Effects of the COVID-19 pandemic on the financial markets: A comparative analysis

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Table of Contents

List of Tables

List of Figures

Abstract

This paper investigates the effects of the COVID-19 pandemic on bond yields and stock returns. The paper examines how the coronavirus outbreak affected the performance of capital assets as well as what role financial contagion played in the evolution of asset prices over time. This paper employs an event study, a regression analysis, using both Ordinary Least Squares (OLS) and Generalised Method of Moments (GMM) estimations as well as a BEKK GARCH model to test for contagion.

The research found that the flight-to-safety phenomenon was more prominent in emerging markets, whereas, in developed markets, bonds were not seen as the safe-haven assets and investors opted to invest in assets such as gold. The second event study showed that investors began reacting in anticipation of the of the Fed announcement in March to slash interest rates, showing herding behaviour rather that market efficiency was driving market behaviour during the pandemic.

With regards to the effect of financial contagion being exhibited during the COVID-19 pandemic, the research had different findings for stock returns and bond yields. Using an MVGARCH BEKK model for the estimations, the research found that cross-market effects in the stock returns showed that the USA exhibited high unidirectional linkages with the other markets, thereby confirming significant effect of financial contagion in stock returns during the pandemic. With bond yields, however, no single country was found to be the source of the volatility.

Declaration

I, Njamba Kapalu, hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Appreciation

All glory to Him who is able to do exceedingly and abundantly above all I can ask or imagine, according to the power that works within me (Ephesians 3:20). Doing my master's degree at WBS was a dream that I had in 2014 and it brings me great joy to see it come to pass. Secondly, I would like to thank the Mandela Rhodes Foundation for believing in my abilities and sponsoring my education.

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CHAPTER 1 - INTRODUCTION AND BACKGROUND TO THE STUDY

1.1.Background

Over the last two decades, various disease outbreaks have had a far-reaching impact on livelihoods and the global economy. In 2003, the world was introduced, on a global scale, to a family of microbes generally known as Coronaviruses. According to the World Health Organisation, "coronaviruses (CoV) are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). A novel coronavirus (nCoV) is a "new strain that has not been previously identified in humans".[1]

The MERS outbreak, which started in the Middle East in 2012, did not have serious consequences due to both its origin and its early diagnosis. The virus, which had its worst bout outside the Middle East, in South Korea in 2015, resulted in 36 deaths, according to WHO.[2] The worst impact of the disease was to South Korea's tourism industry which "went down by 40% from the previous year" (Stephens, 2017). In 2003 when SARS occurred, it lasted for about 6 months. The infectious disease spread to over 24 countries spanning 4 continents and killed approximately 774 people, which was about 10% of those who were infected.[3]

Almost 17 years later, the latest coronavirus, as of July 2020 had claimed over 648,000 lives after beginning less than 8 months earlier, in Wuhan, China. As much as the disease has had deadly effects, with infections surpassing 41,000,000,[4] it has also had a great effect on the economic growth of many countries[5] due to the economic lockdowns that many countries favoured in order to control the disease's spread. According to the first quarter estimate by the World Economic Forum, China's "GDP growth was expected to slow by 0.5 percentage points in 2020, taking at least 0.1 percentage point off global GDP growth".[6] The effects, however, go beyond just China: many economies globally rely on China's business and production, either as raw materials or intermediate goods in production processes.

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[1] https://www.who.int/health-topics/coronavirus [Accessed 12.03 2020]

[2] https://www.who.int/docs/default-source/documents/health-topics/mers/mers-summary [Accessed 13.04.2020]

[3] https://www.cdc.gov/about/history/sars/timeline.htm [Accessed 12.03.2020]

[4] https://coronavirus.jhu.edu/map.html [Accessed 23.10 2020]

[5] https://www.weforum.org/agenda/2020/02/coronavirus-economic-effects-global-economy-trade-travel / [Accessed 13.04.2020]

[6] https://www.weforum.org/agenda/2020/02/why-is-coronavirus-a-global-business-risk/ [Accessed 28.03.2020]

According to the World Economic Forum, "travel restrictions and quarantines affecting hundreds of millions of people" resulted in Chinese factories being short of "labour and parts, disrupting just-in-time supply chains and triggering sales warnings across technology, automotive, consumer goods, pharmaceutical and other industries".[7] This would have a far-reaching effect on many economies, both developed and emerging. When the SARS virus of 2003 spread across the world, China had not yet taken its place as a major world economic player. According to Moody's Analytics (2020), China now contributes over 16% of the global GDP. Figure 1 further highlights trends in China's role in the global economy.

Figure 1 Share of China's global GDP over the last 20 years (Moody's Analytics)[8]

Outside the reliance on trade with China, Italy, which was one of the most affected in Europe, was one of the first countries to end up closing down sections of their country that had been worst hit in an effort to contain the outbreak. Months into the virus, the spread was worldwide.

