Empirical Investigation of Covid-19 Effects on Commodity, Stock and Currency Markets

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COVID-19 Pandemic, 2020 - Economic aspects

Financial markets - Effect of COVID-19 Pandemic on

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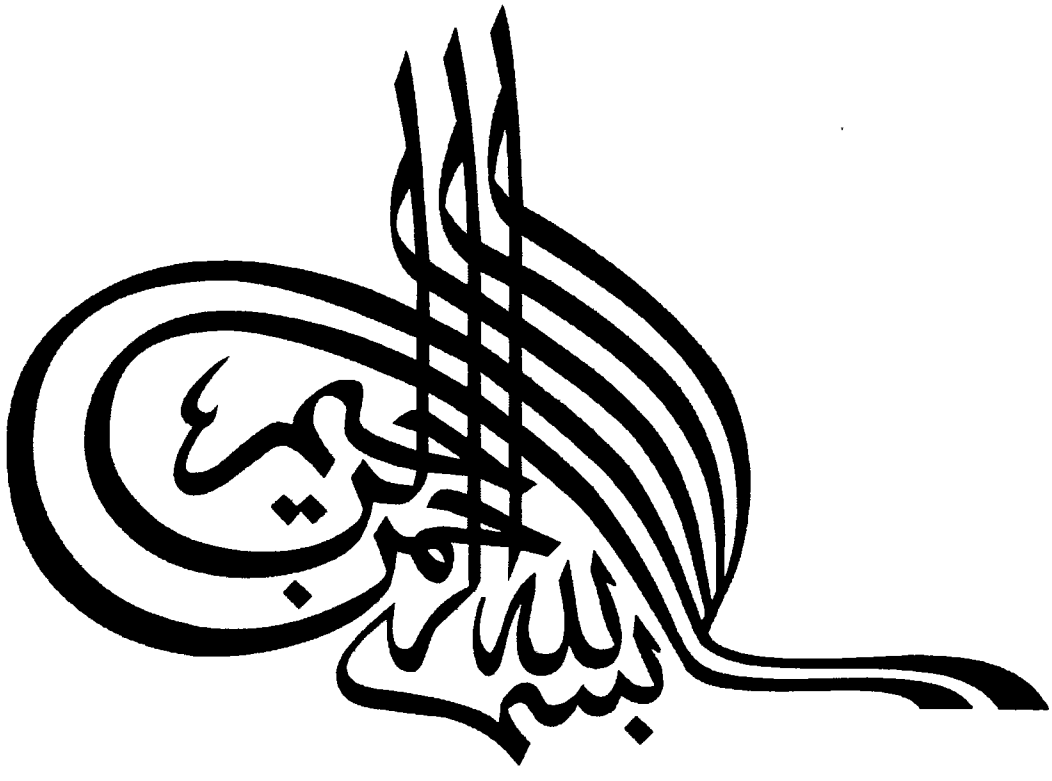

In the name of Allah,
the Most Beneficent,
the Most Merciful

Certificate

The thesis entitled **"Empirical Investigation of COVID-19 Effects on Commodity, Stock and Currency Markets"** in partial fulfillment of MS degree in Finance has been completed under my guidance and Supervision. It is certified that the student has incorporated the necessary changes suggested by the Examiners during viva voce exam on January 25, 2023. Now the thesis is ready for further process.

Supervisor Signature: _____

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(Acceptance by the Viva Voce Committee)

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Dedication

I am dedicating this thesis to two beloved people who have meant and continue to mean so much to me. Although one of them is no longer of this world, her memories continue to regulate my life. First and foremost, I am dedicating this to my mother **Safia Yaqoob (Late)** gone forever away from our loving eyes and who left a void never to be filled in my life. Though your life was short, I will make sure your memory lives on as long as I shall alive. I love you all and miss you all beyond words. May Allah (SWT) Grant you Jannah (Ameen). Secondly, to my great father **Muhammad Yaqoob Awan (Director at IIUI)** who did not only raise and nurture me but also taxed himself dearly over the years of my education and intellectual development and whose continuous affection and prayers have been a source of continuous boost for me.

Also, to my brothers and sisters for providing support and encouraging me at every stage of my life. Last but not least to my friends and fellows for giving advice and always be there for me. Finally, this thesis is dedicated to all those who believe in the richness of learning.

Declaration

I hereby declare that this thesis neither as a whole nor as a part thereof has been copied out from any source. It is further declared that I have carried out this research myself and has completed this thesis based on my personal efforts under the guidance and help of my supervisor. If any part of this thesis is proven to be copied out or earlier submitted, I shall stand by the consequences. No portion of work presented in this thesis has been submitted in support of any application for any other degree or qualification in International Islamic University or any other university or institute of learning.

Muhammad Maqsood

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Abstract

The COVID-19 epidemic is having an increasingly negative influence on the global economic and financial sector, which plays an important part in mitigating the pandemic's unprecedented macroeconomic and financial shock. Financial regulators, researchers, governments, and Policymakers are facing challenges in maintaining financial and economic stability, in the meanwhile, preserving the well-functioning core markets, and ensuring the flow of economic resources to the real economy, given the unprecedented nature of the current crisis. The current study aims to examine the existence of a time-varying conditional correlation between the pair of COVID-19 confirmed new cases, COVID-19 confirmed new deaths and stock, forex, global proxy index, and inflation for the period of starts from when the first case of COVID-19 was reported till Jan 2021. The study has used the econometric methodology named dynamic conditional correlation (DCC) and Granger Causality. The empirical findings conclude the existence of past residual shock and lagged dynamic conditional correlation in most of the pairs at a 5% confidence interval which diminish/eliminate the opportunities for an investor for hedging and portfolio diversification against market risk. Moreover, the current study provides noticeable policy implications for national and international investors, policymakers, and fund managers. The granger causality results conclude that one way causality exists among the ASX, SSE, CAC40, JKSE, NIK, FTSC in case of new stock cases of covid-19 while, the causality between SEN, SA40, NYSE is bidirectional. On the other hand, forex new cases of covid-19 indicates that causality between NC and WON is bi-directional in South Korea. However, one way causality running among the NC, GBP, CNY, EUR, and RING in UK, Malaysia, France, China, and Bangladesh. The granger causality results confirm the one-way causality among the variables in France, India, and UK under new stock death of covid-19 while, two-way causality found in case of China, India, Indonesia, and USA. Results of FOREX new death of covid-19 reveals that no causality exist among the ND, CNY, TAKA, and RING in China, Malaysia, Japan, and Bangladesh. However, bi-directional causality exist among in case of Pakistan, New Zealand, and Indonesia.

Keywords: COVID-19, Dynamic Conditional Correlation, Global Economy, Financial Sector, New Cases, New Deaths

Chapter 1

Introduction

A series of catastrophic crises have occurred around the world over the last two decades such as SARS epidemic in 2003, the Indian Ocean tsunami in 2004, the Chinese Wenchuan earthquake in 2008, the Japan earthquake in 2011, and the resulting Fukushima nuclear power plant meltdown, the Ebola virus in 2014, and the novel coronavirus disease in 2019 COVID (Ruiz Estrada, Park, Koutronas, Khan, & Tahir, 2020). Such major catastrophic, not only represent a significant threat to public safety and property but also have a negative impact on all countries' social and economic stability. COVID-19 originated from China and rapidly expanded over the world before anyone completely knew what was going on (Chinazzi et al., 2020; Sajadi et al., 2020).

The World Health Organization (WHO) has recognized and announced COVID-19 as a "public health emergency of international concern" because it has the rapid transmission/transfusion rate, the broadest extent of infection, and the most challenging in prevention.

Most, importantly the number of confirmed cases of COVID-19 has risen dramatically since the emergence of COVID-19(Cássaro & Pires, 2020). To combat the disease, countries throughout the world have gradually implemented a series of rigorous blockade and isolation policies, such as closing cities or borders, limiting transportation through all mediums air, and postponing important events related to the cultural, societal, and national among other things. Some countries' economic systems even shut down temporarily during this time. The financial, commodity, stock, and foreign exchange market was once in a downward spiral(Si, Li, Xu, & Fang, 2021). Therefore, such an incident has had substantial negative consequences for businesses and households, future investment, risk management as well as creating significant volatility in global financial markets(Baker, Bloom, Davis, & Terry, 2020; Kinateder, Campbell, & Choudhury, 2021).

According to prior findings, financial markets are contagious throughout times of turmoil/uncertainty. The 1994 Mexican peso crisis, the 1997–1998 Asian currency crisis Arestis, Maria Caporale, Cipollini, and Spagnolo (2005), the 1998 Brazilian Real crisis Goldfajn and Baig (2000), the 1998 Russian sovereign debt default crisis (Kenourgios, Samitas, & Paltalidis, 2011),

and the 2008 sub-prime mortgage crisis Mollah, Quoreshi, and Zafirov (2016) are all linked to financial contagion and spillover effects among the stock, bond currency and commodity market. But the financial markets become riskier and gloomier during COVID-19 (Baker, Bloom, et al., 2020a) due to its severe negative impact on the society and economy(Dowd et al., 2020). The market-wide circuit-breakers in the United States have triggered four times in March 2020 alone as a result of the recent pandemic (Cao & Schwartz, 2020).

1.1 Theoretical Background:

The Efficient Market Theory, published by Fama in 1960, provides the theoretical basis for this study. It assumes that capital markets are efficient, and securities incorporate all information available in the market. The efficient market theory states that when new information becomes available, the price of securities adjusts. Based on the information adjustment process of the market, there are three types of market efficiency which include the weak form of efficiency, the semi-strong form of efficiency, and the strong form of efficiency(Fama, 1970). In the weak form of efficiency, prices incorporate/represent all historical known information of the market which leads towards that no investor can exploit other investors on the basis of price because the information is available to all participants of the markets.

Further, the second form of market efficiency is the semi-strong form of market efficiency which provides rationale/assume that prices reflect the information which is publicly available and an investor can exploit other investors by getting the insider information. According to the semi-strong form of efficiency, market participants can exploit more profitable opportunities by taking the decision on the basis of historic and publicly available information. In the last strong form of market, efficiency exists which is the strong form of market efficiency, which provides a rationale that prices reflect historic, publicly available information and insider information. So, no investor can exploit other investors on the basis of these forms' information.

According to the under arching efficient market theory prices adjust on the arrival of new information in the market and information moves towards from one market and transmit/spillover to another market. Hence, spillover of information leads towards the adjustment of prices of the financial instruments on the basis of new information available in the respective market such as stock, bond, derivative, forex, and commodity, etc. Therefore, information related to the COVID-19 new cases and COVID-19 new deaths also spillover in markets, and prices of financial

instruments available in the respective markets adjust based on the arrival of new information related to COVID-19 new cases and COVID-19 new deaths.

The Arbitrage Pricing Theory (APT) is a modern financial theory first developed by Stephen Ross in 1976. In its simplest form, the theory states that the expected return on an asset is a linear function of various macro-economic factors. The theory is based on the concept of arbitrage, which is the simultaneous purchase and sale of an asset in order to profit from a difference in its price. The APT is a more general version of the Capital Asset Pricing Model (CAPM), which states that the expected return on an asset is a function of its systematic risk. The APT suggests that the expected return on an asset is determined by its exposure to a number of macro-economic factors, such as inflation, economic growth, and interest rates. The theory postulates that these factors have a significant effect on the expected returns of assets and that the expected returns can be estimated by the use of linear regression analysis. This analysis is used to determine the degree to which a particular asset is exposed to each of the macro-economic factors, and the estimated returns are then combined to determine the expected return on the asset. The APT has been widely used by investors and financial analysts over the past few decades.

Behavioral finance is a field of finance that studies the influence of psychological, social, cognitive and emotional factors on the economic decisions of individuals and institutions and the ensuing effects on their markets. Behavioral finance highlights the anomalies in decision making that are not explained by traditional finance models. It attempts to explain the cognitive biases and errors that investors make when making decisions, and how these errors can affect the markets. This field has been growing in importance over the past few decades as more and more investors become aware of the irrational decisions they can make and the impact these decisions can have on investment returns. Behavioral finance has been used to explain phenomena such as overconfidence, herding behavior and market bubbles. It has also been used to develop investment strategies and techniques such as portfolio diversification and risk management.

The theory of volatility was first introduced by Robert Shiller in his 1981 book, "The Volatility of Long-Term Asset Returns: Theory, Estimation, and Implications." The theory states that the price of a stock or other asset can be predicted by measuring its volatility, which is the amount of up and down movement in its price over a given period of time. This theory is based on the idea that the more volatile an asset, the greater the likelihood that its price will change. Volatility can be

measured using a variety of technical indicators, such as the standard deviation of the asset's price, moving averages, and Bollinger bands. The theory suggests that investors should be aware of the level of volatility in the markets and adjust their portfolios accordingly.

1.2 Research Gap:

The financial system of any country is a blended mix of its financial markets, Financial Institutions, services, and financial instruments. Any kind of disturbance in any element causes a major threat to the overall country's economy. It is well documented that global crises like pandemics and financial, significantly impact the financial system that overall affects the global economy (Pathak, 2010). We had witnessed how COVID-19 influences the current financial system and world economy. Bank of England (2020) Mentioned in its interim stability report that COVID-19 brings the largest stress event since the hit of previous global financial distress. Several studies confirm the COVID-19 impact on the global financial system i.e. (Giese & Haldane, 2020; Guo, Li, & Li, 2021; Wullweber, 2020; Žigman, Ridzak, & Dumičić Jemrić, 2021).

Stock returns are one of the important elements of the financial system of a country (Hermes & Lensink, 2000). Several studies confirm that COVID-19 directly affects the stock returns (Ashraf, 2020; Okorie & Lin, 2021; Zeren & HIZARCI, 2020). Throughout the pandemic 'league tables' have an eye and keep track of the cases and on the deaths of covid-19 globally. On July 31, 2020, the U.S has the highest number of total covid-19 deaths. A study by Al-Awadhi, Alsaifi, Al-Awadhi, and Alhammadi (2020) noted that daily growth in total confirmed cases of death which was recently caused by COVID-19 has a significant negative effect on the returns of the stock returns. Similarly, findings (Ahmed S.Baig, 2021) conclude that new deaths confirmed cases of coronavirus have a significant increase in market liquidity and volatility.

Onali (2021) provides information related to the impact of covid-19 on the volatility of the stock returns. Empirical findings of this study suggested that by the end of Feb-2020 the magnitude of the negative impact of VIX on the returns of the stock returns has been increased threefold. According to the empirical findings of Yousef (2020) which provide the statistically significant positive impact of the increase in COVID-19 cases on the volatility of stock returns and gold (Ibrahim Yousef, 2020). Hence, the oil and gold market, stock, and exchange rate markets are interrelated with each other (Basher & Sadorsky, 2016; He, Takiguchi, Nakajima, & Hamori,

2020; Sharif, Aloui, & Yarovaya, 2020). Against this backdrop, Hanen Atriad (2021)conducts a study in order to examine the impact of COVID-19 on gold and oil price. Empirical findings indicate the existence of a direct relationship between COVID-19 new cases and gold and oil prices. Moreover, the negative impact of COVID-19 new cases on the gold and oil prices depends upon the nature of the COVID-19 new cases whether they are epidemic or pandemic.

Due to the adverse statistically significant negative impact of COVID-19 on various markets of the financial system an article published by the University of California by Pittalwala (2021) discussed the future of pandemic and the world by saying "Might COVID-19 never go away?". The author mentioned the discussion of experts who reveals that this pandemic changes the living structure of the whole world. Also, one expert Prof. Richard M Carpiano from the School of Public Policy and Department of Sociology of the University of California mentioned "This will not be the last pandemic". Prof Dr. David Lo from the School of Medicine mentioned "The real question is whether human behavior will be up to the task, and recent history has already provided the answer. So, is COVID-19 here to stay? The answer is yes, and another one is coming." Similarly other experts also shared the similar views on this.

If we take this wholehearted expert opinion, the world economy is under a serious threat. This will create again create new chaos that will lead towards financial instability, unemployment, and other crisis like previously happen (B. Jones et al., 2020; H. E. Jones, Manze, Ngo, Lamberson, & Freudenberg, 2021; Shehzad, Xiaoxing, Bilgili, & Koçak, 2021). So there is a gap to analyze the future dynamic correlation of daily change in confirmed COVID-19 cases and deaths with financial markets, forex markets, and global proxies (Arslan, Ahmed, and Akhter (2020)) like gold, oil, and Global inflation rate for future precaution and also a compound study of stock returns, forex markets, and global proxies are also required to give investors and policymakers a glimpse of the whole financial system.

1.3 Problem statement

Ruiz Estrada, Park, and Lee (2020b) this COVID-19 is a universal threat to public health. The world is being pushed into a state of fear and hopelessness through its inevitability due to the reason, that Novel Coronavirus directly attacks health (Torales, O'Higgins, Castaldelli-Maia, & Ventriglio, 2020). The economy is adversely affected by this virus Khan, Fahad, Faisal, Naushad,

and Akbar (2020) because it negatively impacts every aspect of various markets such as financial, forex, commodity, derivatives Kinateder et al. (2021) and labor S. Lee, Schmidt-Klau, and Verick (2020), etc.COVID-19 creates uncertainty and investor bears huge losses on their investment because it impacts both supply and demand within all asset classes(Atkeson, 2020; Baker, Bloom, et al., 2020a). Stock, exchange rate, and commodity markets are not independent in terms of volatility. These markets also respond differently to the arrival of new information which leads towards the increases or decrease in the volatility of the respective market. Investor employs the financial instruments of these markets to hedge the market risk in order to create a diversified portfolio because these markets are interrelated and respond with different magnitude on the arrival of good or bad news. Prior studies conclude that COVID-19 negatively impacts the returns of the equity, bond, currency, and commodity markets due to the reason of contagious effect/information spillover which creates uncertainty among investors and in market structure. Therefore, it is necessary to provide the future dynamic conditional correlation between COVID-19 and stock Aslam, Mughal, Aziz, Ahmad, and Trabelsi (2021), forex Nikolova (2021), and commodity markets Bakas and Triantafyllou (2020); Khan et al. (2020) due to the inevitable nature of the COVID-19 pandemic.

