS	-	+

Note: US-China and US-India, are pairwise correlations between two related markets. NS refers no significant impact of oil prices on dynamic correlations among the markets. The + (−) signs show positive (negative) and statistically significant effect of VIX on dynamic correlations among markets for pre-crisis and post-crisis periods of both US subprime and Covid-19 crises.

It is evident from the results that equity markets are interdependent markets and developed markets have tendency to influence emerging markets. Furthermore, any disorder in developed market will also affect emerging markets. But these are not the only reasons for market inter-dependency. There are considerable global factors that can affect connectedness among markets and these global factors behave differently when there exists any financial distress in developed region. The quantile regression methods provide an intuitive way to address the main determinants of inter-market connectedness. This study also explored the dynamic conditional correlation series in a multivariate structure considering unbalanced responses among worldwide economies and found key global factors (volatility index (VIX), gold prices (GP), oil prices (OP) and USD index (USDX)) that drives the connectedness

among global economies before and after global financial distress. These global risk factors (VIX, GP, OP and USDX) have the ability to determine the asset values of global equity markets and trigger the investors to change their demand for several asset classes conditional to the intensity of connectedness.

When there is global financial distress, VIX has positive and stronger impact on intermarket connectedness of emerging economies with US economy. This significantly increased dependency is caused by the risk premium effect of increased volatility and emphasized the leading role of US economy after global financial distress (Kocaarslan, Soytas, Sari, & Ugurlu, 2018). Gold prices positively and significantly impacting the financial contagion between Asian emerging markets and US market in the pre US-subprime crisis period. Zeng, Lu, & Ahmed (2023) reported gold as a hedging tool to diversify positions in Chinese market. In days of no financial distress in global market, economies are managing a sufficient portion of their investments in safe-haven assets and probably taking active positions in stock market to gain extra return resulting increased correlations among global equity markets. In pre and post Covid-19 crisis periods, the effect of change in gold prices is negative on financial contagion of both emerging economies with US economy. Following the global financial crisis, an increase in gold price may cause the divergence in equity markets and investors become more risk averse and drop their interest in equity markets and redesign their global investment portfolios by changing their positions in gold markets. During high intermarket dependency, an active global investor and portfolio manager who takes position in risky equity markets could liquidate their properties to decrease the inconsistency in their portfolios by making more investments in gold. Global investors and portfolio managers diversify their portfolios by considering their assessments of the risk associated with liquidation value of the equities and by observing conditional correlation patterns between equity markets. The significance of gold prices in transmitting shocks to global intermarket connectedness has been witnessed by Mensi, Ali, Vo, & Kang (2022); Benlagha & Omari (2022); and Kocaarslan, Soytas, Sari, & Ugurlu (2018).

Table 12: Summarized findings for the impact of USD index on dynamic correlations

Quantile	US Subprime Crisis 2007				Covid-19 Crisis			
	US-China		US-India		US-China		US-India	
	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis	Precrisis	Postcrisis
Q(0.05)	+	-	+	NS	+	NS	-	NS
Q(0.10)	+	-	+	+	NS	NS	-	NS
Q(0.25)	NS	-	+	+	+	-	-	-
Q(0.50)	+	+	+	+	NS	NS	-	-
Q(0.75)	+	+	NS	+	+	-	-	-
Q(0.90)	+	+	NS	+	+	-	-	-
Q(0.95)	+	+	+	+	+	-	-	-

Note: US-China and US-India, are pairwise correlations between two related markets. NS refers no significant impact of oil prices on dynamic correlations among the markets. The + (−) signs show positive (negative) and statistically significant effect of VIX on dynamic correlations among markets for pre-crisis and post-crisis periods of both US subprime and Covid-19 crises.

Global financial distress did not make any impact on the relationship between oil prices and the financial contagion between Chinese and US equity markets during low, moderate and high correlation periods. The financial contagion moves indirectly with the prices of the oil because Chinese market is among the finished product export oriented markets and oil is a major element for these markets (Kocaarslan, Soytas, Sari, & Ugurlu, 2018). It causes the potential shift of investments towards oil futures from equity markets that results in reducing the financial contagion between these economies following the global financial distress. The significance of oil is almost same for all net exporters as it is a major input for all the industries whether the country is exporting commodities or finished products. Uddin, Hernandez, Shahzad, & Kang (2020) and Benlagha & Omari (2022) also wittnessed oil as a transmitter of shocks among global equity markets. When there is no global financial distress in the market, global investors and portfolio managers do not promptly rebalance their portfolios with the change in oil prices.