The economic effects of the latest coronavirus and related responses have been compared to those witnessed during the 2008 financial crisis[9]. For example, in 2008, the US stimulus package to overcome the economic effects of the financial crisis was USD 952 billion, which is a fraction of the initial coronavirus stimulus package of USD1.97 trillion, with various other aspects of the world's global economy having been affected.[10] Similarly, reports suggest that global oil demand was substantially affected by the novel coronavirus and the widespread

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[7] https://www.weforum.org/agenda/2020/02/why-is-coronavirus-a-global-business-risk/ [Accessed 28.03.2020]

[8] https://www.moodysanalytics.com/-/media/article/2020/china-coronavirus.pdf [Accessed 31.03.2020].

[9] https://www.economist.com/briefing/2020/03/26/rich-countries-try-radical-economic-policies-to-counter-COVID-19 [Accessed 13.04.2020]

[10] https://www.bloomberg.com/news/articles/2020-03-27/trump-signs-2-trillion-virus-bill-largest-ever-u-s-stimulus [Accessed 28.03.2020] Constant dollar value of 952bn= 800m*376.5(CPI 2019)/316.3(CPI 2008). This is compared to a value of USD1.97trn= 2trn*376.5(CPI 2019)/382.1(CPI 2020 Mar). https://www.bls.gov/cpi/research-series/allitems.pdf

shutdown of economies: demand was “expected to fall by 435 kb/d year-on-year in the first quarter of 2020, the first quarterly contraction in more than 10 years.”[11]

Considering the magnitude of the disease and its economic effects, it would be imperative not to look at it in isolation i.e., from a health perspective only. With a world that is now so intrinsically interlinked, the disease has influenced many economies. In 2003, the effect on the world economy from SARS was about USD 56 billion (Knobler, 2004) which is a fraction of the USD 2.66 trillion which Bloomberg had initially projected to be the cost of the pandemic to the global economy.[12]

1.2.COVID-19 and the financial markets

This research endeavours to understand the extent to which the COVID-19 pandemic has affected the financial markets of developed countries relative to those of developing nations. Stock markets and bond markets generally impound the impact of news announcements, investor sentiment and policy changes reasonably quickly. For example, the S&P 500 dropped 25% from 24th February 2020 to 18th March 2020; the Dow Jones Industrial Average had similar response, losing more than 30% of its value by March 2020[13] as a result of “outbreak headlines and emerging liquidity needs”. As shown in the time series charts in Figure 3, there were similar effects on the S&P BSE Sensex of India and the Shanghai Composite Index of China.

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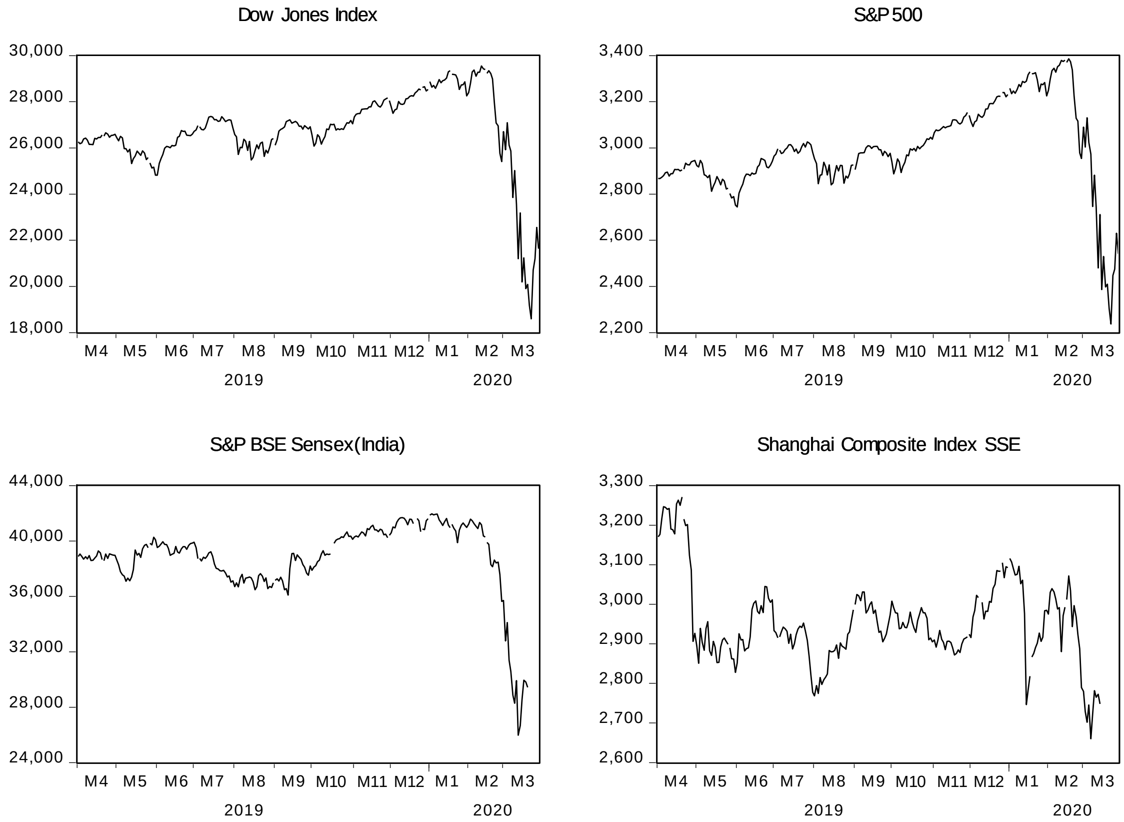
[11] https://www.iea.org/reports/oil-market-report-february-2020 [Accessed 12.03.2020]