1.4 Research Objectives

1. To explore whether there exists a time-varying dynamic correlation among global COVID-19 confirmed new cases, forex market, global proxy index, global inflation, and stock returns.
2. To examine whether there exists a time-varying dynamic correlation among COVID-19 confirmed new deaths, forex market, global proxy index, global inflation, and stock returns.
3. To explore the co-integration relationship among global COVID-19 confirmed new cases, COVID-19 confirmed new deaths, forex market, global proxy index, global inflation, and stock returns.
4. To analyse the direction of causality from global COVID-19 confirmed new cases and COVID-19 confirmed new deaths to forex market, global proxy index, global inflation, and stock returns.

1.5 Research Questions

The study main research questions are following:

1. Does there exist a time-varying dynamic correlation among global COVID-19 confirmed new cases, forex market, global proxy index, global inflation, and stock returns?
2. Does there exist a time-varying dynamic correlation among COVID-19 confirmed new deaths, forex market, global proxy index, global inflation, and stock returns?
3. Does there exists co-integration relationship among global COVID-19 confirmed new cases, COVID-19 confirmed new deaths, forex market, global proxy index, global inflation, and stock returns?
4. What is the direction of causality from global COVID-19 confirmed new cases and COVID-19 confirmed new deaths to forex market, global proxy index, global inflation, and stock returns?

1.6 Significance of the study:

Due to inevitable nature of the COVID-19, it becomes very serious concern for the market participants, regulators and for the society. Because, COVIID-19 directly impact and health and collapse the economy by negatively impacting each aspect of the life, industry, financial system and market structure. According, to the report published by (World Health Organization, 2021) (WHO) coronavirus is inevitable due to the arrival of the Omicron variant. Prior findings conducted in order to find out why financial markets becomes gloomy/uncertain or increase in the market risk during the periods of financial crisis and health pandemic which are volatility spillover and volatility modelling Andriosopoulos, Galariotis, and Spyrou (2017), weak financial system Caporale, Cipollini, and Spagnolo (2005), poor financial regulation Mollah et al. (2016) and excessive/increase leverage(Kenourgios et al., 2011).

But, recently D. T. Nguyen, Phan, Ming, and Nguyen (2021) concludes the COVID-19 impact as an emerging risk on the global equity market and empirical findings provide the existence of volatility spillover and contagion effect of the COVID-19 on the global stock returns returns. Therefore, the contagion effect of COVID-19 also it is an emerging risk that also impacts the stock

returns, forex market, commodity market and other markets. Hence, empirical findings of the study contribute to the literature by providing future dynamic correlation between COVID-19 new cases and COVID-19 new deaths on the volatility of the stock and forex which helps investors for devising their safe heaven strategies during the pandemic. Moreover, the results of the following study also contribute to the existing established literature by providing comprehensive results related to the volatility and information spillover between global COVID-19 new cases, global COVID-19 new deaths with global inflation, and global proxy index. Apart from investors, this study guides market participants, regulators, and policy makers in designing the strategies for minimizing the adverse impact of pandemics and epidemics.

1.7 Organization of the Study:

The study is divided into five segments. The first chapter defines and introduces the area/topic while also providing details on the following topics: Introduction, Theoretical Background, Gap Analysis, Problem Statement, Research Questions, Research Objectives, and Research Significance are all included in this dissertation. In order to develop a testable proposition, the study's second chapter includes a review of all relevant empirical studies related to the research topic and research hypothesis. The study's third chapter covers variables, data, the study's time frame, and the econometric model DCC-GARCH is employed in order to derive the results. In Chapter 4 of this dissertation, the outcomes of the econometric model, as well as their economic empirical justifications are discussed. Following, chapter 4 summarizes the conclusion as well as the policy implications of the study.

Chapter 2

Literature Review

P. Yang, Chu, Chung, and Sung (1999) Studied economic impact of epidemic disease in Taiwan and found that total damage to economy surpasses 3 billion US dollars. Armien et al. (2008) studied dengue epidemic in Panama by incorporating clinical characteristics in finding national economic cost. He found that this epidemic had cost the economy 16.9 million dollars.

Bloom and Mahal (1997) had studied the Aids epidemic threat of economic growth. His study examines that would slow the increase of economic growth. Their major finding is that the Aids epidemic has a bad effect on the increase rate of per capita income and there is no evidence of causality . Vijayakumar et al. (2013) studied the impact of the Chikungunya epidemic. His finding is the health expenditure obtained is high irrespective of the level of income. Ruiz Estrada, Park, and Lee (2020a)studies the evaluation of the final impact of Wuhan COVID 19. He evaluates the impact of Wuhan contagious COVID 19 on four sectors i.e. tourism, air transportation, International trade and electricity. He also evaluates the impact of this contagious on the temporary performance of a country. Ye and Florescu (2020)studies the equity market of COVID 19 .He matches some particular historical event with the market response as taken measure by the NODA indicator .Gupta, Moyer, and Stern (2005) in his work. A case study of the impact of quarantine in Toronto elaborates that it is not in the interest of humanity to remain forceful to infections as it saves both life and money.

H. Y. Yang and Chen (2009) says in his work A case study of the SARS epidemic in Taiwan elaborates that those who came to Taiwan it impacted the economy of Taiwan and it will lead to tourism crisis. Ayittey, Ayittey, Chiwero, Kamasah, and Dzuvor (2020) in his work the impact of Wuhan on china and the whole world identities that the hub of corona has disturbed almost every walk of life including trade and transportation .The contagious virus has declined the market and its production. Luo and Tsang (2020) in GDP has declined by the corona comes to conclusion that almost 40% of china economy has destroyed by corona .it includes stop of supply, the loss of labor and the lockdown over the public. Sohrabi et al. (2020) reviews who global emergency and identifies the death ratio along with cases that the current corona will decline both life and

economy. K.-C. Lee, Nguyen, Liao, and Chen () compared the economy of China and U.S.A in his works China trade war and comes to know that the current economic war between the two country has impacted the world. Moreover China economy becomes weaker and weaker owing to America reaction. Albulescu (2020a) states in his work coronavirus and financial pickle. Almost 40 days. when corona breaks out the cases within China and out of China have strong impact over the Chinese and world market. Baker, Bloom, et al. (2020b) in his work the unparallel stock returns and the impact of corona and compared the Spanish flue with the novel corona. He comes to know that in the past the world economy had been demolished by the flu. Similarly, the novel corona will impact the world and its economy.

Barro, Ursua, and Weng () in his work the comparison of influenzas and novel corona comperes the three stages of both disease .He evaluates that both of the pandemic have devastated the public and the economy .in his views of both epidemic body impact the famous stock and people like American economy and the killing of Woodrow Wilson. Bates, Thurmond, and Carpenter (2001) in his paper the contribution rate among beef dairy and sheep sates that the great disease Like great influenza and corona disease the market and common public. Livestock related companies bankrupt due to contagious diseases.

Leduc and Liu (2020) in his work skepticism channel of the coronavirus elaborates that the novel corona disrupts the economy along with supply and demand apart from this it also spreads the of anxiety. Holshue et al. (2020) in his work the first confirmed case in U.S.A states that when the corona breaks out in U.S.A like China it disrupts the American economy and public. This dynamic disease disrupts almost everything in the world including American economy .Baldwin and Mauro (2020) in his paper the consequences of COVID 19 on stock returns investigates that due to COVID 19 the world has lockdown and it body affected the world economy for example all industries areas under the target of COVID 19. The evaluates in his paper what next in COVID 19. He illustrates the march of COVID 19 .and the socio-political situation of the world is a great question before the policy maker. he suggested that it must be eradicated with the help of WHO.

Gormsen and Koijen (2020) in his work effect on stock and growth. He states that the current forecast of market declined and many economic hubs of the world on Sharpe. The current market demise cannot be controlled until we maintain the growth of market and the expectations of the public. Koshle, Kaur, and Basista (2020) in his paper hurdles of business and works in India states

that due to COVID19 a rampant unemployment has faced by the work. Further he states that working from the home is an idle idea. It increases the uncertainty of the public in the of economy. Ramelli and Wagner (2020) in his work feverous stock and the reaction of COVID 19 concludes that market holders a very negative response owing to the current epidemic known as COVID 19

Tiberius (2020) investigated in his paper COVID 19 and the oil price of U.S.A. His paper investigates that U.S.A has controlled its oil production and thus unlike China and other affected countries U.S.A will survive in this crisis. Li, Zhang, Zhang, and Zhang (2020) studied and recommended investment strategies during the corona virus crisis which started in late 2019 and become worse day by day in the start of 2020. Investment strategy and analysis took into consideration three industries which include health care, luxury good industry, and silver copper ratio. Health care industry could be best during the health period as (H. Y. Yang & Chen, 2009) noticed the spike in demand of healthcare instruments such as masks and respiratory tract protection kits in 2002 SARS outbreak. Therefore, whenever an outbreak occurs big investments as well as demands are of healthcare equipment. Luxury goods industry depends heavily on the tourism industry, and the Latter badly hit during any outbreak. Under great pressure and risky atmosphere investors look for risk-averse investment strategies and for this precious metal is great importance.

Corbet, Larkin, and Lucey (2020) investigates the impact of Coronavirus outbreak on gold and cryptocurrencies in China physical and financial contagion in start of year 2020. He find that the relationship between Chinese stock returns and Bitcoin significantly behave the during the this period same as in previous outbreak of 2003, Bhuyan, Lin, and Ricci (2010) found that stock returns in infected countries show a significant goes up in the cointegrated relationship and dynamic co-movements as compare to previous epidemic diseases (SARS). Albulescu (2020b) in his work the crash of oil price in COVID 19 elaborates that during the initial stage of this epidemic. The oil industry in P.S.A has declined and almost 20% of the oil in the world has decreased. As a result, the global economy has been badly impacted. After the 49 days of the coronavirus the world economy and oil market has crashed.

Rani (2020) in his paper India economy and COVID 19. He comes to know owing to this flu the whole economy of India has crashed. Since this epidemic is on its peak in India. Further he says

almost all of life has impact from daily wages to business tycoon all and sundry are disturbed and disrupted.

Sansa (2020a) states in his paper the petrol price in China during COVID 19. He compares the petrol price with the confirmed coronavirus. from January to February and with the reference of chines statistic. He investigates the China along the world. this plague has demolished the petrol market in China. During the month of January Gasoline and petrol market has crashed 7% per day as the study shows.

Sansa (2020b) in his paper impact of COVID 19 on chines and American market. He researches from 1st march to 25 march. In his study he takes both markets to be a dependent variable and COVID 19 to be an independent variable. He find a very amazing fact and the confirmed cases has a positive significant relationship with the market .K. Nguyen (2020) in his paper the tale of 10 weeks of 2020 . His paper examines the impact of the outbreak on stocks and on 11 sectors. He takes data from 10 countries and compares this sector with each other .He comes to a conclusion that all the energy sectors has a negative impact . Karabag (2020) in his work the global crisis and COVID 19 Impacts. He states that coronavirus has a created a global crisis. He also discussed the short and long terms impact of corona on regional and global level. He find out that COVID 19 has provided research opportunity in the field of political science, economics, management and technology. Selmi and Bouoiyour (2020) in his work A tug of war 'He states that demand and supply are on shock. Due to lockdown shop, and factories are closed. He concludes that the outbreak has greatly impacted 9.7% of stock. He finds out that the global economy has declined.

C. Wang et al. (2020) in his paper psychological responses in China during epidemic. He states in his work that the current outbreak has disrupted. Data is collected and comes to know that anxiety, depression, and stress are created owing to COVID 19. The plague has decreased the status of life in his survey, 1210 respondents from 94 cities of China has polled. He concluded that like other problem, COVID19 has promoted psychological problems this has disrupted the life .Tariq et al. (2020) in his work real time monitoring of COVID 19 in Singapore. She elaborates that the current epidemic that disturb the world is now getting worse and worse. This his decreased the production of everything in Singapore. the ratio of death is not too much in Singapore. But still the process of normal life has shocked. The daily cases are destroying human life and economy. Jain and Biswal (2016) in his work dynamic correlation among oil price, gold price exchange rate in India. His

paper evaluates that when Indian government has imposed some taxes. this has a strong relation with Indian economy. The global gold and oil price have devalued Indian rupees. thus, in this outbreak the Indian economy has crashed Ruiz Estrada, Park, Koutronas, et al. (2020) in his work the massive impact of virus on the economy of Wuhan states that the massive disease has disturbed economics performance. His work evaluates the Wuhan market how the market crashed during this coronavirus.

2.1 Theoretical framework

The theoretical model of the daily new case of COVID-19 and daily new death case of COVID-19 related to the volatility spillover on the stock returns, gold price, oil price, exchange rate and global inflation is given below.

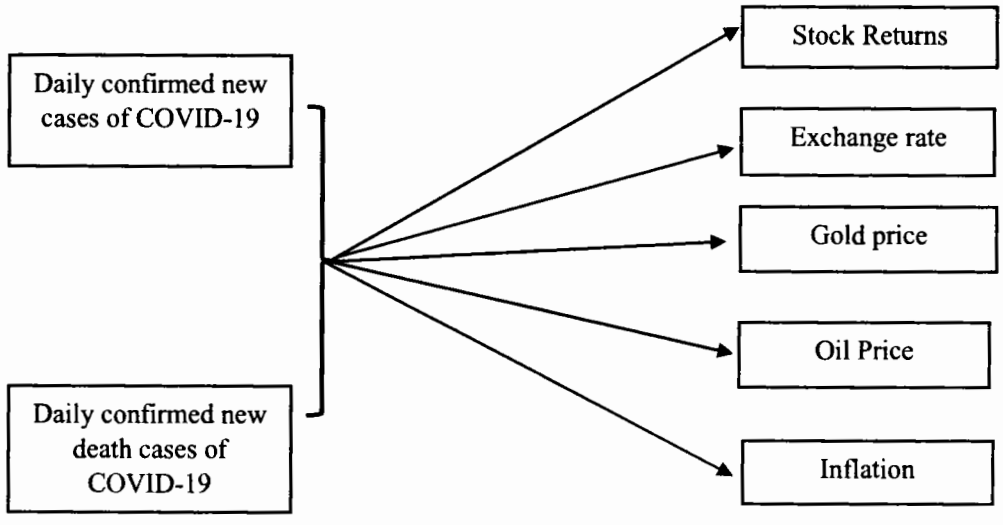


Figure 2. 1: Volatility spillover link between COVID-19 and the stock returns, exchange rate, gold price, oil price & inflation

Chapter 3

Data and Methodology

This chapter is divided into four major sections which provide information related to the theoretical framework, population and sample, description of variables and econometric model which is employed in order to achieve the objective of the study.

Stock returns

We have COVID-19, For the measurement of Novel Coronavirus we must use two proxies "Daily Confirm New Cases of COVID-19" and "Daily Confirm New Death Cases of COVID-19". We must analyze the volatility spillover on the Stock returns. It's acknowledged that such Pandemics had Disturbed Economy in the past as we see in work of Bloom and Mahal (1997) where we see that Owing to AIDS Economics Growth faced serious threat. Apart from this, in Numerous other cases it was seen that how the Plague declined economy. SARS in Taiwan (2003) had impacted the economy. Cholera in November 2010. Dengue Fever in September 2006. Avian Flu June 2006. Swine Flu April 2009. It's categorically Understood that due to COVID-19 it's not a suitable option for the investors to invest their capital. The COVID-19 upends every aspect of life, the speed of this contagious shows that the investors aren't affected psychologically but they afraid of death. Thus, Pakistan stock returns got disturb because of COVID-19 in the months of March/April.

Exchange rate

The Novel Coronavirus has also impacted on Exchange Rate Since the world has Lock downed and trade among Countries has stopped. Thus, Exchange rate has disrupted. IMF has relaxed in Debt, as a result Local Currency became stronger. Thus, Exchange rate affected.

Gold price

Gold prices have increased day by day. The investors took out their capital from the Stock returns and invested it in Gold. Since it's a very precious metal and from ancient times people used to buy gold for trade. The Demand of other metals have decreased, and price of gold has gone higher and higher. Since the Reserve of a country depends upon Gold. That's why investors invested in gold.

Oil price

Sansa in his work "Analyzes of the impact of the COVID-19 to the petrol price in China. He took confirmed cases as an independent variable while oil price as dependent variable. While in this study daily confirmed new cases and death Cases as an independent variable and oil price as a dependent Variable. Sansa worked on 34 days in China i.e. January 20 to 23 February. While Mine are 50 Countries November 2019 to up to date on the emergent of COVID-19, the death Case and Daily case have increased. Therefore, the world has been lock down and as a result oil prices has reduced. Since Industries, Public Transport are closed thus the demand of oil has reduced and oil industries has crashed. We see in Pakistan Oil price has come down. It never happened in the past.