USD index is a vital global risk factor and is also considered as a safe haven along with gold. It has indirect influence on the financial contagion between Indian and US economy both in pre-distress and port-distress periods of Covid-19 crisis and direct influence on the financial contagion between Asian emerging economies and US economy in pre-distress periods of Us-subprime and Covid-19 crises. It may be due to the reason that in days of turmoil, major investors seek positions in safe-haven instruments like USD index to protect their investments that causes the demand of USD to increase and strengthen the USD currency. Asadi, Roubaud, & Tiwari (2022) evidenced the long-run outperformance of connectedness among equities, oil and USD. In a nut shell, after the global financial distress, the financial contagion among equity markets depends on the trade and financial characteristics of respective markets.

Based on the results of this study it can be concluded that, Investors can enhance diversification and potentially reduce overall portfolio volatility and concentration risk in any asset class by incorporating commodities, smaller stocks and undervalued stocks in their investment portfolios. Furthermore, the investment portfolio may be enhanced with the addition of commodity related equities to cater the commodity prices fluctuations. Consequently, the performance of commodity related equities may reduce the global equity markets connectedness. Along with above discussed factors, financial contagion among global equity markets can also be influenced by investment strategies and investor preferences. Therefore if coordinated actions and similar strategies are adopted by different market participants, such as institutional investors or funds managers to allocate their portfolios based on value and size factors, it can contribute to reduce connectedness among equity markets globally. It is also important to notice that investment styles change with the change in market conditions and shifts in investor sentiments. Bissoondoyal-Bheenic, Do, Hu, & Zhong (2022) witnessed the larger impact of investor sentiment on volatility connectedness during bearish market. During high market volatility, investors adjust their portfolios based on their perception of risk and return potential may shift from growth stocks to value stocks and larger stocks to smaller stocks results in reduce equity markets connectedness globally.

6. Conclusion

Developed capital markets are robust and mature while developing markets often exhibit higher growth rates. As developed capital markets are not immune to economic fluctuations, experience periods of volatility that result in higher currency volatility in developing world. It discourages foreign investors and affect the stability of financial markets. Investor sentiments and information flow play a crucial role in transmission of financial contagion. The information of daily fluctuations in global conditions are required to capture common variations in global equity markets' returns.

This particular study has explored the influential impact of USD index, gold and oil markets on inter-market connectedness in unpredictable environment. This study has proposed a model that provides an insight to investors those have global perspective to form a portfolio that is optimally diversified via rebalancing across the markets. Dynamic Conditional Correlations MGARCH model has been applied to analyze the financial contagion between developed and emerging economies. Further, the influence of financial and nonfinancial sectors on financial contagion among global equity markets is examined by using quantile regression analysis. The findings of the study indicate that the impact of global risk factors from financial and non-financial sectors (volatility index, gold prices, oil prices and USD index) vary with the degree of financial contagion among US and emerging Asian economies. The study also compares the varying impacts of these global risk factors around the two major global financial crisis, Us-subprime crisis and Covid-19 crisis. The study evidences that global financial crisis reasons structural breaks in the relationship between underlying global economic factors, volatility index, gold prices, oil prices and USD index, and dynamic correlations among US and emerging economies. The study emphasizes the importance of global macroeconomic variables in determining economic policies and asset allocation strategies to reducing the effect of financial contagion and to optimize diversification.

In this model, investors' sentiments and expectations change about global markets daily and there is a need of portfolio's restructuring. Therefore, global investors are reallocating assets in their portfolios on day to day basis for rebalancing. When negative sentiments and volatility in global markets heightened, it results in global risk aversion and financial contagion among global economies is reliant on it. The degree of global risk aversion is determined by changes in global economic condition that lead to change investor demand for emerging Asian and US equities. The need for rebalancing global portfolios arise when the degree of global risk aversion escalate. The relationship between Asian equity markets and US market during high financial contagion depends on the exposures to global risks of Asian emerging markets. Cross market correlations vary with the adjustments in investors' demand based on global economic conditions. Investors can enhance diversification and potentially reduce overall portfolio volatility and concentration risk in any asset class through diversifying across global markets and to manage financial contagion among global equity markets.

Finally, the researchers have suggested some further research in this domain that existing literature might be extended by examining co-movements among sectoral returns in global markets, time-varying correlations between regional countries, examining the existing model on other regional block countries by considering regional financial risk factors and examining the existing model by adding other global macroeconomic factors.

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