[12] https://www.bloomberg.com/news/articles/2020-03-27/trump-signs-2-trillion-virus-bill-largest-ever-u-s-stimulus [Accessed 28.03.2020] Constant dollar value of 56bn= 40m*376.5(CPI 2019)/270.2(CPI 2003). This is compared to a value of USD2.66trn= 2.7trn*376.5(CPI 2019)/382.1(CPI 2020 Mar). https://www.bls.gov/cpi/research-series/allitems.pdf

[13] https://www.bloomberg.com/news/articles/2020-03-18/trump-bump-flattened-as-post-inauguration-stock-rally-is-erased [Accessed 28.03.2020]

Figure 2 Time series representation of Stock Market Indices for the period April 2019 to March 2020



The continuous and sequential impact of news and announcements of economic data on the stock markets show that stock prices respond reasonably fast to new information, consistent with the notion of the efficient market hypothesis (Bodie, Kane and Marcus, 2017; Fama, 1970; Fama, 1991). The large and negative response of stock prices across the world to the COVID-19 outbreak is reminiscent of the large magnitude of reaction that stock markets commonly display to negative shocks relative to reactions to positive shocks both in emerging equity markets (Piveta, Morais, Macêdo and Godoy, 2014) and in developed equity markets (Bird, Du and Willett, 2017; Dumitriu, Stefanescu and Nistor, 2012). The asymmetric reaction of stock prices to different innovations has been attributed, in the literature, to several reasons including investors' irrational behaviour (Pochea, Filip and Pece, 2017).

Investor behaviours, such as imitation and herding behaviour, result in the emergence of a "strengthening of interactions among asset prices" which have the potential to result in stock market crashes. The contagion effects are aligned less and less to fundamentals and valuations, and more to sentiment (Cipriani and Guarino, 2008; Spelta, Flori, Pecora, Buldyrev and Pammolli, 2020).

The COVID-19 crisis has affected many aspects of financial markets thus far. There has been massive instability in currency markets. The South African Rand, for example, that traded at R13.99/$ at the end of 2019 had lost up to 23% of its value by early April, trading at R19.34/$[14]. This, however, has not been the case for currencies like the Rand and others in emerging markets only. The US Dollar also strengthened against "safe-haven currencies such as the Yen and the Swiss Franc and pushed currencies like the Pound and the Norwegian Krone to their weakest level in decades"[15]. However, the US Dollar has not been the main haven. "Bullion has soared this year as the global health crisis tipped economies into recession and spurred central banks to launch huge stimulus measures".[16] Gold prices continued to rally in 2020, reaching levels that had not been reached in the last seven years.

A profound impact has been seen in emerging markets due to funds being moved to "safer" assets[17] as global recession "heightens risk aversion". The Economist[18] reported that as at the beginning of April 2020, foreign investors had "pulled USD83 billion from emerging markets since the start of the crisis, the largest capital outflow ever recorded". The IMF recorded over 90 "emergency financing requests of expressions of interest as of 9th April 2020"[19]. The demand from both low-income and emerging markets for the emergency financing was around USD100 billion. These are extremely high numbers for emerging markets and requests could rise even further. This is likely to be coupled with requests for relief of debt payments which could be hampered by the collapse in government revenues as they prioritise raising "health-related spending and imports to reduce death tolls." [17]

Many emerging markets are commodity economies. As such, the lockdown of most countries and the lack of production in many countries resulted in reduced demand for raw materials. As at early March 2020 markets had fallen dramatically with Soya bean prices down nearly 6%

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[14] https://www.bloomberg.com/news/articles/2020-04-09/nedbank-says-worst-over-for-rand-with-em-flows-set-to-return [Accessed 14.04.2020]

[15] https://www.economist.com/finance-and-economics/2020/03/21/the-dollar-is-in-high-demand-prone-to-dangerous-appreciation [Accessed 14.04.2020]

[16] https://www.bloomberg.com/news/articles/2020-04-14/gold-s-powerful-rally-has-bulls-setting-their-sights-on-1-800?utm_source=allcaughtup-article [Accessed 14.04.2020]

[17] https://www.spglobal.com/ratings/en/research/articles/200204-coronavirus-impact-key-takeaways-from-our-articles-11337257 [Accessed 14.04.2020]

[18] *The Economist*, 2020. The Next Calamity. (March 28th - April 3rd 2020), p.9.

[19] https://www.imf.org/en/About/FAQ/imf-response-to-COVID-19#Q4 [Accessed 14.04.2020]

from highs seen in January, copper prices further down by more than 10%[20] and this was the case for many others resulting in a gross negative impact. The effects of the virus on commodities has been reflected in emerging economies' currencies, majority of whose performance depends on commodity export proceeds.