Inflation

The novel coronavirus not only impact the financial market but it also influences the macroeconomic variables of the economy. Because, coronavirus negatively impact the macroeconomic variable of the country such as inflation and GDP etc. During, COVID-19 when lock down announce in the country leads towards decrease in the business activity, profits and wages which further decreases the purchasing power of the nation. So it is not just to move forward without considering inflation in this framework.

Inflation is an important economic variable because it affects the purchasing power of people's money. Inflation also has an effect on interest rates. When inflation is high, interest rates tend to rise, making it more expensive to borrow money. Inflation can also impact investment decisions, as investors may choose to invest in assets that have the potential to provide a return that is higher than the rate of inflation. Finally, inflation has a direct effect on economic growth, as it can increase uncertainty and reduce consumer spending.

3.1 Population and Sample

The objective of the study is to explore the information spillover related to COVID-19 confirm new cases and COVID-19 new deaths to the stock, forex. Moreover, the aim of the study also includes providing global insights/ information spillover of COVID-19 new cases and COVID-19 new deaths to the global commodity and inflation. Therefore, the population of the study consists of stock returns, forex market, commodity market, and COVID-19 cases. In this backdrop sample of the study consist of the fifteen stock and forex market of the developed and developing countries

that are mostly affected by the COVID-19 such as Australia, Bangladesh, China, France, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea, UK, and USA in order to find out the information/volatility spillover created by COVID-19 confirmed new cases and COVID-19 confirmed new deaths.

Moreover, in this study, to provide the global insights regarding the volatility spillover between global COVID-19 confirmed new cases, COVID-19 confirmed new deaths and a global proxy index is employed which represents the global commodity (selected commodities are oil and gold) markets. As, we are concerned with exploring the information spillover created due to COVID-19 confirmed new cases and COVID-19 confirmed new deaths. So, the time frame of the sample period starts when first confirmed case of COVID-19 and the first confirmed case of death due to COVID-19 was reported till Jan 2021 for all selected fifteen stock and forex market is represented in Table 3.1.

Table 3. 1: List of Countries

	Stock returns		**Forex Market**	
	Start	**End**	**Start**	**End**
Australia	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
Bangladesh	Mar, 2020	Jan, 2021	Mar, 2020	Jan, 2021
China	Dec, 2019	Jan, 2021	Dec, 2019	Jan, 2021
France	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
India	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
Indonesia	Feb, 2020	Jan, 2021	Feb, 2020	Jan, 2021
Japan	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
Malaysia	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
New Zealand	Feb, 2020	Jan, 2021	Feb, 2020	Jan, 2021
Pakistan	Feb, 2020	Jan, 2021	Feb, 2020	Jan, 2021
Singapore	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
South Africa	Mar, 2020	Jan, 2021	Mar, 2020	Jan, 2021
South Korea	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
UK	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021
USA	Jan, 2020	Jan, 2021	Jan, 2020	Jan, 2021

3.2 Description of variable

This study comprised of following independent variables which are related to the volatility spillover created by the independent variables such as COVID-19 confirmed new cases on the dependent variables which are stock, forex, the global proxy index that represent the gold & oil market and inflation. All aforementioned independent and dependent variables is represented in Table 3.2 and then explained below.

Table 3. 2: List of Variables

Variables	Nature	Start	End
Stock returns	Dependent variable	First Case*	Jan, 2021
Exchange Rate	Dependent variable	First Case*	Jan, 2021
Gold Price	Dependent variable	Jan, 2020	Jan, 2021
Oil Price	Dependent variable	Jan, 2020	Jan, 2021
Inflation	Dependent variable	Jan, 2020	Jan, 2021
Daily case of COVID-19	Independent variable	First Case*	Jan, 2021
Daily death case of COVID-19	Independent variable	First Case*	Jan, 2021

Frist Case* Refers to respective country registered first case

3.3 Independent Variables

In this study, the number of independent variables is two such as daily cases of COVID 19 and daily death cases of COVID 19.

i. **Daily cases of covid 19**

ii. **Daily death cases of covid 19**

3.3.1 Daily case of COVID-19

It refers to the number of people infected due to pandemic Covid-19 on daily basis.

3.3.2 Daily death case of Covid-19

It refers to the number of people died due to infection of perilous pandemic Covid-19 on daily basis.

3.4 Dependent Variable

Our study takes four explained variables such as the stock returns, exchange rate, gold price, and oil price, to access the relationship between the Covid-19 and other economic indicators. The number of dependent variables is five which are being influenced by the independent variables.

3.4.1 Stock returns index

The stock returns is renowned as the barometer of the economy. Stock returns index that measures a stock returns or stock returns performance, or stock returns index is a subset of the stock returns that assists investors to compare Present levels of prices with past prices to evaluate market performance. It is calculated from the prices of selected stocks. The KSE-100 Index is a stock index that serves as a benchmark to compare prices on the Pakistan Stock returns (PSX) over a period. KSE-100 index is price-weighted index. In order to determine the value of the companies in index, companies with the highest market capitalization are selected.
Yilmazkuday (2020) has investigated the impacts of COVID-19 on the United States of America and it's 500 indices. The paper has found that about one percent development in the cases results 0.01% reduction in the 500 indices. Historical analyzes of the decomposition of 500 index further found that USA has faced many cases in the month of March 2020. This has changed the global economy along with the local Economy.

3.4.2 Forex

An exchange rate can be defined as the value of one country's currency versus the value of another nation's currency or economic zone. For example, how many Pak Rupees will be required to buy 1 USD? It is the rate "defined by the national authorities or the rate determined in the legally sanctioned exchange market". The exchange rate is determined first on monthly basis then the overall average is taken of all monthly rate termed as the average annual rate.

3.4.3 Gold prices

Gold is a precious metal and its price is an important economic indicator in researches to develop causal relationships. The price of gold is determined by a combination of supply-demand factors and investor behavior. Although it seems a simple mechanism but the way those factors work

together is occasionally nonsensical Gold price Straight forward measure just divided the karat number of your jewelry by 24 and multiply by 100.

Yousef ()Investigated that gold Price has been increasing day by day as a result of COVID-19 in the United States of America. Since all over the world the investors think gold as a safe Investment in the market. They also take advantage of the economic turmoil and consider gold as a safe asset. During such situations, gold don't decrease its rate. Ünvan (2020) has investigated how COVID-19 impacted on Turkey's Gold Price. When the value of the Lira came down the price of gold in Turkey has decreased. As we see that during lockdown Turkish Lira and Turkish gold gram price was seen in the matrix of 92.77 percent. When Lira devalued, gold and stock returns have disturbed.

3.5 Econometric Model

3.5.1 Stationarity test

The data is initially subjected to stationary tests in order to determine the degree of integration of the fifteen countries between new covid cases and new covid death cases. The research indicates that the best methods for determining the stationarity of the data are (ADF), (PP), and (KPSS). The order of the integration of each series Id is examined by using each of these three tests. The design of the null hypothesis differs fundamentally between the ADF, PP, and KPSS tests, with the null hypothesis for the tests of ADF and PP stating that the series are non-stationary in the order of integration under consideration.

However, in this study, only ADF and PP tests are used to investigate the order of integration between the series of new case of covid and death cases of the fifteen countries because ADF and PP tests have a limitation that they show biased results in the case of the small sample but shows unbiased results in the case of the large sample. The null hypothesis of KPSS states that the series is stationary in which order of integration Id is to be estimated.

3.5.2 Johansen Cointegration

Examining the long-term relationship among the exchange rate, oil prices, gold prices, inflation, covid new cases and new death cases is one of the goals of this study. The maximum-likelihood technique is used against this background. The cointegrating vectors between stock price and exchange rate are tested using the maximum likelihood approach, which tests all different cointegrating vectors in a multivariate context. These cointegration relationships' parameters are estimated. The estimation of these cointegration connections is calculated using maximum eigenvalue tests and trace statistics. To avoid any misspecification for the selection of exogenous variables, Johansen cointegration empirical approach treated all variables as dependent variables.

Additionally, the Johansen cointegration method offers a uniform framework for analysing and estimating the relationship within the vector error correction framework (VECM). Because the stock price and exchange rate have a similar trajectory in the cointegration framework, this provides the basis for the existence of causation, at least in one direction, in the Granger. Consequently, using the method of numerous variables used in this study, Johansen A long-term relationship between exchange rate, oil prices, gold prices, inflation, covid new cases and new death cases is investigated using cointegration as an empirical methodology.

3.5.2 ARCH Test

ARCH was introduced by Engle. Slandered assumption, in linear regression analysis, is, that the variance of all squared error terms, is same, which is called homoscedasticity, or in other words constant variance. However, heteroscedasticity is the problem exhibit by many time series data. Which means the variance of error term is not equal that the error terms are larger for some period of data and smaller for other period. So in order to figure out valid coefficients estimates from models which exhibit disease of heteroscedasticity, ARCH models are designed.

The pre-requisite for using ARCH family of models are the presence of autocorrelation and heteroscedasticity. So by choosing ARCH test both issues can be simultaneously tested. If the probability of chi-square is less than 5%, autocorrelation and heteroscedasticity exists.

Ordinary least square (OLS) regression is run for model under consideration to collect residuals for Eagles ARCH test. Later collected residuals are squared. After that following secondary regression has been ran.

$$u_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 ..... + \alpha_3 u_{t-p}^2 + v_t$$

Where u is the residual of initial ordinary least square regression,

p lags are included in this secondary regression.

The Collected R^2 statistic from this regression is multiplied with the number of observations T. $T*R^2$ follows the chi-square distribution and null hypothesis is that there is no ARCH Effect present.

3.5.3 Dynamic Conditional Correlation (DCC)

To estimate the dynamic conditional correlation between the pair of COVID-19 confirmed new case and all dependent variables an econometric model DCC-GARCH was proposed by (Engle, 2002) . In DCC model dynamic conditional correlation is estimated through using the multivariate GARCH model, wherein previous returns are employed in order to forecast the future volatility. To resolve the computational restraints, this study uses a dynamic conditional correlation estimation technique (DCC). The DCC-GARCH estimation technique is a more advanced version of the constant correlation estimator (CCC). Because it considers the time-varying effect when calculating the correlation matrix, DCC surmounts constant correlation estimation. The multivariate DCC econometric model used by Antonakakis, Cunado, Filis, Gabauer, and De Gracia (2018) is represented in the following equations:

$$X_t = \Omega_t + \beta_t \quad Where\ \beta_t | \Omega_t \square N(0, \hat{\lambda}) \quad \text{..... Eq (3.1)}$$

$$\beta_t = \pi_t^{1/2} \Omega_t, \quad Where \Omega_t \square N(0,1) \quad \text{..... Eq (3.2)}$$

$$\pi_t = D_t x_t D_t \quad \text{..... Eq (3.3)}$$

Whereas $X_t = (X_{1,t}, \ldots X_{N,t})$ is the vector of volatilities denoted by $N \times 1$ and $\Omega_t = (\Omega_{1,t}, \ldots \Omega_{N,t})$

is the vector of conditional mean which is represented by Ω_t and π_i represent the conditional covariance matrix. Whereas, diagonal matrix of the square of the conditional variance is demonstrated by Dt = diag ($\pi_t^{1/2}$, . . . $\pi_i^{-1/2}$) whereas the univariate GARCH-type model is demonstrated by the π_i (ii, t) and in the last t is the t × (N(N−1)/2) A) matrix consisting of the time varying correlation.

$$X_t = diag\left(q_{i,t}^{-1/2},...,q_{NN,t}^{-1/2}\right) A_t diag\left(q_{ii,t}^{-1/2},....,q_{NN,t}^{-1/2}\right)^n \quad \text{..... Eq (3.4)}$$

In the mean while symmetric positive matrix is described by $A_t = (qij,t)$ is $N \times N$ and described below.

$$A_t = \left(1 - X - \beta\right) A + X\Omega_{t-1}\Omega_{t-1}'\beta A_{t-1} \quad \text{..... Eq (3.5)}$$

3.5.4 Granger Causality

In this study, Granger Causation is an empirical methodology established by Granger (1969) and made popular by Sims (1972), that is used to investigate the direction of causality between variables such as exchange rate, oil prices, gold prices, inflation, covid new cases and new death cases. The objective of the Granger Causality empirical approach is to determine whether the lag price values or past prices of one variable are used in the prediction of the change in another variable. Granger and Engle Granger (1987) formed the causality test, which is used to evaluate the direction of causality between as exchange rate, oil prices, gold prices, inflation, covid new cases and new death cases pair-wise granger causality is more illuminating. It demonstrates either one-way or two-way causality between the variables. If X is the granger cause of Y, then X is appropriate for the future prediction of Y.

$$\emptyset_t = \sum_{i=1}^{\lambda} \theta_i \emptyset_{t-i} + \sum_{i=1}^{\kappa} \beta_j \sigma_{t-j} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

$$\sigma_t = \sum_{i=1}^{\lambda} \theta_i \emptyset_{t-i} + \sum_{i=1}^{\kappa} \beta_j \sigma_{t-j} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.7)$$

However, $\emptyset_t$ represent the logarithm of the daily Covid-19 new cases and σ_t denotes the logarithm of the daily Covid-19 death cases, μt which is the error term and normally the uncaptured portion of the dependent variable and optimal lag length of the Covid-19 new cases and Covid-19 new deaths denoted by λ and κ. The Granger Causality test includes the establishment of the joint null that coefficient of σ_t and μt are all concurrently 0 which are given below.

$$H_0 : \beta_1 = \beta_2 = \cdots = \beta_\kappa = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.8)$$

$$H_0 : \theta_1 = \theta_2 = \cdots = \theta\lambda = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.9)$$

The F-test is used as the foundation for the Granger Causality test. If the null hypothesis of any regression is shown to be false, then the F-test concludes that there is a causal relationship between the variables, which leads to the acceptance of the hypothesis.

Chapter 4

Results and Discussion

4.1 Descriptive Statistics:

4.1.1 Descriptive statistics of Stock returns:

Descriptive statistics of the stock returns of Australia, Bangladesh, China, France, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea, UK and USA are presented in a very comprehended form in Table 4.1. Computation of the descriptive statistic is the preliminary step while employing any econometric model for exploring the results in order to achieve the objective of the study. Because, descriptive statistics provide information related to behavior, nature and trend of the data defining it through different parameters such as mean, median, standard deviation, variance, minimum, maximum, etc. The descriptive statistics of the stock returns are divided into further two categories based on the nature of the parameters which are a measure of central tendency and measure of variability.

The measure of central tendency is comprised of the parameter related to mean, median and Jarque Bera which provides information related to the average behavior of the data based on the actual prices of the stock returns. Moreover, measure of central tendency is consists of the all parameters which capture the riskiness and fluctuation of the data for predicting future trends. The parameters reported in Table 4.1 related to the measure of variability are standard deviation, skewness, kurtosis, minimum and maximum. Mean and median value shows the average daily return of the stock returns of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and the USA.

The standard deviation is used to estimate the accurate deviation of the stock price from their average, which provides evidence related to the riskiness of the stock returns. To capture the overall deviation of the stock price minimum and maximum are computed for all the stock returns indices. Because, the minimum value provides the minimum possible deviation in the stock returns of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan,

Singapore, South Africa, South Korea, and the USA. While simultaneously maximum provide information to the maximum daily deviation in the prices of the stock returns from their average daily price. In order to find the dispersion of daily price data of the stock returns skewness is computed and results reported in Table 4.1 shows the stock returns of all countries are right-skewed except Australia which is left-skewed. The sample daily data of the majority stock returns is leptokurtic because value of B > 3 except Australia, India and Pakistan which shows the mesocratic tail.

Table 4. 1: Descriptive Statistics (stock returns)

	Mean	Median	Min	Max	Std	Skewness	Kurtosis	Jarque Bera
Australia	5028.712	4990.700	3782.800	5935.500	455.855	-0.060	2.601	1 878
Bangladesh	1629.880	1679.050	1203.430	2236.770	215.628	0.365	3.349	6.282
China	6349.043	6678.630	5061.810	7220.660	6349.043	6349.043	6349.043	6349 043
France	997.357	988.890	733.930	1182.100	997.357	997.357	997.357	997.357
India	11366.74	11434.90	7719.100	14751.30	11366.74	11366.74	11366.74	11366.740
Indonesia	1030.199	1020.330	731.030	1301.990	119.969	0.351	2.806	5.202
Japan	22936.64	23088.88	16552.83	28698.26	22936.64	22936.64	22936.64	22936.640
Malaysia	10603.59	10775.71	8214.630	11863.50	10603.59	10603.59	10603.59	10603.590
New Zealand	11622.90	11690.96	8498.700	13610.74	11622.90	11622.90	11622.90	11622.900
Pakistan	38162.60	39627.05	27228.80	46091.96	4422.009	-0.332	2.194	10.807
Singapore	282.312	273.600	228.770	340.220	282.312	282.312	282.312	282.312
South Africa	49739.09	50541.29	34239.3	58857.76	49739.09	49739.09	49739.09	49739.090
South Korea	4890.676	4864.140	3224.95	6898.640	4890.676	4890.676	4890.676	4890.676
UK	6191.05	6104.88	4993.89	7534.37	484.999	0.770	3.978	35.364
USA	12690.5	12810.9	8777.38	15097.3	12690.5	12690.50	12690.5	12690.500

4.1.2 Descriptive Statistics of Exchange Rate Markets:

Descriptive statistics related to the exchange rate markets of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and the USA are presented in the following Table 4.2. Descritive statistics are used to provide insight related to the data for predicting the future trend of the prices. In the following Table 4.2, various parameters are used to explain the average exchange rate market behavior of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and the USA along with its ability to deviate from standardized actual daily

price behavior. Based on the results maximum average price is shown by Indonesia and the minimum average exchange rate with respective to USD is shown by the UK. Standard deviation, minimum and maximum measure the riskiness of the exchange rate markets during the sample time frame which starts from the day at which the first case of COVID-19 reported till 30-Jan-2021.

Table 4. 2: Descriptive Statistics (Forex Market)

	Mean	**Median**	**Min**	**Max**	**Std**	**Skewness**	**Kurtosis**	**Jarque Bera**
Australia	1.4433	1.4209	1.2816	1.7416	0.0979	0.6802	3.0588	20.0878
Bangladesh	84.2491	84.6300	0.0000	85.0690	5.5817	-15.0482	227.635	492263
China	6.8751	6.9520	6.4550	7.1696	0.2104	-0 6271	1.9743	28.6604
France	0.8724	0.8622	0.8111	0.9351	0.0361	0.0923	1.6038	21.5709
India	74.2812	74.1950	71.1150	76.9750	1.3318	-0.3424	2.6698	6.1885
Indonesia	14641	14620	13870	16575	595.97	1.4062	4.9273	113.8157
Japan	106.4433	106.3420	102.7000	111.9670	2.0199	0.3641	2.5255	8.2464
Malaysia	4.1981	4.1710	4.0040	4.4450	0.1065	0.1866	1.9878	12.7041
New Zealand	1.5317	1.5194	1.3710	1.7628	0.0912	0.3349	2.3903	8.0677
Pakistan	162.8004	162.5050	154.1350	168.2500	3.7674	-0.1872	2.0176	10.9609
Singapore	1.3779	1.3736	1.3176	1.4598	0.0324	0.1365	2.2446	7.0171
South Africa	16.7004	16.7347	14.5255	19.1096	1.1624	-0.0064	2.3175	4 5042
South Korea	1175.2370	1187.8900	1083.5300	1273.0000	46.9204	-0.5587	2.1650	21.3233
UK	0.7782	0.7739	0.7284	0.8705	0.0275	0.4821	3.1754	10.2040
USA	-	-	-	-	-	-	-	-

Similarly, skewness and kurtosis are estimated in order to measure the location of the data and quantum of data whether it lies at the left or right tail of the normal distribution. According to the estimated results in **Table 4.2** exchange rate markets of Australia, France, Indonesia, Japan, Malaysia, New Zealand, Singapore, and the UK are positively skewed while the rest of the exchange rate markets have long-tail distribution on the left side. Moreover, Australia, Indonesia, and the UK have leptokurtic tail distribution while the rest of the exchange rate markets have the mesocratic tail distribution while remaining exchange rate markets have the mesocratic tail distribution. JarqueBera normality test on the exchange rate markets shows that exchange rate markets of Australia, France, Indonesia, Japan, Malaysia, New Zealand, Singapore, and the UK are not normally distributed.

4.1.3 Descriptive statistics of COVID-19 New Cases

Table 4.3 shows the descriptive statistics of the COVID-19 new cases of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and the USA during the sample time frame. The data of COVID-19 starts from the day at which in each country the first day of COVID was reported till the date 30-Jan-2021. Mean values show the average daily COVID-19 cases reported in each country. Based upon the data maximum average daily cases of COVID-19 were reported by the UK and minimum daily average COVID-19 cases were reported in New Zealand. Minimum and maximum show the number of daily new COVID-19 cases reported in each country till 30-Jan-2021. Based upon the results reported in Table 4.3 all countries have right-skewed tail distribution and heavy positive tails or leptokurtic distribution. Jarque Bera shows that daily data related to new cases of COVID-19 is not normally distributed.

Table 4. 3: Descriptive Statistics (New Cases)

	Mean	**Median**	**Min**	**Max**	**Std**	**Skewness**	**Kurtosis**	**Jarque Bera**
Australia	78	19	0	716	133	2	8	559
Bangladesh	1677	1609	0	4019	1053	0	2	6
China	245	18	0	15133	1125	10	120	154620
France	8473	3106	0	106091	13583	3	17	2513
India	29092	20346	0	97894	28433	1	2	27
Indonesia	2857	1904	0	12568	2740	1	4	74
Japan	899	410	0	7563	1363	2	9	648
Malaysia	462	54	0	4008	786	2	8	433
New Zealand	7	2	0	89	15	4	17	2378
Pakistan	1637	1157	0	12073	1543	2	11	867
Singapore	162	34	0	1426	247	2	7	379
South Africa	4092	1999	0	21832	4747	1	5	111
South Korea	199	76	0	1237	272	2	6	240
UK	9850	2977	0	62556	14203	2	6	226
USA	65439	39294	0	278337	70018	1	3	78

4.1.4 Descriptive statistics of COVID-19 New Deaths

To find out the nature and trend of the data related to the daily death reported due to COVID-19 in the country of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and USA. The sample time frame starts from the date when the first death due to Corona Virus was reported till the date 30-Jan-2021. According to the descriptive statistics reported in Table 4.4 maximum daily deaths due to COVID-19 in the USA and minimum average daily deaths due to COVID-19 were reported in Singapore and New Zealand. Maximum values show the maximum daily death occurred in the USA which is 4476.0000. Almost the tail distribution of the new deaths caused due to COVID-19 has the long tail distribution on the right side and all countries have the leptokurtic tail distribution.

Table 4. 4: Descriptive Statistics (New Deaths)

	Mean	Median	Min	Max	Std	Skewness	Kurtosis	Jarque Bera
Australia	2.67	0.00	0.00	59.00	6.24	4.69	34.06	11405.39
Bangladesh	25.55	27.00	0.00	64.00	14.82	-0.19	2.19	7.68
China	9.06	0.00	0.00	252.00	28.70	4.52	28.09	7763.41
France	200.89	73.00	0.00	1438.00	283.23	2.14	8.02	474.21
India	424.94	355.00	0.00	2003.00	382.70	0.75	2.98	24.23
Indonesia	84.55	74.00	0.00	346.00	68.45	1.21	4.65	83.63
Japan	12.62	6.00	0.00	104.00	17.84	2.40	9.39	697.96
Malaysia	1.75	0.00	0.00	15.00	2.74	2.03	7.50	400.87
New Zealand	0.07	0.00	0.00	4.00	0.37	7.58	69.66	45961.37
Pakistan	35.20	23.00	0.00	313.00	38.18	2.50	14.74	1614.21
Singapore	0.07	0.00	0.00	2.00	0.30	4.64	25.57	6475.82
South Africa	125.82	82.00	0.00	844.00	157.11	2.36	9.32	601.41
South Korea	3.78	1.00	0.00	40.00	6.20	2.74	11.40	1101.64
UK	257.04	87.00	0.00	1826.00	339.73	1.75	6.20	239.43
USA	1122.49	960.00	0.00	4476.00	984.64	1.19	4.17	76.97

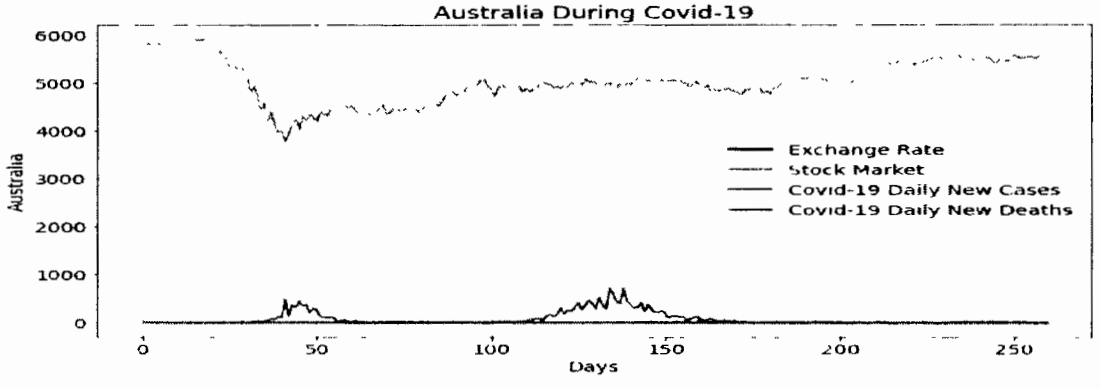
Table 4.5 provides the information related to the global gold, oil, inflation, COVID-19 confirmed new cases and Covid-19 confirmed new deaths across the sample time period represented in Table 3.2. Descriptive statistics are computed on the daily prices of the commodity markets, inflation and global COVID-19 confirmed new cases and COVID-19 confirmed new deaths. The

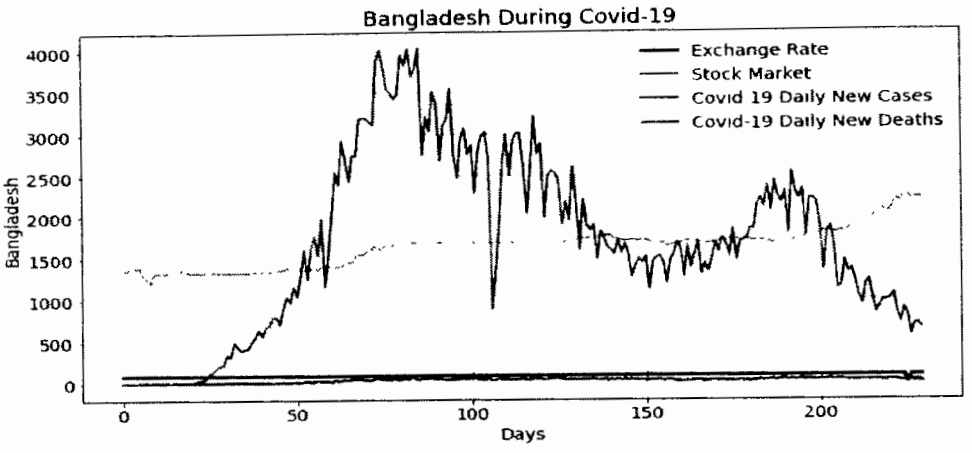
descriptive statistics are divided further into two segments related to the central tendency and variability. In this regard mean and median are computed for measuring the central tendency of gold, oil, inflation, COVID-19 confirmed new cases and COVID-19 confirmed new deaths during the sample time period. Moreover, minimum, maximum standard deviation, skewness, kurtosis is implemented in order to examine the variability of the gold, oil, inflation, COVID-19 confirmed new cases and COVID-19 confirmed new deaths.

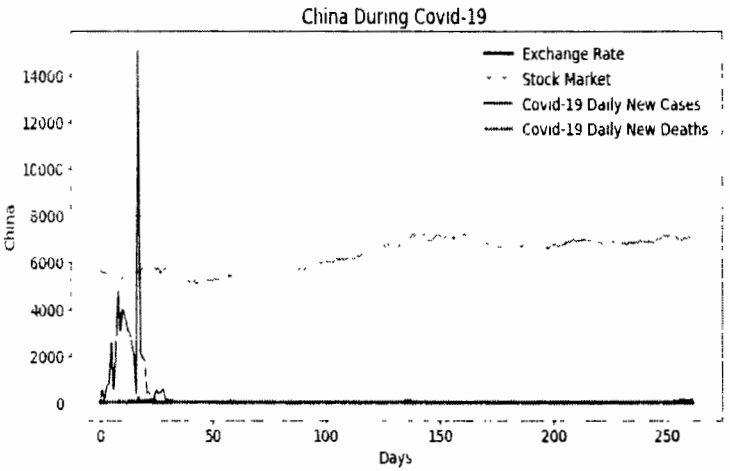
Table 4. 5: Descriptive Statistics (Global Insight)

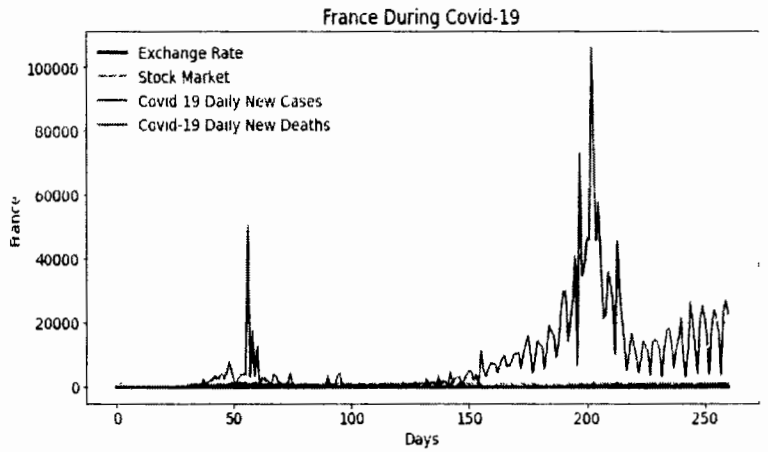
	Mean	Median	Min	Max	Std	Skewness	Kurtosis	Jarque Bera
Gold	1789.065	1806.550	1469.300	2045.500	130.548	-0.362	2.160	13.416
Oil	39.251	40.625	12.960	58.260	9.623	-0.754	3.192	25.200
Inflation	2.103	2.050	1.243	3.052	0.321	1.071	4.493	74.389
Covid19- New Cases*	1150156	925314	0	3796438	1150156	1150156	1150156	1150156
Covid19- New Deaths*	26470.7	24826.5	0	76380.0	17406.7	0.588	3.246	15.745

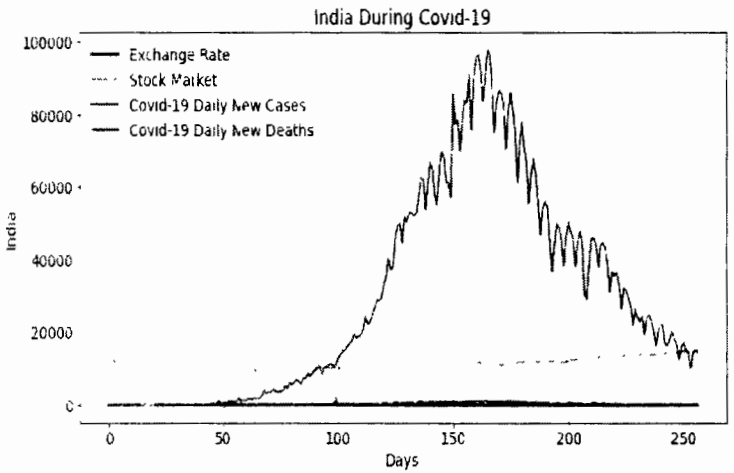
Note*: COVID-19 New Cases and New Deaths represents the Overall Global Data

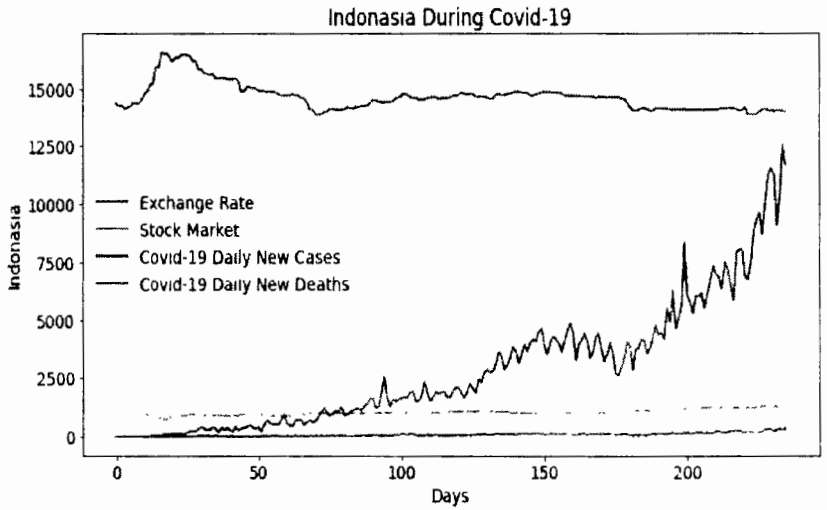


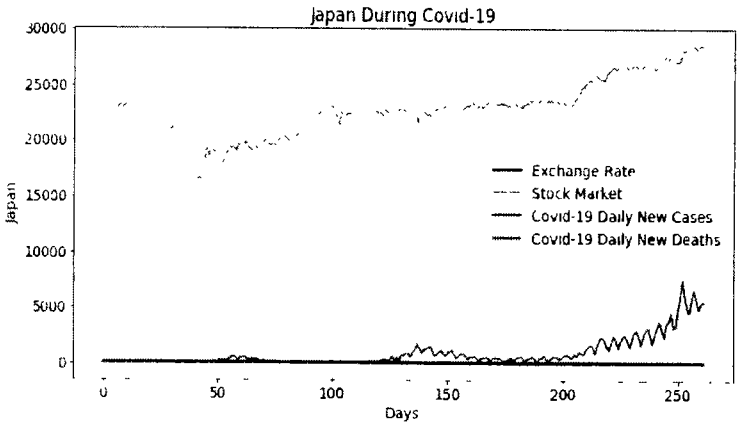

Bangladesh During Covid-19
Exchange Rate
Stock Market
Covid 19 Daily New Cases
Covid-19 Daily New Deaths
Bangladesh
4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
Days