1.3.Research problem statement

Analysing the disease, and its effect on the financial system, helps us appreciate the reasons why words such as "contagion", which are typically related to diseases, have gained wide usage in describing developments in the financial markets. Merriam Webster defines contagion as "the transmission of a disease by direct or indirect contact". In the financial markets, the former US Treasury Secretary, Geithner, cited by Peckham (2013) stated that "contagion spreads, transmitting waves of distress to other markets". Based on this application of the word contagion, it is easy to see the interrelatedness between a contagious disease and financial contagion. Indeed, Peckham (2013) submits that it is important to trace the conceptual linkages between financial and biological contagions in order to properly assess financial risk in an increasingly interconnected global market.

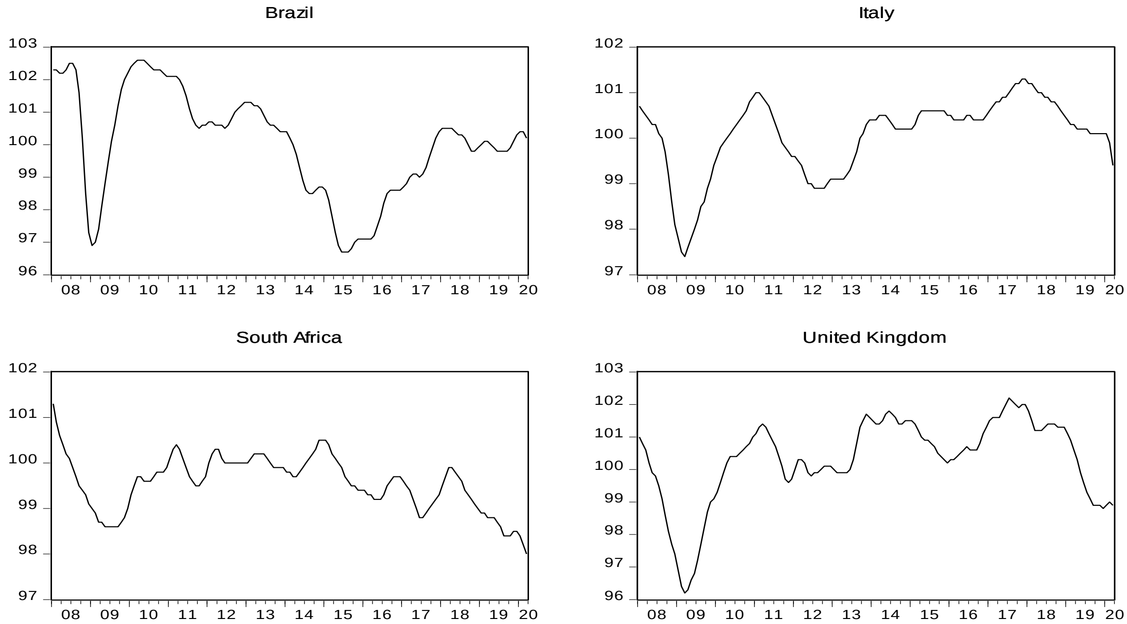
In the financial markets, financial contagion has been defined as, "significant increase in cross market linkages after a shock to an individual country (or group of countries)" (Dornbusch, Park and Claessens, 2000). The current coronavirus pandemic has influenced many financial markets but the extent of this has yet to be quantified. Secondly, whether the observed financial markets effects are direct (arising from concerns about the economic impact of the virus) or indirect (e.g. due to contagion effects from other financial markets) is also yet to be tested. However, alternative views have been expressed about the spread of price volatility across financial markets. Yago (2003) states that "when investors draw their capital from countries with the same problems as were present in the first such country, this is a demonstration effect, and not contagion". This could, therefore, be the explanation of the effects on different world economies. These market dynamics are examined in this paper.

Financial shocks come in many forms. In all its forms it seems that it results in fear that then informs the reactions. No more is this the case than with financial contagion resulting from health pandemics. Research done shows that financial shocks "exert a much higher contribution

[20] https://www.economist.com/finance-and-economics/2020/03/05/commodity-economies-face-their-own-reckoning-due-to-COVID-19
[Accessed 14.04.2020]

on real economic activity and credit during the crisis periods than in normal times". Furthermore, it can be expected that such a shock can result in "pronounced contraction of industrial production" (Silvestrini and Zaghini, 2015). As we endeavour to understand how the coronavirus has impacted the financial markets, it is important to understand how this factor has helped drive the economic effects of the pandemic. This requires that we isolate the effects of the virus and the mechanics by which its effects feed into the prices or performance of capital markets.

Figure 3 Times series graph of Business Confidence Index (BCI) from 2008 to March 2020



Source: OECD Data

One aspect that does influence the markets are investor sentiments. A large part of the formulation of these sentiments lies in the risk that investors are keen to take based on their perception of what could happen. According to Brooks (2014) "it is possible to use a simple historical average measure as a forecast for future volatility". Unfortunately, in scenarios of unforeseen pandemics, especially one where an antidote is yet to be found, it is near impossible to forecast volatility. Uygur and Taş (2013) highlight how "not all the investors are fully rational and their demand for risky assets is influenced by their beliefs or sentiments that are not absolutely justified by the fundamental news". This shows why the markets react in ways that are hard to predict and cause greater volatility than normal.