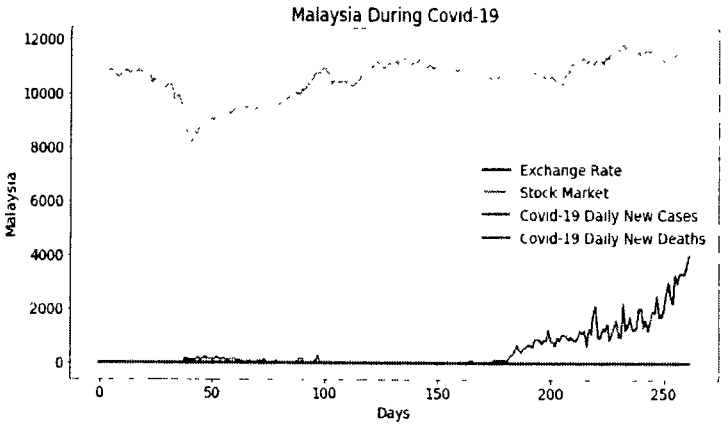

China During Covid-19
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths
China
Days

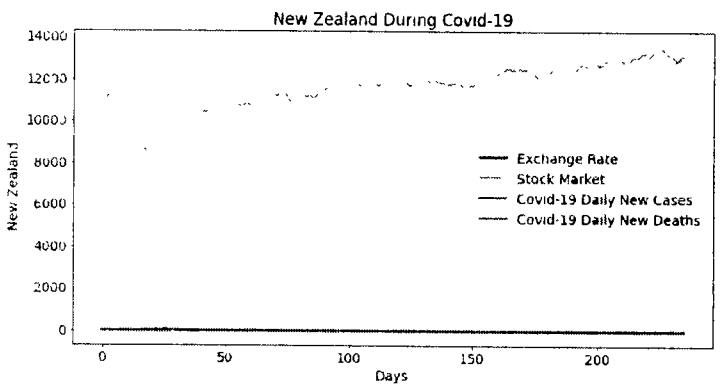

France During Covid-19
Exchange Rate
Stock Market
Covid 19 Daily New Cases
Covid-19 Daily New Deaths
France
Days

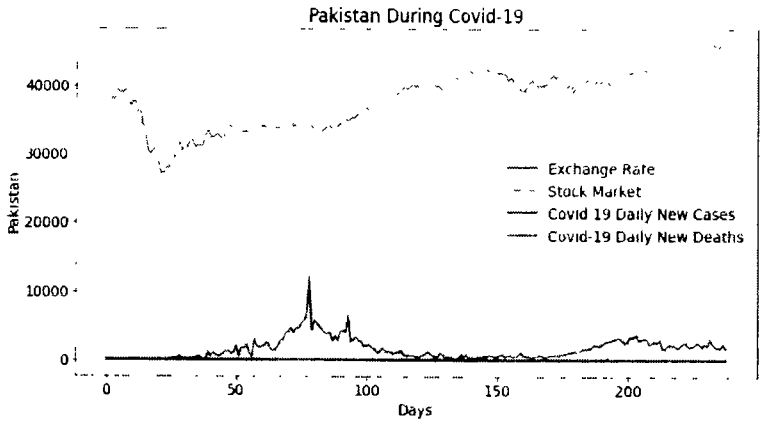

India During Covid-19
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths
India
Days

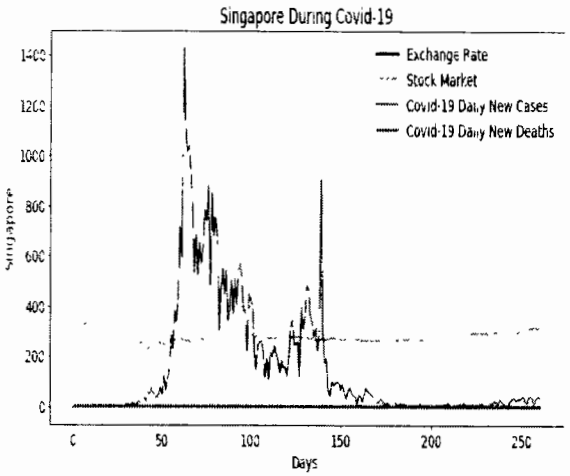

Indonasia During Covid-19
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths
Indonasia
Days

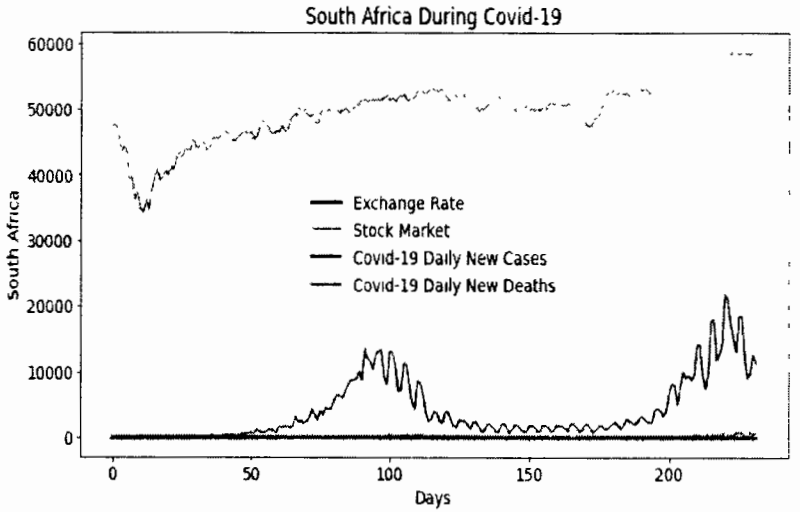

Japan During Covid-19
Japan
Days
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths

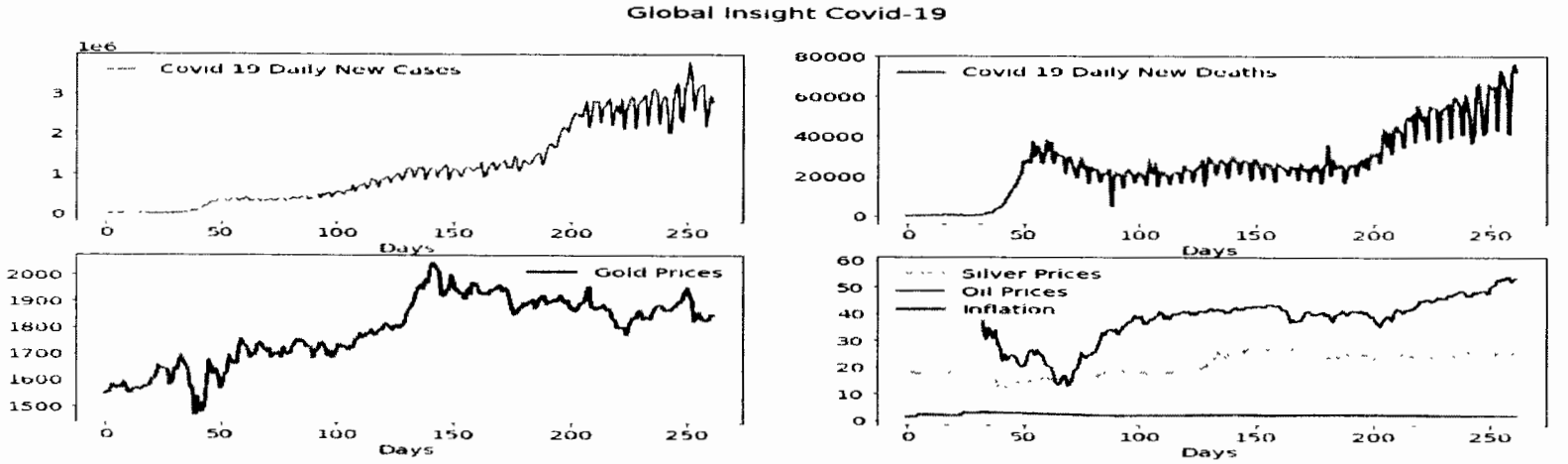

Malaysia During Covid-19
Malaysia
Days
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths


New Zealand During Covid-19
New Zealand
Days
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths


Pakistan During Covid-19
Pakistan
Days
Exchange Rate
Stock Market
Covid 19 Daily New Cases
Covid-19 Daily New Deaths


Singapore During Covid-19
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths
Singapore
Days


South Africa During Covid-19
Exchange Rate
Stock Market
Covid-19 Daily New Cases
Covid-19 Daily New Deaths
South Africa
Days


Global Insight Covid-19
1e6
Covid 19 Daily New Cases
Days
Covid 19 Daily New Deaths
Days
Gold Prices
Days
Silver Prices
Oil Prices
Inflation
Days

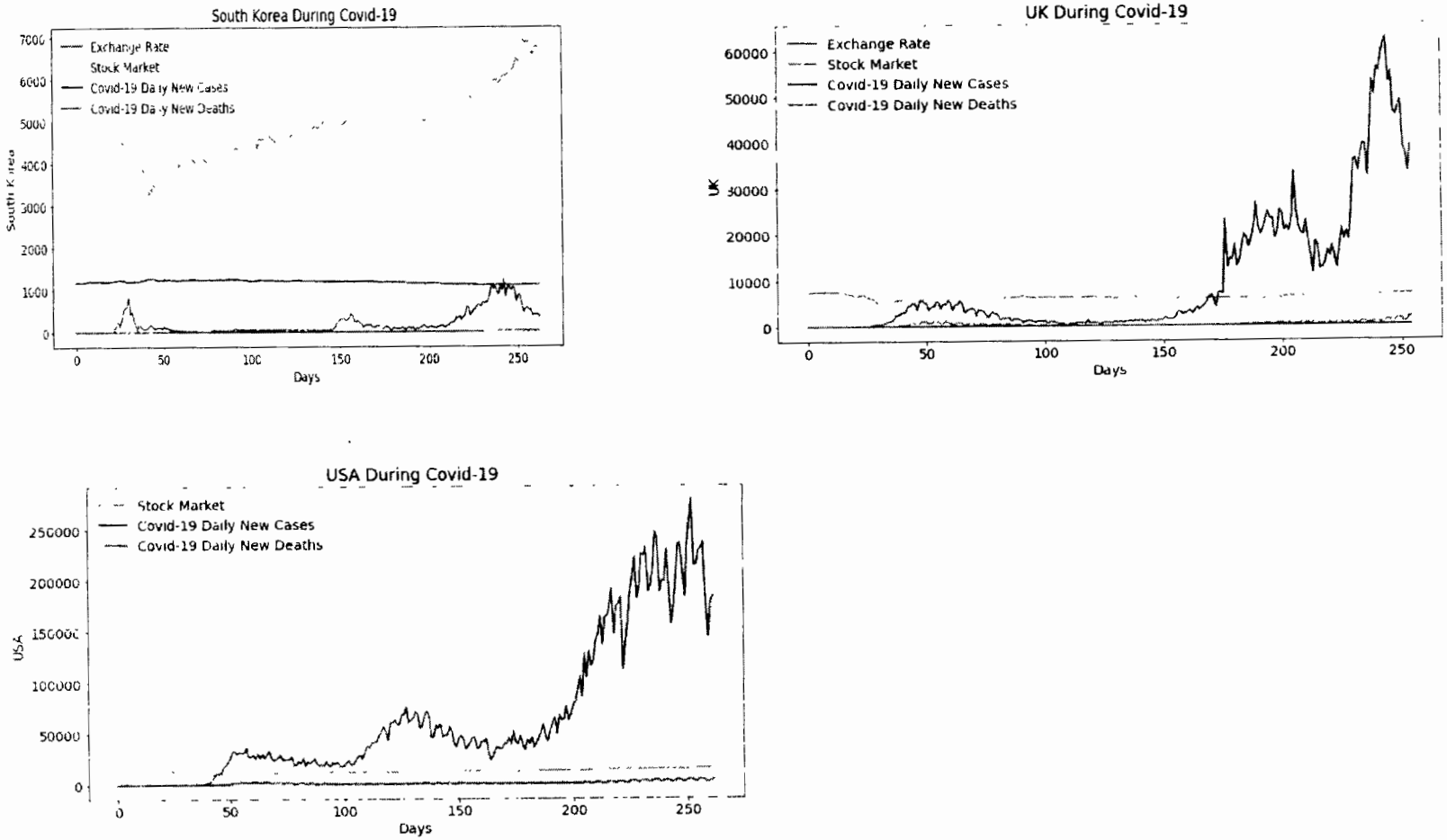


Figure 4. 1: Graphical Outlook

4.2 Data Pre-Processing

Data diagnostic is the basic and essential step of data analysis. Because, data diagnostic enables to determine which empirical model will be implemented to derive the empirical results from the specific data set such as time-series data is not stationary due to uncertainty, complexity, and nature of the data. Therefore, establishing the stationarity of the data is the preliminary and fundamental step while applying any statistical model. Against this backdrop, the Augmented Dickey Filler test (ADF) is implemented on the data set of all variables to determine the order of stationarity. In the following Table, 4.6 empirical results of the new corona virus cases and new deaths of all countries are reported. Based on the results reported in Table 4.6, the majority of the data series of new cases are stationer at first difference except for Australia and China which are stationed at the level. Similarly, the data series related to new deaths of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, Pakistan, South Africa, South Korea, UK and US is stationer at first difference while at the same time China and Singapore exhibit the stationarity at the level.

Table 4. 6: Unit Root Test (COVID-19 Cases)

	New Cases		New Deaths	
	Level	**1st Difference**	**Level**	**1st Difference**
Australia	0.0505	-	0.1557	0
Bangladesh	0.4907	0.00	0.3177	0.00
China	0.0002	-	0.1474	0.00
France	0.2909	0.00	0.0284	-
India	0.2483	0.00	0.6815	0.00
Indonesia	0.9999	0.00	0.9997	0.00
Japan	0.9992	0.0004	1	0.00
Malaysia	0.7637	0.00	0.3008	0.00
New Zealand	0.1224	0.00	0.0406	-
Pakistan	0.2366	0.00	0.3576	0.00
Singapore	0.1447	0.00	0.0196	-
South Africa	0.052	0.00	0.9536	0.00
South Korea	0.5282	0.00	0.0471	0.00
UK	0.2174	0.00	0.5201	0.00
USA	0.8626	0.00	0.3996	0.00

Table 4.7 shows the estimated results of ADF and ARCH of the stock returns and exchange rate market across all countries. On the basis of the empirical results reported in Table 4.7 Australia,

Bangladesh, China, France, India, Indonesia, Japan, Malaysia, Pakistan, Singapore, South Africa, UK, and USA is stationer at 1st difference but from the sample empirical result of the New Zealand exhibit the stationary at Level. The exchange rate market of Australia, Bangladesh, China, France, India, Malaysia, Pakistan, UK, and USA is stationer at first difference. However, the exchange rate market of Indonesia, Japan, New Zealand, Singapore, South Africa and USA is stationary at the level because the p-value is statistically significant at the level.

Table 4. 7: Data Pre-Processing (Stock and Forex Markets)

	Stock returns			Exchange Rate		
	Level	**1st Difference**	**ARCH**	**Level**	**1st Difference**	**ARCH**
Australia	0.3138	0.000	0.000	0.1111	0.0000	0.0000
Bangladesh	0.8866	0.000	0.000	0.94	0.0000	0.0000
China	0.4961	0.000	0.0001	0.4856	0.0000	0.000
France	0.4457	0.000	0.231	0.0625	0.0000	0.0094
India	0.3765	0.000	0.0531	0.2747	0.0000	0.052
Indonesia	0.9104	0.000	0.0002	0.0501	-	0.000
Japan	0.3333	0.000	0.000	0.0016	-	0.000
Malaysia	0.3288	0.000	0.000	0.1316	0.0000	0.0016
New Zealand	0.0049	-	0.000	0.0682	-	0.000
Pakistan	0.8972	0.000	0.000	0.3045	0.0000	0.0001
Singapore	0.6287	0.000	0.000	0.0184	-	0.000
South Africa	0.2038	0.000	0.0521	0.0011	-	0.057
South Korea	0.7126	0.000	0.000	0.2011	0.0000	0.0421
UK	0.3843	0.000	0.1258	0.0992	0.0000	0.000
USA	0.2872	0.000	0.0001	-	-	-

After establishing the stationarity of the data, the ARCH test is applied in order to investigate the existence of heteroscedasticity in the stock returns and exchange rate market of Australia, Bangladesh, China, France, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea, UK and USA. Because the existence of heteroscedasticity enables to employed the volatility model such as the GARCH family and Dynamic conditional correlation model. Table 4.6 shows the statistically significant ARCH effect in the stock returns of all countries except France and UK because the p-value is greater than 0.005. Moreover, ARCH effect in the exchange rate market is statistically significant in all countries (as p-value <0.05) except USA which shows the nonexistence of statistically significant heteroscedasticity.

The above-mentioned Table 4.8 reports the results related to the ADF test and ARCH test employed for identifying the existence of stationarity and heteroscedasticity in global commodity markets including gold & oil, global Covid-19 new cases, and data series of Covid-19 new deaths. Based on the ADF results all series are stationarity at first difference except the data series of global inflation which is stationarity at level and presence of heteroscedasticity only in global gold and oil markets.

Table 4. 8: Data Pre-Processing (Commodity and Inflation)

	Level	1st Difference	ARCH
Gold	0.2739	0.0000	0.0000
Oil	0.2983	0.0000	0.0697
Inflation	0.0285	-	0.8992
COVID-New Cases	0.5319	0.0000	-
COVID-New Deaths	0.643	0.0000	-

4.3 DCC Computation

4.3.1 Stock returns and COVID-19 New Daily Cases

After examining the existence of ARCH effect the next most imperative step is to explore the existence of a time-varying conditional correlation between the new cases of COVID-19 and the stock returns of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea, and the USA.

In this backdrop, Table 4.9 represents the empirical results of DCC along with the appropriate model from the GARCH family in order to capture the time dynamic conditional correlation. The best-fitted model from the GARCH family is selected based on the lowest AIC criteria because the model having the lowest AIC criteria enables an estimation of the results more precisely. Hence, GARCH, T-GARCH, and E-GARCH are employed to estimate the dynamic conditional correlation for the series of COVID-19 new cases and stock returns. This table also provides information related to the coefficients of the selected model along with their significance value (p-value) and selected best-fitted model based on the lowest AIC.

Table 4. 9: DCC GARCH (Stock returns and New Cases)

Series	α	β		Selected Model
Australia	-0.0459 0.0469	0.4632 0.4685	-3.9007	T-GARCH
Bangladesh	-0.0215 0.0000	0.8739 0.0000	-6.6250	E-GARCH
China	-0.0217 0.0000	0.8350 0.0000	3.9648	GARCH
France	No ARCH Effect			
India	0.0715 0.6060	0.3174 0.6726	-5.9232	GARCH
Indonesia	-0.003451 0.8337	-0.923186 0.0003	-5.6100	T-GARCH
Japan	-0.03483 0	0.776214 0	-4.824831	E-GARCH
Malaysia	-0.027714 0.0051	0.911246 0	-4.254741	E-GARCH
New Zealand	-0.04406 0	0.817302 0	-15.56095	GARCH
Pakistan	-0.02586 0.033	0.926177 0	-5.283629	T-GARCH
Singapore	-*	-	-	-
South Africa	-0.028239 0.4435	0.854711 0.0135	11.95541	GARCH
South Korea	0.055866 0.4615	-0.060599 0.9247	-4.407109	T-GARCH
UK	No ARCH Effect			
USA	-0.021851 0	0.980168 0	-5.641732	E-GARCH

-*: *Series does not meet the stability conditions*

Based on the estimated results reported in Table 4.9 best-fitted model for the pair between COVID-19 new cases and stock returns of Australia, Indonesia, Pakistan and South Korea is the T-GARCH model. Moreover, E-GARCH is selected for the pair between COVID-19 new cases and the stock returns of Bangladesh, Japan, Malaysia and the USA due to the lowest AIC among all other

models. The last GARCH model is selected for the covid-19 new cases and stock returns of China, India, New Zealand and South Africa. A denotes the past residual shock for all the series of stock returns and COVID-19 new cases and the lag dynamic conditional correlation between stock returns and COVID-19 new cases is represented by β.

According to the results reported in Table 4.9 past residual shock for the pair between stock returns of Australia, Bangladesh, China, Japan, Malaysia, New Zealand, Pakistan, USA and COVID-19 new cases is statistically significant because the p-value is less than 0.05 and the sign of the coefficient for these pair is negative which means that past residual shock of the COVID-19 new cases decreases the current volatility of the stock returns. Besides this, past residual shock for the series of COVID-19 new cases does not impact the current volatility of the stock returns of India, Indonesia, South Korea and South Africa because the p-value of these pairs is greater than 0.05.

β provides the information related to lagged dynamic conditional correlation between COVID-19 new cases and stock returns Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, Pakistan, Singapore, South Africa, South Korea, UK and USA. On the basis of reported results in Table 4.9 lagged dynamic conditional correlation between COVID-19 new cases and stock returns is statistically significant for all pairs except Australia, India and South Korea as p-value > 0.05. The coefficient sign of the **β** is positive for all statistically significant pairs which provide information related to the increase in the current correlation between due to the lagged dynamic correlation except for the pair of COVID-19 new cases and stock returns of Indonesia. Because the coefficient sign of the pair-wise correlation between COVID-19 new cases and the Indonesian stock returns is negative which provides information related to the inverse relationship between the current pair-wise correlation of COVID-19 new cases and the Indonesian Stock returns with lag dynamic conditional correlation.

Table 4. 10A: GRANGER (Stock returns and New Cases)

Lag Length Selection (New Cases)				
	AIC	**SIC**	**HQIC**	**LAG**
Australia	-3.577056*	-3.38042	-3.497923*	3
Bangladesh	-5.685536*	-5.59328	-5.648284*	1
China	-3.706858*	-3.56226	-3.6486	2
France	-2.274575*	-1.79838	-2.08297	8
India	-4.707335*	-4.28232	-4.536242*	7
Indonesia	-5.273284*	-4.75869	-5.06562	8

Japan	-4.714515*	-4.29554	-4.54595	7
Malaysia	-3.803500*	-3.55211	-3.70236	4
New Zealand	Does not Meet the Stationarity Conditions			
Pakistan	-4.385693*	-3.87588	-4.18002	8
Singapore	-4.337876*	-4.13604	-4.25657	3
South Africa	-5.036901*	-4.57854	-4.85186	7
South Korea	-3.802171*	-3.66291	-3.74615	2
UK	-3.923107*	-3.43863	-3.72803	8
USA	-4.950952*	-4.47611	-4.75991	8

The above table presents the results which depicts the values of AIC, SIC, HQIC and Lag length of all selected countries by taken the stock new cases of Covid-19. It indicates that the countries like France, Indonesia, Pakistan, UK, and USA selected the eight lags under the AIC while, the South Africa, Japan, and India select the seven lags. In case of Australia, Bangladesh, and India selected the three, one, and seven lags respectively by the AIC and HQIC. Moreover, two and four lags are selected in China, South Korea, and Malaysia respectively under the AIC. However, the New Zealand does not meet the stationarity conditions. The AIC lag length values are used for model selection for each country. Therefore, the optimal lag length for the model is three, one and seven for the Australia, Bangladesh, and India countries respectively. The * indicates that lag selected by AIC is statistically significant at 5% for all countries except the New Zealand.

Table 4. 11B: GRANGER (Stock returns and New Cases)

Multivariate Co-Integration Test-Trace Statistics					
	Hypothesis	**Eigen value**	**Trace Statistic**	**Critical Value at 5%**	**Prob**
Australia	None *	0.24	69.3333	11.2248	0.0000
	At most 1 *	0.0985	26.3439	4.1299	0.0000
Bangladesh	None *	0.3756	106.9051	11.2248	0.0001
	At most 1 *	0.3225	88.3916	4.1299	0.0001
China	None *	0.3626	112.1576	11.2248	0.0001
	At most 1 *	0.2333	66.1461	4.1299	0.0001
France	None *	0.2300	65.5868	11.2248	0.0000
	At most 1 *	0.0627	16.2599	4.1299	0.0001
India	None *	0.0918	23.8732	11.2248	0.0002
	At most 1 *	0.0640	16.4087	4.1299	0.0001
Indonesia	None *	0.1112	26.5256	11.2248	0.0001
	At most 1 *	0.0507	11.7183	4.1299	0.0007
Japan	None *	0.1275	34.5036	11.2248	0.0000
	At most 1 *	0.1134	30.4577	4.1299	0.0000

Malaysia	None *	0.288519	87.14393	11.2248	0.0001
	At most 1 *	0.125788	34.41479	4.129906	0
New Zealand		Does Not meet the Stationarity condition			
Pakistan	None *	0.213704	55.77782	11.2248	0
	At most 1 *	0.091031	22.14302	4.129906	0
Singapore	None *	0.337478	102.9255	11.2248	0.0001
	At most 1 *	0.260245	75.35917	4.129906	0.0001
South Africa	None *	0.21999	55.40406	11.2248	0
	At most 1 *	0.130819	31.26557	4.129906	0
South Korea	None *	0.292284	89.53958	11.2248	0.0001
	At most 1 *	0.164761	46.62958	4.129906	0.0001
UK	None *	0.152018	40.39942	11.2248	0
	At most 1 *	0.047865	12.01675	4.129906	0.0006
USA	None *	0.131111	35.41598	11.2248	0
	At most 1 *	0.041146	10.5881	4.129906	0.0013

The above table show the results of multivariate co-integration test-trace statistics for the new stock cases. In this study, Eigen values and trace statistics are used to find out the long run relationship among the variables which explains the cointegrating vectors between two series. The results reflect the long run association among the variables. Furthermore, it shows that existence of two integrated equations which is statistically significant at 5% level in the selected countries except for the New Zealand.

Table 4. 12C: GRANGER (Stock returns and New Cases)

	New cases			
	Variables		**F-Statistics**	**Prob**
Australia	NC does not Granger Cause ASX	256	0.9974	0.3947
	ASX does not Granger Cause NC		3.72694	0.012
Bangladesh	NC does not Granger Cause DSE	228	0.42758	0.5138
	DSE does not Granger Cause NC		2.53669	0.1126
China	NC does not Granger Cause SSE	241	1.96443	0.052
	SSE does not Granger Cause NC		0.43527	0.8991
France	NC does not Granger Cause CAC40	252	1.48551	0.1632
	CAC40 does not Granger Cause NC		2.07194	0.0393
India	NC does not Granger Cause SEN	249	3.53823	0.0012
Indonesia	NC does not Granger Cause JKSE	226	2.58504	0.0103

	JKSE does not Granger Cause NC		0.68834	0.7016
Japan	NC does not Granger Cause NIK	253	1.39574	0.199
	NIK does not Granger Cause NC		0.86958	0.5428
Malaysia	NC does not Granger Cause FTSC	257	0.85008	0.4947
	FTSC does not Granger Cause NC		3.97315	0.0038
New Zealand				
	Does Not meet the Stationarity condition			
Pakistan	NC does not Granger Cause KSE		5.49072	0.0047
	KSE does not Granger Cause NC		0.51404	0.5988
Singapore	NC does not Granger Cause SSGF	252	2.98478	0.0319
	SSGF does not Granger Cause NC		0.59877	0.6164
South Africa	NC does not Granger Cause SA40	224	2.76117	0.0092
South Korea	NC does not Granger Cause KOPSI	260	1.85778	0.1581
	KOPSI does not Granger Cause NC		1.43265	0.2406
UK	NC does not Granger Cause FTSC	246	1.02071	0.4211
	FTSC does not Granger Cause NC		1.55515	0.1395
USA	NC does not Granger Cause NYSE	253	4.14747	0.0001

The results of pair-wise granger causality test for new stock cases of COVID-19 are presented in table. The results show that Uni-direction causality from ASX to NC in case of Australia. However, no causality exists among the NC to DSE, FTSC, and KOPSI in Bangladesh, UK, and South Korea. The one-way causality running from NC to SSE, CAC40 to NC, NC to JKSE, NC to NIK, FTSC to NC, NC to KSE, SSGF in China, France, Indonesia, Malaysia, Pakistan, and Singapore at 5% significant level.

4.3.2 Forex Markets and COVID-19 New Daily Cases

In the above Table 4.10 estimated results related to the COVID-19 new cases and exchange rate markets of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and the USA. In the above mentioned the independent variable is the COVID-19 new cases and the dependent variable is exchange rate markets to measure the relationship between the past residual shock on current volatility and impact of lagged dynamic conditional correlation on current correlation of the COVID-19 new cases and exchange rate markets. According to the empirical results reported in Table 4.10 stability

for all the pairs is met except for the pair of China and Singapore with COVID-19 new cases which leads towards dropping these pairs for further estimation of the past residual shocks on current volatility and lagged dynamic conditional correlation impact on current correlation.

From the various heteroscedasticity measuring models of GARCH family, GARCH, T-GARCH and E-GARCH is employed to estimate the output of the DCC for the pairs of COVID-19 new cases and exchange rate markets of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and USA. The best-fitted model for the pair is selected based on minimum AIC value. E-GARCH is selected for the pair of COVID-19 new cases and exchange rate markets of Australia, Bangladesh, France, India, Japan, and South Africa. Moreover, T-GARCH is selected for the rest of the pairs.

Based on the empirical results, the coefficient of the α is statistically significant for the pairs of Covid-19 new cases and exchange rate markets of Bangladesh, Japan, Malaysia, South Africa and South Korea which provides evidence related to the statistically significant existence of the past residual shock. Moreover, the sign of the coefficient of α is negative for the pair of COVID-19 new cases and exchange rate markets of Bangladesh, Japan, and South Korea which means that past residual shock of the COVID-19 new cases decreases the current volatility of the exchange rate market. Hence, the current volatility of the exchange rate market of Malaysia and South Africa is decreasing because the sign of the coefficient is negative.

The pair wise lagged dynamic conditional correlation is denoted by the B in the above-reported Table 4.10 which is statistically significant for Australia, Bangladesh, France, Indonesia, Malaysia, New Zealand, South Korea, South Africa and Pakistan (as p-value < 0.05) with positive coefficient while rest of the pair shows the insignificant impact of past residual shock on current volatility. The sign of the coefficient provides information related to the positive/increase or negative/decrease the influence of the past residual shock on the current volatility. Nexus to Table 4.10 the sign of the β is positive for above mentioned statistically significant pairs of exchange rate markets and COVID-19 new cases which information that current correlation between pairs is increased due to an increase in lagged dynamic conditional correlation.

Table 4. 13: DCC GARCH (Forex markets and New Cases)

Series	α	β		Selected Model
Australia	-0.0174	0.9153	-5.2129	E-GARCH
	0.4294	0.0000		
Bangladesh	-0.0090	0.7736	3.6699	E-GARCH
	0.0000	0.0000		
China	-	-	-	
France	0.0125	0.8174	-4.9786	E-GARCH
	0.7383	0.0207		
India	-0.0193	0.7047	-8.5890	E-GARCH
	0.5882	0.1161		
Indonesia	0.0228	0.8548	-7.6732	T-GARCH
	0.3893	0		
Japan	-0.0384	-0.2218	4.6660	E-GARCH
	0	0.7424		
Malaysia	0.0423	0.9640	-7.3182	T-GARCH
	0	0		
New Zealand	0.0296	0.8119	-4.9791	T-GARCH
	0.5747	0.0009		
Pakistan	0.0499	0.7739	-7.3588	T-GARCH
	0.3837	0.0000		
Singapore	-*	-	-	-
South Africa	0.1598	0.8766	5.0881	E-GARCH
	0.0000	0.0000		
South Korea	-0.0442	0.7349	-13.7865	T-GARCH
	0.0000	0.0000		
UK	0.0916	-0.1253	-6.7607	T-GARCH
	0.2231	0.8027		

-*: *Series does not meet the stability conditions*

Table 4. 14A: GRANGER (Forex markets and New Cases)

Lag Length Selection (New Cases)

	AIC	SIC	HQIC	LAG
Australia	-4.100605*	-3.80565	-3.98191	2
Bangladesh	-10.12236*	-9.90359	-10.03398*	3

China	-6.693968*	-6.607210*	-6.659015*	1
France	-5.011747*	-4.6476	-4.86522	6
India	-7.935436*	-7.51042	-7.76434	7
Indonesia	-7.645240*	-7.13065	-7.43757	8
Japan	-6.938410*	-6.46357	-6.74737	8
Malaysia	-6.479762*	-6.22837	-6.37862	4
New Zealand	Does not Meet the Stationarity Conditions			
Pakistan	-6.398206*	-6.06833	-6.26513	5
Singapore	Does not Meet the Stationarity Conditions			
South Africa	Does not Meet the Stationarity Conditions			
South Korea	-6.397753*	-5.97996	-6.22968	7
UK	-5.913711*	-5.48623	-5.74159	7
USA	-	-	-	-

The result of lag length selection criteria for the forex new cases are mentioned in the above table. The optimal lag length under the AIC is the one, two, three, four, five, six, for the China, Australia, Bangladesh, Malaysia, Pakistan, France and seven for India, south Korea, and UK. The eight lag is selected by AIC in case of Indonesia and Japan.

Table 4. 15B: GRANGER (Forex markets and New Cases)

Co-Integration Test-Trace Statistics					
	Hypothesis	**Eigen value**	**Trace Statistic**	**Critical Value at 5%**	**Prob**
Australia	None *	0.24	95.6773	12.3209	0.0001
	At most 1 *	0.0985	26.3439	4.1299	0.0000
Bangladesh	None *	0.3596	144.4081	12.3209	0.0001
	At most 1 *	0.1900	46.3704	4.1299	0.0001
China	None *	0.4922	286.9117	12.3209	0.0001
	At most 1 *	0.3721	116.8062	4.1299	0.0001
France	None *	0.1669	85.2483	12.3209	0.0001
	At most 1 *	0.1430	39.0406	4.1299	0.0000
India	None *	0.1318	48.6160	12.3209	0.0000
	At most 1 *	0.0533	13.5790	4.1299	0.0003
Indonesia	None *	0.1005	38.6256	12.3209	0.0000
	At most 1 *	0.0637	14.8001	4.1299	0.0001
Japan	None *	0.1812	83.1123	12.3209	0.0001
	At most 1 *	0.1218	32.7419	4.1299	0.0000
Malaysia	None *	0.3446	166.0338	12.3209	0.0001

	At most 1 *	0.2004	57.4641	4.1299	0.0001
New Zealand		Does Not meet the Stationarity condition			
Pakistan	None *	0.176963	69.36027	12.3209	0
	At most 1 *	0.100131	24.37202	4.129906	0
Singapore		Does Not meet the Stationarity condition			
South Africa		Does Not meet the Stationarity condition			
South Korea	None *	0.200084	84.44233	12.3209	0.0001
	At most 1 *	0.10345	27.73709	4.129906	0
UK	None *	0.145909	51.87653	12.3209	0
	At most 1 *	0.052591	13.23585	4.129906	0.0003
USA			-		

Cointegration trace test statistics results are given in above table. If trace statistics values are greater than the critical values, null hypothesis rejected. Furthermore, it shows that existence of two integrated equations which is statistically significant at 5% level in the selected countries except Singapore, South Africa, and New Zealand.