The information above (Figure 3) shows the Business Confidence Index for Brazil, Italy, South Africa, and the UK. For all the countries the BCI fell below 100, save for Brazil. Numbers below 100 indicate pessimism towards future performance. In the first quarter of 2020, COVID-19 was the primary reason for the fall in business sentiment. Italy plunged 17.6 points, the highest in Europe.[21]

It is useful to relate the effects of the COVID-19 on the financial markets to similar pandemics in the past. The study of Keogh-Brown and Smith (2008) found that the economic impact of SARS was between USD 30 billion and USD 100 billion. As this research was done 5 years after the crisis, it was able to isolate information through "published national statistics". It compared "actual effects of SARS with the predictions made at the time of the outbreak, before data were available". The countries assessed were those that had at least 5 cases of SARS noted by the World Health Organisation. In aiming to establish results and the specific economic indicators to use, the research did not differentiate between the effects of SARS and "the impact of policies to contain SARS", the chosen indicators were therefore GDP, GDP growth, Exports and Trade as well as the Budget. The comparative analysis found that the impact from the SARS outbreak was short lived as significant economic losses were matched by significant economic gains in the subsequent periods. One reason given could be, for example, in the case of China, losses may have been felt in the tourism, food and travel sectors of their economy, however, a compensatory effect in other sectors (e.g. medical equipment) could "serve to hide the loss to GDP".

The research also found that the countries that had experienced the most severe impact were those that had the most critical outbreak, with "a reasonably robust positive correlation between severity of outbreak and severity of impact". Additionally, the economic impact was "determined largely by the desire of people to reduce their public iterations (travel, leisure, tourism)" which would serve to show the importance of the correct portrayal of "the risk posed by the outbreak to the population". As the study occurred years after the pandemic it was able to ascertain certain effects and consequences. This research does not cover the full scope of the research shown to be undertaken by Keogh-Brown and Smith (2008); however, their results provide a foundation for the analysis to be undertaken by this study.

[21] https://www.ft.com/content/fa5b5e1b-1a9e-4e01-aa03-4622e754de5e [Accessed 13.04.2020]

Looking only at developed nations would bias the research if we are to fully grasp how external shocks affect stock and bond markets specifically. During the period when SARS affected the world, in 2003, many of the world's emerging and frontier markets had not yet had thriving financial markets. However, with increased global trade and access, there are many thriving and growing stock and bond markets around the world. For instance, BRICS countries, that is, Brazil, Russia, India, China and South Africa, have been some of the fastest growing economies over the last 20 years and therefore have been "major recipients of global investment flows" (Mensi, Hammoudeh, Reboredo and Nguyen, 2014).

With this, there are thus possible linkages between BRICS financial markets and financial markets of developed nations. Mensi et al., (2014) state that "changes in the global economic factors could be a channel through which fluctuations in the world's economic and financial conditions are transmitted to the BRICS stock markets and affect their economic growth". It could also be possible to see a positive effect on BRICS stock markets following financial shocks as "investment speculation and risk diversification opportunities may arise". Mensi et al., (2014) also found that the BRICS' stock markets move in tandem with the stock markets of developed nations in markets that are bullish while they are "independent when the market is bearish, with the exception of Brazil". Further to this, it was found that there was absence of "significant co-movements between the Chinese and the global stock markets in times of turmoil". This investigation was done during times of the financial crisis in 2008 which originated from the developed nations.

This study looks at the effects of COVID-19 on the capital markets of emerging economies such as South Korea and Brazil, Russia, India, China and South Africa, more commonly referred to as BRICS, in comparison with those countries termed as developed countries. For the purpose of this study, the developed countries consist of the United States of America, the United Kingdom, Sweden, New Zealand, Singapore and Italy which was the initial epicentre for the pandemic in Europe[22]. As earlier mentioned, the case of coronavirus is too recent to be able to fully ascertain the economic impact of the pandemic. The full shocks on global trade, changes in monetary policy and travel restrictions are yet to be felt as they had been implemented only 3 months into the crisis. Due to this, the investigations are restricted to the

[22] https://www.bloomberg.com/news/articles/2020-03-01/europe-braces-for-coronavirus-s-spreading-economic-impact [Accessed 13.04.2020]

stock and bond markets which offer daily responses to the news and policy announcements as they have and continue to happen.

A study of this nature is important, not only because so little research has been done on effects of diseases on financial markets but also important to understand the potentially negative effect of globalisation. As countries become more interdependent, there is greater likelihood that a disaster in Europe has significant effect on the success of the Asian markets. Pike et al., (2014) highlight the importance of understanding what impact epidemics and pandemics have on the global economy. This is for there to be policies set to mitigate the impacts which are "more cost-effective policies".

Not enough research has been done to understand the effects of pandemics on the global economy and specifically on the stock and bond markets. SARS and the 1918 Influenza Pandemic are seen as reference points with regards to pandemic effects on the economy and more specifically on financial markets.