Table 4. 16: GRANGER (Forex markets and new cases)

	New cases			
	Variables		**F-Statistics**	**Prob**
Australia	NC does not Granger Cause ASX	256	0.9974	0.3947
	ASX does not Granger Cause NC		3.72694	0.012
Bangladesh	NC does not Granger Cause TAKA	221	1.08647	0.3557
	TAKA does not Granger Cause NC		0.52622	0.6647
China	NC does not Granger Cause CNY	255	0.437	0.5092
	CNY does not Granger Cause NC		0.41945	0.5178
France	NC does not Granger Cause EUR	252	1.11755	0.352
	EUR does not Granger Cause NC		0.94645	0.4789
India	NC does not Granger Cause INR	249	5.98457	2.00E-06
	INR does not Granger Cause NC		5.78705	3.00E-06
Indonesia	NC does not Granger Cause RUPH	226	5.1134	8.00E-06
	RUPH does not Granger Cause NC		1.43441	0.1837

Japan	NC does not Granger Cause JPY	253	0.19776	0.991
	JPY does not Granger Cause NC		2.37711	0.0177
Malaysia	NC does not Granger Cause RING	257	0.95178	0.4347
	RING does not Granger Cause NC		0.43089	0.7863
New Zealand	Does Not meet the Stationarity condition			
Pakistan	NC does not Granger Cause PKR	232	2.56245	0.0281
	PKR does not Granger Cause NC		1.2134	0.3037
Singapore	Does Not meet the Stationarity condition			
South Africa	Does Not meet the Stationarity condition			
South Korea	NC does not Granger Cause WON	255	2.73103	0.0096
UK	NC does not Granger Cause GBP	247	1.37711	0.2158
	GBP does not Granger Cause NC		1.20956	0.2982
USA				

The above table shows the granger results in case of forex new cases of covid-19. In case of Australia, ASX granger cause the NC at 5% significance level, but NC does not granger cause ASX. It indicates the existence of one-way causality between the NC and ASX. There is no causality among the NC, GBP, CNY, EUR, RING in UK, Malaysia, France, China, and Bangladesh. Moreover, unidirectional causality exists between the NC, INR, RUPH, PKR, JPY, and WON in India, Indonesia, Japan, and Pakistan.

4.3.3 Stock returns and COVID-19 New Daily Deaths

Refer to above-mentioned Table 4.11 which consists of the empirical findings obtained after employing the econometric model named DCC. Due to differences in the stock returns characteristic & structure of the Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and the USA various models from GARCH family are applied for extracting the accurate output. Therefore, GARCH, T-GARCH and E-GARCH are implemented on all pairs of COVID-19 new deaths and stock returns and the best-fitted model is selected based on the lowest value of AIC. In the above Table, 4.11 ARCH effect does not exist between the series of the stock returns of France and UK which is the violation

of the preliminary assumption that the ARCH effect should be significant for the application of GARCH based models.

Moreover, in the data series of Pakistan and COVID-19 new deaths, the stability condition does not meet which leads towards to drop the series for estimation of past residual shock impact on current volatility and conditional dynamic conditional correlation impact on current correlation. Due to the uncertain and chaotic nature of data related to the stock returns and COVID-19 new deaths, econometric model E-GARCH is selected based on the lowest AIC value for the pair of COVID-19 new deaths and stock returns of Australia, India, Indonesia, Japan, Malaysia, Singapore, South Africa, and USA. However, for the series of Bangladesh and New Zealand GARCH model and for China and South Korea T-GARCH is selected because these models have the minimum AIC value among other remaining heteroscedasticity models which have been applied.

Past residual shock is statistically significant for the stock returns of Bangladesh, China, Indonesia, New Zealand, Singapore and South Africa and COVID-19 new deaths. The statistically significant negative coefficient of **α shows** that past residual shock cause decrease in the current volatility of stock returns of Bangladesh, China, Indonesia, New Zealand, Singapore, and South Africa. Besides this the next parameter **β** represents the coefficient related to the lagged dynamic conditional correlation whether the correlation between past and current data exists or not. According to the results reported in Table 4.11 related to the coefficient of **β** lagged dynamic conditional correlation between the COVID-19 new deaths and stock returns of Australia, Bangladesh, China, Indonesia, Malaysia, Singapore, New Zealand and South Africa is statistically significant and with a positive sign.

Table 4. 17: DCC GARCH (Stock returns and New Deaths)

Series	A	β		Selected Model
Australia	0.0753	0.7559	-5.2960	E-GARCH
	0.1029	0.0014		
Bangladesh	-0.0450	0.8612	-5.9888	GARCH
	0.0000	0.0000		
China	-0.009721	0.990583	-5.144953	T-GARCH
	0.0085	0		
France	No ARCH Effect			

India	0.0695 0.2997	-0.1314 0.8640	-5.7366	E-GARCH
Indonesia	-0.0163 0.0030	1.0031 0.0000	-4.6044	E-GARCH
Japan	0.001165 0.9692	0.8614 0.4728	-4.205899	E-GARCH
Malaysia	0.098861 0.1568	0.767923 0	-5.458926	E-GARCH
New Zealand	-0.04406 0	0.817302 0	-15.56095	GARCH
Pakistan	-*	-	-	
Singapore	-0.01617 0	0.778187 0	-9.114808	E-GARCH
South Africa	-0.02507 0.0007	0.996907 0	-3.785828	E-GARCH
South Korea	0.014541 0.7874	0.43818 0.7187	-0.935189	T-GARCH
UK	No ARCH Effect			
USA	0.060746 0.3143	0.675175 0.1352	-4.358084	E-GARCH

-: Series does not meet the stability conditions*

Table 4. 18A: GRANGER (Stock returns and New Deaths)

Lag Length Selection (Deaths Cases)

	AIC	SIC	HQIC	LAG
Australia	-3.993000*	-3.684	-3.86865	5
Bangladesh	-5.211117*	-5.118859*	-5.173865*	1
China	-4.983134*	-4.50829	-4.792089*	8
France	-2.614880*	-2.1247	-2.417417*	8
India	-4.729598*	-4.304586*	-4.558504*	7
Indonesia	-3.905955*	-3.4519	-3.72272	7
Japan	-3.955827*	-3.70444	-3.854685*	4
Malaysia	-4.719606*	-4.52408	-4.640940*	3
New Zealand	13.52851*	13.97974	13.71057	7
Pakistan	-4.036698*	-3.75814	-3.924198*	4

Singapore	Does not Meet the Stationarity Conditions			
South Africa	-3.710197*	-3.25183	-3.52516	7
South Korea	-3.740918*	-3.54595	-3.662483*	3
UK	-3.520044*	-3.03557	-3.32497	8
USA	-4.714059*	-4.29508	-4.545490*	7

The above table presents the results which depicts the values of AIC, SIC, HQIC and Lag length of all selected countries by taken the stock death cases of Covid-19. It indicates that the countries like China and France, select the eight lags under the AIC and HQIC while, India, Indonesia, New Zealand, USA, South Africa select the seven lags. In case of Bangladesh, one lag is selected by the AIC SIC, and HQIC. Moreover, three lags for the Malaysia, South Africa and four lags in case of Pakistan, Japan are selected under the AIC and HQIC. However, Singapore does not meet the stationarity conditions. The AIC lag length values are used for model selection for each country. Therefore, the optimal lag length for the model is one and seven for Bangladesh, and India countries respectively which is selected by all criteria. The * indicates that lag selected by AIC, SIC, and HQIC is statistically significant at 5% for all countries except Singapore.

Table 4. 19B: GRANGER (Stock returns and New Deaths)

Co-Integration Test-Trace Statistics					
	Hypothesis	**Eigen value**	**Trace Statistic**	**Critical Value at 5%**	**Prob**
Australia	None *	0.22	85.1452	12.3209	0.0001
	At most 1 *	0.0795	20.9469	4.1299	0.0000
Bangladesh	None *	0.4888	240.7431	12.3209	0.0001
	At most 1 *	0.3226	88.4234	4.1299	0.0001
China	None *	0.1866	80.6437	12.3209	0.0001
	At most 1 *	0.1095	28.9991	4.1299	0.0000
France	None *	0.1679	57.4691	12.3209	0.0000
	At most 1 *	0.0542	13.3638	4.1299	0.0003
India	None *	0.1633	52.6397	20.2618	0.0000
	At most 1	0.0334	8.4306	9.1645	0.0688
Indonesia	None *	0.1609	63.7003	12.3209	0.0000
	At most 1 *	0.1010	24.0626	4.1299	0.0000
Japan	None *	0.1309	68.2325	12.3209	0.0000
	At most 1 *	0.1213	32.7270	4.1299	0.0000
Malaysia	None *	0.3848	170.8984	12.3209	0.0001
	At most 1 *	0.1640	46.0385	4.1299	0.0001
New Zealand	None *	0.1488	48.1439	18.3977	0.0000

	At most 1 *	0.0488	11.4040	3.8415	0.0007
Pakistan	None *	0.287745	100.9904	12.3209	0.0001
	At most 1 *	0.103743	24.6437	4.129906	0
Singapore		Does Not meet the Stationarity condition			
South Africa	None *	0.248113	93.49639	12.3209	0.0001
	At most 1 *	0.125494	29.90354	4.129906	0
South Korea	None *	0.340962	154.4274	12.3209	0.0001
	At most 1 *	0.16605	46.84808	4.129906	0.0001
UK	None *	0.11673	53.75195	12.3209	0
	At most 1 *	0.090873	23.34139	4.129906	0
USA	None *	0.161638	54.38568	12.3209	0
	At most 1 *	0.03792	9.780405	4.129906	0.0021

The above table show the results of multivariate co-integration test-trace statistics by taken the stock death cases. In this study, Eigen values and trace statistics are used to find out the long run relationship among the variables which explains the cointegrating vectors between two series. The results reflect the long run association among the variables. Furthermore, it shows that existence of two integrated equations which is statistically significant at 5% level in the selected countries except Singapore.

Table 4. 20C: GRANGER (Stock returns and New Deaths)

New Deaths				
	Variables		**F-Statistics**	**Prob**
Australia	ND does not Granger Cause ASX	254	0.65533	0.6577
	ASX does not Granger Cause ND		2.50111	0.0313
Bangladesh	ND does not Granger Cause DSE	228	0.05565	0.8137
	DSE does not Granger Cause ND		0.30524	0.5812
China	ND does not Granger Cause SSE	253	2.51551	0.0122
France	ND does not Granger Cause CAC40	242	0.68425	0.7052
	CAC40 does not Granger Cause ND		2.56566	0.0107
India	ND does not Granger Cause SEN	249	1.23317	0.2853
	SEN does not Granger Cause ND		10.2743	3.00E-11
Indonesia	ND does not Granger Cause JKSE	227	3.94371	0.0005
Japan	ND does not Granger Cause NIK	257	1.00428	0.4059
	NIK does not Granger Cause ND		1.74649	0.1403
Malaysia	ND does not Granger Cause FTSC	258	0.01214	0.9982
	FTSC does not Granger Cause ND		1.62346	0.1844

New Zealand	ND does not Granger Cause NEWSTK	229	1.66551	0.1189
	NEWSTK does not Granger Cause ND		0.85302	0.5447
Pakistan	ND does not Granger Cause KSE	231	0.13157	0.8768
	KSE does not Granger Cause ND		1.02951	0.3589
Singapore				
	Does Not meet the Stationarity condition			
South Africa	ND does not Granger Cause SA40		1.13255	0.3439
	SA40 does not Granger Cause ND		0.90041	0.5071
South Korea	ND does not Granger Cause KOPSI	259	1.55245	0.2015
	KOPSI does not Granger Cause ND		1.35763	0.2563
UK	ND does not Granger Cause FTSC	252	2.70776	0.0687
	FTSC does not Granger Cause ND		0.87545	0.418
USA	ND does not Granger Cause NYSE	254	2.67631	0.011

The results of pair-wise granger causality test for new deaths of COVID-19 are presented in table. The results show that uni-direction causality from ASX to ND in case of Australia. However, no causality exists among the ND to DSE, NIK, FTSC, NEWSTK, KSE, SA40, and KOPSI in Bangladesh, Japan, Malaysia, New Zealand, Pakistan, South Africa, South Korea respectively. The one-way causality running from ND to CAC40, SEN to ND, ND to FTSC in France, India, and UK at 5% significant level.

4.3.4 Forex Markets and COVID-19 New Daily Deaths

After explaining the results related to the impact of COVID-19 new deaths on the stock returns of Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea and USA. **Table 4.12** represents the results of the exchange rate markets and new deaths of the COVID-19 in a very comprehensible form. All the data series of the exchange rate markets, and COVID-19 new deaths meet the stability condition except the series of the exchange rate market of Pakistan which does not meet the stability condition.

Table 4. 21: DCC GARCH (Forex markets and New Deaths)

Series	A	β		Selected Model
Australia	-0.0070	0.6503	-6.6292	E-GARCH
	0.0000	0.5777		

Bangladesh	-0.0091 0.0000	0.8247 0.0000	4.4067	E-GARCH
China	-0.0464 0.0000	0.8523 0.0000	-23.3694	E-GARCH
France	0.2358 0.1135	0.5209 0.0433	6.5982	T-GARCH
India	-0.018641 0	0.976208 0	-7.773349	GARCH
Indonesia	0.049609 0.4926	0.643529 0.0789	-7.6732	E-GARCH
Japan	-0.045937 0	0.792555 0	-8.87081	E-GARCH
Malaysia	0.073552 0.1864	0.834729 0	-8.026573	E-GARCH
New Zealand	0.0263 0.6208	0.8127 0.0003	-4.9247	GARCH
Pakistan	-* -	- -	- -	
Singapore	0.10571 0.0682	-0.108802 0.2122	-5.597039	E-GARCH
South Africa	-0.091076 0	0.817036 0	3.862222	T-GARCH
South Korea	0.125791 0.1317	0.300772 0.3033	-3.292045	E-GARCH
UK	0.019616 0.4281	0.921584 0	-5.208102	E-GARCH

-*: *Series does not meet the stability conditions*

The best-fitted GARCH, T-GARCH, and E-GARCH model are selected based on the lowest AIC value is reported in **Table 4.12** Past residual shock for most of the pair is statistically significant except the pair of COVID-19 new deaths and exchange rate markets of France, Indonesia, Malaysia, New Zealand, South Korea, and UK. The coefficient sign of the parameter related to past residual shock is α is negative which past residual shock decreases the current conditional volatility in the exchange rate market created by COVID-19 new deaths. Moreover, lagged dynamic conditional correlation is denoted by β and is statistically significant for the pair of exchange rate markets and COVID-19 new deaths in Bangladesh, China, France, India, Japan, Malaysia, New Zealand, South Africa, and UK.

Table 4. 22A: GRANGER (Forex markets and New Deaths)

Lag Length Selection (Deaths Cases)				
	AIC	**SIC**	**HQIC**	**LAG**
Australia	-3.993000*	-3.684	-3.86865	5
Bangladesh	-9.678025*	-9.45926	-9.58964	3
China	-7.936707*	-7.46186	-7.74566	8
France	-5.390416*	-4.90024	-5.19295	6
India	-7.712730*	-7.28772	-7.541636*	7
Indonesia	-6.229969*	-5.95754	-6.12003	4
Japan	-6.122345*	-5.81509	-5.99873	5
Malaysia	-7.408946*	-7.15756	-7.30781	3
New Zealand	-5.299839*	-4.84861	-5.11778	7
Pakistan	-6.257507*	-5.91705	-6.12001	5
Singapore	-7.790922*	-7.37194	-7.62235	3
South Africa	Does not Meet the Stationarity Conditions			
South Korea	-6.269174*	-5.90708	-6.12351	6
UK	-5.529446*	-5.04497	-5.33437	8
USA	-	-	-	-

The result of lag length selection criteria for the forex new death cases are mentioned in the above table. The optimal lag length under the AIC is three for Bangladesh, Singapore, and Malaysia. Under AIC criteria the lag length is four for Indonesia, five for Australia, Pakistan, Japan, and six for the France and south Korea. In case of New Zealand and India, seven lag length is selected by AIC while, eight lag is selected in case of UK and China.

Table 4. 23B: GRANGER (Forex markets and New Deaths)

Co-Integration Test-Trace Statistics					
	Hypothesis	**Eigen value**	**Trace Statistic**	**Critical Value at 5%**	**Prob**
Australia	None *	0.22	85.1452	12.3209	0.0001
	At most 1 *	0.0795	20.9469	4.1299	0.0000
Bangladesh	None *	0.3602	160.7814	12.3209	0.0001
	At most 1 *	0.2474	62.5301	4.1299	0.0001
China	None *	0.1740	75.1936	12.3209	0.0000
	At most 1 *	0.1039	27.4146	4.1299	0.0000
France	None *	0.1798	68.2772	12.3209	0.0000
	At most 1 *	0.0827	20.7189	4.1299	0.0000
India	None *	0.1535	52.4184	25.8721	0.0000
	At most 1	0.0437	11.0849	12.5180	0.0858
Indonesia	None *	0.3382	121.6138	12.3209	0.0001
	At most 1 *	0.1115	27.0747	4.1299	0.0000
Japan	None *	0.2166	113.8829	12.3209	0.0001

	At most 1 *	0.1833	51.6432	4.1299	0.0001
Malaysia	None *	0.3782	178.5061	12.3209	0.0001
	At most 1 *	0.1970	56.3931	4.1299	0.0001
New Zealand	None *	0.1357	47.2773	25.8721	0.0000
	At most 1 *	0.0580	13.7381	12.5180	0.0311
Pakistan	None *	0.244395	91.74257	12.3209	0.0001
	At most 1 *	0.122927	29.2497	4.129906	0
Singapore	None *	0.093076	38.86541	25.87211	0.0007
	At most 1 *	0.054387	14.14826	12.51798	0.0264
South Africa		Does Not meet the Stationarity condition			
South Korea	None *	0.175915	81.21109	12.3209	0.0001
	At most 1 *	0.118604	32.06692	4.129906	0
UK	None *	0.132619	57.45086	12.3209	0
	At most 1 *	0.088092	22.59292	4.129906	0
USA					-

The above table show the results of multivariate co-integration test-trace statistics by taken the forex new death cases. In this study, Eigen values and trace statistics are used to find out the long run relationship among the variables which explains the cointegrating vectors between two series. The results reflect the long run association among the variables. Furthermore, it shows that existence of two integrated equations which is statistically significant at 5% level in the selected countries except South Africa and USA.

Table 4. 24C: GRANGER (Forex markets and New Deaths)

	New Deaths			
	Variables		**F-Statistics**	**Prob**
Australia	ND does not Granger Cause ASX	254	0.65533	0.6577
	ASX does not Granger Cause ND		2.50111	0.0313
Bangladesh	ND does not Granger Cause TAKA	221	0.64657	0.5859
	TAKA does not Granger Cause ND		0.61459	0.6062
China	ND does not Granger Cause CNY	253	0.97105	0.4593
	CNY does not Granger Cause ND		0.69272	0.6978
France	ND does not Granger Cause EUR	242	1.17211	0.317
	EUR does not Granger Cause ND		3.78928	0.0003
India	ND does not Granger Cause INR	249	1.6496	0.1225
	INR does not Granger Cause ND		5.25109	1.00E-05
Indonesia	ND does not Granger Cause RUPH	229	3.1662	0.0088

Japan	ND does not Granger Cause JPY	256	0.27536	0.9263
	JPY does not Granger Cause ND		1.47654	0.198
Malaysia	ND does not Granger Cause RING	258	0.31942	0.8113
	RING does not Granger Cause ND		0.36339	0.7795
New Zealand	NEWND does not Granger Cause NEWX	231	3.146	0.0092
Pakistan	ND does not Granger Cause PKR	225	2.10925	0.0655
Singapore	SINGND does not Granger Cause SINGX	254	1.12243	0.3496
	SINGX does not Granger Cause SINGND		2.23951	0.0319
South Africa	Does Not meet the Stationarity condition			
South Korea	ND does not Granger Cause WON	255	0.97785	0.448
	WON does not Granger Cause ND		0.66642	0.7004
UK	ND does not Granger Cause GBP	246	2.20363	0.0281
	GBP does not Granger Cause ND		0.85858	0.5523
USA				

The above table shows the granger results in case of forex new death cases of covid-19. In case of Australia, ASX granger cause the ND at 5% significance level, but ND does not granger cause ASX. It indicates the existence of one-way causality between the ND and ASX. There is no causality among the ND, TAKA, CNY, JPY, and RING in case of Malaysia, Bangladesh, China, and Japan. Moreover, unidirectional causality exists between the ND, INR, SINGGX, EUR, and GBP in India, Singapore, UK, France, and Pakistan.

4.3.5 Commodity Markets, Inflation and COVID-19

The above-mentioned Table 4.13 provides insights related to the lagged volatility spillover and the existence of time-varying conditional correlation in global commodity markets which are gold, and oil created by the daily global COVID-19 new cases and COVID-19 new deaths over the time period from. Table 4.13 is divided into two sections, based upon the reported results such as the first section represents results related to the global COVID-19 new cases and global commodity markets. Further, the second section of Table 4.13 reports results related to the global COVID-19 new deaths and commodity markets. The best-fitted model is selected is E-GARCH & T-GARCH for the pair of COVID-19 new cases & commodity markets and COVID-19 new death and

COVID-19 new death based on the lowest AIC value among various implemented GARCH models.

Among global economic variables inflation shows the insignificant existence of volatility which leads towards the violation of the preliminary assumption that there should be the significant ARCH effect. So, DCC is applied on the global gold and oil markets along with COVID-19 new cases and COVID-19 new deaths. Past residual shocks reported in Table 4.13 are statistically insignificant for all the pairs of global gold & oil markets with global COVID-19 new cases and COVID-19 new deaths. Moreover, the coefficient sign of α is positive which provides insights related to the positive impact of past/lagged shock on the current volatility of the global gold and oil markets.

The lagged dynamic conditional correlation denoted by β is statistically significant for the pair of COVID-19 new cases and the global oil market with a positive coefficient. Hence, the pair of COVID-19 new death and global gold and oil market also shows the statistically significant lagged dynamic conditional correlation at a 5% confidence interval.

Table 4. 25: DCC GARCH (Commodity markets, Inflation, and COVID-19)

	New Cases			
Series	**α**	**B**	**AIC**	**Selected Model**
Gold	0.007245 0.6861	0.91213 0	- 5.76488	E-GARCH
Oil	0.0168 0.8055	0.6774 0.1682	-3.7638	E-GARCH
Inflation	No-ARCH Effect			

	New Deaths			
Gold	0.0180 0.5724	0.9528 0.0000	-5.0912	T-GARCH
Oil	0.055567 0.3903	0.893814 0	-3.0992	T-GARCH
Inflation	No-ARCH Effect			

Chapter 5

Conclusion

COVID-19 is considered to be one of the worst pandemics ever because, hundreds of thousands of people have already died as a result of the COVID-19 epidemic (Vera-Valdés, 2021). COVID-19 not only affects the health of individuals but also it adversely impact the economies, financial markets and creates uncertainty around the globe (Engelhardt, Krause, Neukirchen, & Posch, 2021). Volatility modeling of the financial assets is one of the most imitative factors while considering it for investment due to the reason that volatility modeling provides insights related to the contagion/information spillover and systematic risk of the financial assets which further effect and derive future returns. An in-depth understanding of the factors which create volatility and the dynamics of the volatility of the financial assets enables the investor to create a balanced and diversified portfolio by allocating resources effectively and efficiently.

Therefore, the purpose of the study is to explore the dynamic conditional correlation between COVID-19 confirmed new cases and COVID-19 confirmed new deaths with stock and forex. Besides this, the purpose of the study is also to examine the dynamic conditional correlation between global COVID-19 confirmed new cases, global COVID-19 confirmed new deaths with global inflation and global proxy index which further comprised of gold, and oil market. In this regard, to achieve the objective of this study, stock and forex markets of the fifteen developing and developed countries are Australia, Bangladesh, China, France, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Singapore, South Africa, South Korea, UK and USA is selected.

The pair-wise granger causality test for new stock cases of COVID-19 show uni-direction causality among ASX, SSE, CAC40, JKSE, NIK, FTSC, KSE, SSGF in China, France, Indonesia, Malaysia, Pakistan, Australia, and Singapore at 5% significant level. On the other hand, bi-directional causality exists NC to SEN, SA40, and NYSE in case of India, South Africa, and USA respectively.

In case of forex new cases of covid-19, ASX granger cause the NC at 5% significance level in Australia, but NC does not granger cause ASX. It indicates the existence of one-way causality

between the NC and ASX. There is no causality among the NC, GBP, CNY, EUR, RING in UK, Malaysia, France, China, and Bangladesh. Moreover, unidirectional causality exists between the NC, INR, RUPH, PKR, JPY, and WON in India, Indonesia, Japan, and Pakistan. In case of South Korea, bi-directional causality exists between the WON and NC which shows that NC granger cause the WON and WON granger cause the NC.

The results of pair-wise granger causality test for new deaths of COVID-19 show that uni-directional causality from ASX to ND in case of Australia. However, no causality exists among the ND to DSE, NIK, FTSC, NEWSTK, KSE, SA40, and KOPSI in Bangladesh, Japan, Malaysia, New Zealand, Pakistan, South Africa, South Korea respectively. The one-way causality running from ND to CAC40, SEN to ND, ND to FTSC in France, India, and UK at 5% significant level. On the other hand, the causality running form ND to SSE, JKSE, and NYSE is bi-directional in case of China, Indonesia, and USA.

The granger results in case of forex new death cases of covid-19 indicates that ASX granger cause the ND at 5% significance level in Australia, but ND does not granger cause ASX. It indicates the existence of one-way causality between the ND and ASX. There is no causality among the ND, TAKA, CNY, JPY, and RING in case of Malaysia, Bangladesh, China, and Japan. Moreover, unidirectional causality exists between the ND, INR, SINGGX, EUR, and GBP in India, Singapore, UK, France, and Pakistan. In case of Pakistan, New Zealand, and Indonesia, bi-directional causality exists between the variables of ND and PKR, ND and NEWX, ND and RUPH. It shows that ND granger cause the PKR, NEWX, and RUPH while PKR, NEWX, and RUPH is also granger cause the ND.

For estimating the results, the study is further divided into two stages which comprised of implantation of DCC-GARCH on the pair of COVID-19 confirmed new cases and COVID-19 confirmed new deaths with stock and forex market. Moreover, in the second stage, DCC-GARCH is used to examine the global information spillover related to the COVID-19 confirmed new cases and COVID-19 confirmed new deaths on the global proxy index and inflation. The estimated results reported in Table 4.9 show that in France and UK ARCH effect is not statistically significant which leads towards the violation of preliminary assumption for the implementation of DCC. Besides this best-fitted model from GARCH, E-GARCH and T-GARCH are selected on the basis of AIC.

Past residual shock is statistically significant with a negative coefficient for all the pairs of COVID-19 confirmed new cases and stock returns except for the stock returns of India, Indonesia, South Africa and South Korea because p-value > 0.05. Negative sign shows that the past residual shock created by COVID-19 confirmed new cases will decrease the current period volatility of the stock returns due to the economic resilience, insensitivity of capitalism and level of cooperating coherence in the aforementioned countries Uddin, Chowdhury, Anderson, and Chaudhuri (2021) due to the existence of the capital intensive industry. Moreover, lagged dynamic conditional correlation for the pair of COVID-19 confirmed new cases and stock returns returns are statistically significant Ruiz Estrada, Park, Koutronas, Khan, & Tahir, 2020Shaikh (2021); Shi (2021) except for the pair of Australia, India and South Korea with a positive sign.

According to the reported results in Table 4.10 the pair of COVID-19 confirmed new cases and the forex market of Singapore and China does not meet the stability condition while the rest of the pairs meet the stability condition. Moreover, past residual shock is statistically significant for the pair of COVID-19 confirmed new cases and forex markets of Bangladesh, Japan, Malaysia, South Africa and South Korea Wang, Li, and Huang (2020) due to the reason that COVID-19 creates huge shocks/volatility in the financial markets while rest of the pair shows statistically insignificant the existence of the past residual shock created due to the decrease in efficiency of the forex market during pandemic COVID-19 D. Wang et al. (2020). Hence, pairwise lagged dynamic conditional correlation is statistically significant for the forex market of Australia, Bangladesh, France, Indonesia, Malaysia, New Zealand, South Korea, South Africa and Pakistan (as p-value < 0.05) with a positive coefficient caused due by the herding behavior of the investor which decreases market efficiency of the forex market (Han, Wang, & Xu, 2020). While rest of the pair shows an insignificant impact on the current correlation of COVID-19 new confirmed cases and forex markets.

The empirical results of the estimated results related to the pair-wise dynamic conditional correlation of COVID-19 confirmed new deaths with stock and forex market and are reported in Tables 4.11 and 4.12. For the computation of results GRACH, T-GARCH, and E-GARCH with DCC are used in order to achieve the objective of the study, and the best-fitted model is selected on the basis of the lowest AIC. Nexus to Table 4.11 and 4.12 past residual shock is statistically significant for the pair of COVID-19 confirmed new deaths and stock returns of Bangladesh,

China, Indonesia, New Zealand, Singapore, and South Africa Feng, Yang, Gong, and Chang (2021); Lan, Huang, and Huang (2020) due to the reason COVID-19 adversely impact the society, industries, and economies (Fu & Shen, 2020; Nicola et al., 2020).

Additionally, past residual shock for the COVID-19 confirmed new deaths and the forex market is statistically significant for all pairs Feng et al. (2021) except a few due to the stability of the currency. Based on the reported results in Table 4.11 and 4.12 lagged dynamic conditional correlation between COVID-19 confirmed new deaths and stock and forex markets is statistically significant for the majority of the pairs due to the contagious of the whole global economy and herding behavior of the investor(Singh, Bansal, Bhardwaj, & Agrawal, 2021).

The second stage of the study comprised of the estimation of the volatility spillover created by global COVID-19 confirmed new cases, global COVID-19 confirmed new deaths to the global proxy index and inflation. According to the estimated results reported in Table 4.13 data series of global inflation and shows an insignificant ARCH effect while the rest of the series shows a statistically significant ARCH effect. For the pair of global COVID-19 confirmed new cases and oil and gold market DCC-E-GARCH is selected as the best-fitted model based on the lowest AIC and T-GARCH is selected for the pair of global COVID-19 confirmed new deaths with the oil and gold market.

Past residual shock is statistically insignificant for both pairs as reported in Table 4.13 because gold is considered as a safe heaven asset in order to hedge the market uncertainty (Elgammal, Ahmed, & Alshami, 2021). Moreover, the pair of global COVID-19 confirmed new cases, global COVID-19 confirmed new deaths with gold is statistically significant Yousef and Shehadeh (2020) due to the increase in economic and financial instability. Besides this the pair of global COVID-19 confirmed new cases is statistically insignificant due to the presence of leverage effect (Meher, Hawaldar, Mohapatra, & Sarea, 2020), high level of liquidity and no intervention of the government for the pricing of the pricing of the oil (Putra & Robiyanto, 2019) and the pair of global COVID-19 confirmed new deaths with oil shows the significant dynamic conditional correlation.

5.1 Recommendations and Policy Implication

Based on the results of the study conducted related to examining the existence of a time-varying conditional correlation between the COVID-19 confirmed new cases and COVID-19 confirmed new deaths with stock, forex, global proxy index, and global inflation. All of these recommendations are based on the multiple dimensions of the play markets such as an investor, regulator, buyer, seller, and policymaker.

According to the empirical finding in the Table in 4.9,4.10,4.11,4.12 and 4.13, the past residual shock is statistically significant for most of the pairs of COVID-19 confirmed new cases and COVID-19 confirmed new deaths with stock forex and oil markets. As a result, an investor must consider the persistence of volatility while hedging against the systematic risk of the stock, forex and gold market during COVID-19 because statistically significant past residual shock eliminates the opportunity of hedging the market volatility of stock and forex market. Besides this, DCC output shows the existence of the time-varying conditional correlation with the positive coefficient which diminishes the opportunity for portfolio diversification in the stock and forex markets during COVID-19.

Moreover, the aforementioned results reported in Table 4.9,4.10,4.11,4.12 related to the pairwise lagged dynamic conditional correlation of COVID-19 confirmed new cases are statistically insignificant for the stock, and forex markets Australia, India Japan, and South Korea. So, an investor can construct their portfolio by adding the stocks and financial assets of these countries during the pandemic COVID-19 for the diversification of the portfolio. In this continuation, the empirical findings show the insignificant lagged dynamic conditional correlation for the pair of COVID-19 confirmed new deaths with India, Japan, South Korea & USA stock, and forex market. So, investors construct the portfolio by selecting the securities which have the statistically significant past lagged dynamic conditional correlation with less coefficient or the pair having statistically insignificant lagged dynamic conditional correlation to hedge against the market uncertainty.

Numerous, studies have been conducted on the volatility modeling of the COVID-19, time-varying connectedness, and other important economic and financial system-related variables. Hence, it is recommended also to examine the time-varying conditional correlation between COVID-19

confirmed new cases and COVID-19 confirmed new death with green Sukuk and green bond. The empirical findings of the study are also useful for the policymakers and regulators for devising different strategies of macroeconomic stabilization in order to increase economic resilience.

In case of another pandemic Governments should ensure that policies are in place to protect investors and ensure financial stability during a pandemic. This could include measures to limit speculation and ensure that market participants are treated fairly. It should also be considered to introducing measures to minimize volatility in stock and foreign exchange markets, such as relaxing margin requirements, providing liquidity through central bank purchases of securities, and providing short-term liquidity facilities. Measures should be taken to promote investor confidence, such as ensuring transparency in financial markets, providing clear guidance on market practices, and providing access to accurate and timely data and information. Governments should consider ways to increase access to capital for businesses, such as providing financial assistance, tax relief, and financing to help businesses survive the crisis. In addition to that governments should consider strengthening market infrastructure, such as strengthening the ability of market participants to access and process information and data, and improving market surveillance systems. Along with enhancing market oversight by strengthening the ability of regulators to detect and investigate market manipulations

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