The 1918 influenza pandemic was a tragic event that has escaped the minds of many people today, due to the passing of time. The pandemic, which is more commonly referred to as the 'Spanish flu', killed over 40 million people worldwide from 1918 to1920. A striking difference with COVID-19 is that most of the people killed by the Spanish flu were between the ages of 18 and 40 (Garrett (2007). The deaths of the main working age population was one of the significant reasons for the negative economic impact. It is estimated that the effect of the flu related deaths in 43 countries, in 1918 to 1920, led to declines in GDP of about 6% and a 26% negative impact on stock returns in the USA[23]. It must also be added, however, that during 1919 the Dow Jones also witnessed one of its best years in the period 1915 to 2019[24]. At that time markets were not as integrated. Differing economic scenarios make it difficult to compare the effects on financial markets. Considering that, with regards to financial magnitude, SARS happened almost two decades ago in 2003 when global integration was still relatively lower[25,26], there isn't much up-to-date research that explains how international financial

[23] https://scholar.harvard.edu/files/barro/files/barro_vox_coronavirus_03202020.pdf [Accessed 21.07.2020]

[24] https://voxeu.org/article/1918-influenza-did-not-kill-us-economy [Accessed 21.07.2020]

[25] https://www.ncbi.nlm.nih.gov/books/NBK525302/ [Accessed 13.04.2020]

[26] Potrafke (2014) shows using Aggregate Globalisation Indices from 1970 to 2010, the continuous growth of globalisation. From the mid 1990's economic globalisation shows a more rapid increase.

markets react to global disease outbreaks, and how such reactions can proliferate across borders.

Consequently, the investor community is not adequately informed about the behaviour of financial markets around global disease outbreaks of the magnitude of the coronavirus in ways that can facilitate their portfolio choices. Thus, a study of the effects of the recent coronavirus outbreak on the financial markets is not only timely but also crucial. Haldane (2009) observed that within a set range, “interconnected networks serve as shock absorbers”; however, considering that this risk is shared through diversification, once the system “tilts the wrong side of the knife edge, the interconnectedness may “serve as a shock amplifier”. Based on this observation, it is also important to understand the role of greater financial integration in the possible propagation of coronavirus effects across global capital markets. This study sheds light on these issues using data from selected developing and developed markets.

1.4.Purpose of the study

The purpose of this study is to attempt to understand the effect of the coronavirus on the financial sector with a focus on stock and bond markets. The aim is to comparatively analyse the effects on emerging markets, more specifically South Korea and the BRICS nations, and developed nations (UK, USA, Sweden, Singapore, New Zealand, and Italy). Further objective is to provide a platform for future research of the effects of the pandemic, once full statistical data are available.

1.4.1. Research questions

1. How did the coronavirus outbreak affect the performance (returns and risk) of stock returns and bond yields in the emerging and developed markets?
2. What was the role of financial contagion in the evolution of asset prices in stock and bond markets in emerging and developed markets during the coronavirus outbreak?

1.4.2. Research objectives

The primary objective of the research is to investigate and empirically test the effects of the recent coronavirus outbreak on the performance of the stock and bond markets. Specifically, this study seeks to achieve the following objectives:

1. To ascertain the effect of the coronavirus pandemic on the performance (return and risk) of stock returns and bond yields in developed and emerging markets.

2. To establish the role that financial contagion may have played in informing changes in asset prices of stocks and bonds following the outbreak of the coronavirus.

1.5.Significance of the study

The coronavirus pandemic is potentially the greatest crisis to face the global economy since the financial crisis of 2007/9. The financial crisis is believed to have had far reaching effects because of the interrelatedness of financial institutions and the evolving globalisation. The fall of Lehmann Brothers, for example, was felt immediately “on stock markets all over the world” as it filed for bankruptcy with “estimated debts of over USD600 billion” (Ciro, 2012). This played a role in “cascading bank failures”, affecting credit shortages which resulted in “blocked investments and corporate operations, plunging the world into a deep recession”[27]; the expansion of many financial institutions into emerging markets (Ghosh, 2016) and creation of a global village made the impact all the grander as, other things remaining equal, “globalisation tends to intensify a country’s sensitivities to foreign shocks”[28]. Twelve years later, the coronavirus pandemic has happened with the world financial markets more integrated, implying that any volatility generated by the pandemic would likely present the world with a greater challenge. The sheer magnitude of the potential impact of the market shocks emanating from the pandemic, the subject of this study, therefore, makes this study relevant and timely.

The emerging markets have provided great reward for those in developed countries that have been willing to tolerate higher risk. As a result, there is now even closer ties between stock markets in various countries. As institutions have grown in emerging markets, they have diversified their portfolios to include “less risky assets” such as those in developed countries. With stock markets so intertwined, it is of great importance that an understanding of how the greater interrelatedness impacts contagion of shocks across markets, from such developments as the coronavirus outbreak. This study is, consequentially, an important part of the many that will seek to find solutions on how highly integrated financial markets can improve safeguards in order to deal with future shocks from pandemics and financial crises.

[27] https://www.oecd-ilibrary.org/economics/economic-globalisation/the-2008-financial-crisis-a-crisis-of-globalisation_9789264111905-9-en [Accessed 13.04.2020]

[28] http://siteresources.worldbank.org/DEC/Resources/BenefitsandRisksofFinancialGlobalizationSchmukler.pdf [Accessed 13.04.2020]

1.6.Organisation of study

The remainder of this research is organised in the following manner. Chapter 2 contains the literature review that examines theories such as herd behaviour and market efficiency. It further highlights factors affecting bond yields and stock returns as well as the effects of financial contagion and the effects of pandemics on financial markets, Chapter 3 reviews the empirical methods which include an event study, regression analysis (using both Ordinary Least Squares and Generalised Method of Moments estimation techniques) and the BEKK GARCH model to test for volatility spillovers. Chapter 4 reports the analysis and results of the various estimations undertaken and concludes with Chapter 5 which provides the summary conclusions.

CHAPTER 2 - LITERATURE REVIEW

The literature review that follows, covers the factors affecting stock and bond market returns. It begins with a theoretical literature review which includes a presentation of the efficient market hypothesis and herd behaviour. This is then followed by a review of research which has had a bias towards financial contagion and understanding how it directly impacts emerging markets following market shocks. Considering that the main aim is to draw an understanding from research into pandemics and their effects on stock and bond markets, the literature review closes with an analysis of works done around this topic.

2.1.Theoretical literature review

2.1.1. Efficient Market Hypothesis

The efficient market hypothesis proposes that asset prices adjust to new information immediately and as a result, no arbitrage opportunities remain for above-normal returns without taking above-normal risks (Malkiel, 2005). Fama (1970) identifies three different levels of market efficiency, namely:

Strong-form efficiency: this states that a market is efficient if all information relevant to an asset's price is quickly and accurately reflected in the market price, whether or not the information is available to existing or potential investors.

Semi-strong-form efficiency: this states that a market is efficient if all relevant information that is publicly available is quickly reflected in the market price.

Weak-form efficiency: This states that if the market is weak-form efficient, then there is no correlation between the previous price and the current price.

In EMH, information processing is assumed to be costless. As a result, the information is immediately incorporated into asset prices. Ball (2009) advances the matter that though it may seem sensible to assume that the cost of acquiring the information is a "negligible" cost to investors, the interpretation and processing costs have not received adequate attention. It is further proposed that the theory focuses only on the "demand side of the market".

In researching stock prices and the efficient market hypothesis in developed and developing countries, Lee, Lee and Lee (2010) found that, with the introduction of structural breaks and cross- sectional correlation into their model, that “real stock price indices are stationary”. They, therefore, concluded that there was a presence of the existence of inefficient stock markets.

Taking into consideration the limitations as well as evidence provided against the efficient market hypothesis, there is still major support for this theory. The major support is based on how, over a period of time, actively managed investment funds fail to outperform a passive index fund (Malkiel, 2005).

In the last financial crisis of 2008, EMH was blamed as one of the reasons for the crisis. It was said that the bubble occurred because the industry was dominated by people who viewed “current prices as correct and so failed to verify true asset values” (Ball, 2009). This, however, could be as a result of herd behaviour that has the potential to result in patterns that bring about erroneous decision making by large groups of people (Bikhchandani, Hirshleifer and Welch, 1992). The efficient market hypothesis is not perfect, but it is a theory that enables us to explain the concept of efficiency based on the theory of a random walk process (Bodie, Kane and Marcus, 2017).

In a study to determine stock market efficiency in China, after the Global Financial Crisis, Mahmood (2010) found that equity markets contribute far less to the development process in the developing world than in developed markets. As a result, equity markets in the developed world are more efficient. The research found that the Chinese stock market is weak form efficient and that there was no significant change in market efficiency before and after the crisis occurred. Even among the emerging markets, the theory has proved to give different results. For example, random walk hypothesis testing run on the financial data of 11 African countries found no evidence of weak form efficient markets that follow a random walk in the majority of the countries, most notably South Africa and Nigeria (Appiah-Kusi and Menyah, 2003). Studies done using daily stock returns on the Indian stock markets offers evidence showing that the Indian stock markets are inefficient (Mishra, Das and Pradhan, 2009).

Thenmozhi and Nair (2014) in their research on the impact of changes in macroeconomic factors on treasury bond returns found that there was autocorrelation in the bond returns. All the markets that their study focused on (India, Brazil, US, UK and Germany) excluding the US bond market were inefficient since “bond returns had a statistically significant relationship with its own lag.”

Many years have passed since the GFC. Greater financial integration and removal of barriers to equity markets in developing nations, have helped in forming better efficiency in stock markets (Mishra, Das and Pradhan, 2009).

2.1.2. Herd Behaviour

Another theory that is applicable to asset price behaviour during the COVID-19 pandemic is that of the herd effect. This speaks more to the impact that psychology has on asset prices. An investor is said to be exhibiting cases of herd behaviour, or what Malkiel (2003) refers to as the "bandwagon effect", when he imitates the actions of other investors or financial gurus rather than investing based on their own information and knowledge (Decamps and Lovo, 2005) (Chiang and Zheng, 2010). In many cases, this goes against the efficient market hypothesis as this behaviour can result in asset prices deviating from economic fundamentals (Chiang and Zheng, 2010). When there is herd behaviour, investors' actions do not incorporate any new information on market fundamentals which would result in market efficiency, but rather end up acting on other investors' previous actions (Decamps and Lovo, 2005).

An analysis into the Indian stock market which showed that the market was inefficient also proposed that traders exhibited "swarm-like" entry into the markets following higher asset returns and just as sudden an exit when stock market asset returns were lower (Mishra, Das and Pradhan, 2009). It can be inferred from this that herd effects are more prevalent in inefficient markets. This notion can be further supported by research done by Demirer and Kutan (2006) which found no existence of herd behaviour in both the Shenzhen stock exchange and the Shanghai stock exchange. It further found that investors made rational choices that are supported by asset pricing models.

Chang, Cheng, and Khorana (2000) examined herd behaviour in equity markets and found that equity return dispersion, during periods of high price volatility for the US and Hong Kong, resulted in increases rather than decreases in herd behaviour. This provided further evidence for herd behaviour in developed markets. The study by Chiang and Zheng (2010) which used stock returns data from May 1988 to April 2009 of 18 economic units, including the United Kingdom, the USA, Japan, Brazil, China and Singapore, found that in most cases, "investors in each national market were herding around the US market."

During times of greater market volatility, emerging stock markets show signs of greater co-movement (Boyer, Kumagai and Yuan (2006). Financial crises trigger herd behaviour (Chiang and Zheng, 2010) and the resultant effect of this behaviour is that of financial contagion with herd activity in the country where the crisis originated from being the source. Contagion, rather than changes in asset fundamentals, have been seen to spread crises through international investors. There has been significant asset price volatility caused by COVID-19 and this research notes, even though this crisis was not caused by fundamental factors, the effects of both herd behaviour and contagion effects on the volatility.

2.2.Emerging Financial Markets

2.2.1. Factors affecting emerging market bond yields

Well-functioning financial markets are a fundamental part of a growing economy. Over the years, as emerging markets have sought to grow and participate more soundly on the global stage, developments in their financial markets have been a critical component of their growth and resilience strategies. Infrastructure development as well as the financing of budget deficits require a "deep and liquid bond market" (Park, Taniguchi, and Tian, 2019).

In a study designed to understand the development of corporate bond markets in Asia, looking at the periods from 1995 to 2014, the study found that the existence of a developed corporate bond market could have been one of the reasons why" Asian countries were not strongly affected by the financial crisis of 2008" (Kowalewski and Pisany, 2019).

The development of bond markets has not been without challenges in emerging markets. These include liquidity, good investor profiles and active "institutional participation" (Click and Plummer, 2005). Chan, Covrig and Ng (2005) developed an international asset allocation model that showed that excess burden arising from market friction erodes the "expected returns on overseas investments". Looking at critical matters that have plagued emerging markets over the years, corruption would be amongst the fore factors that have affected the development of bond markets in emerging markets.

Governments and firms in developing markets are impacted by corruption-based sentiments which have an impact on asset performance. A study done by Ciocchini, Durbin, and Ng (2003) found that "countries that are perceived as more corrupt" would have to pay "higher premiums when issuing bonds". Aside from corruption impacting many aspects of the economy, it also plays a part in default risk determination. The perception of a corrupt government has a profound effect on that country's asset prices. In investigating the effect of corruption on employment, poverty and inequality, Khan and Pillay (2019) point out how in December, 2015, the Johannesburg Stock Exchange lost ZAR378 billion when Pravin Gordhan (the Finance

Minister) was fired by then President Zuma, for his "opposition to the – neither needed nor affordable- ZAR 1 trillion nuclear deal with Russia". This is a clear sign of the effect of public perception, especially as a result of corruption. Another example which further highlight the denting effect of corruption on emerging markets is how in Russia, more than $4 billion in IMF loans apparently disappeared shortly before Russia defaulted in 1998 (Ciocchini et al.,2003). This research found that on average, "a one-point improvement on the corruption score lead to a 12.6% decrease in sovereign bond spreads and a 25.5% decrease in corporate spreads.

Despite these negative sentiments, over the last two decades, fighting corruption has been an important issue in many emerging markets. Park et al., (2019) propose that "emerging markets have become more central to global "portfolio allocation due to an improved risk-return profile". Following the 2009 financial crisis, interest rates in the developed economies were low and "emerging bond markets attracted investors seeking higher returns". The empirical findings show that "foreign investors care about macroeconomic prospects and stability, which are captured by sovereign ratings, while domestic investors are relatively less sensitive to domestic macroeconomic conditions". This supports their premise of increased emerging market bond participation due to overall increased risk-return profiles.

Factors like those mentioned above, directly impact the treasury market. A country's economic growth can be hampered by things like corruption and perception. However, more generally applicable factors include inflation, interest rates, monetary and fiscal policy which research has shown to have a positive effect on the bond risk premia (Wright, 2011; Ang and Piazzesi, 2003; Thenmozhi and Nair, 2014). In researching macroeconomic factors and their effect on bond risk premia, Ludvigson and Ng (2009) found that inflation and real economic variables affect bond returns in the US. This is consistent with the study of Thenmozhi and Nair (2014), who not only confirmed that macroeconomic variables significantly affect bond returns in developed markets such as the US and the UK but also found that their "explanatory power is relatively high" in emerging markets such as Brazil and India.

In many emerging market economies, there is great participation from foreign investors in bond markets. The global nature of participation in bond markets result in financial integration. Foreign participation, therefore, becomes a "channel for transmitting risks and shocks" (Park et al., (2019). Bond yields in emerging markets are thus affected by "external factors, which weakens the effectiveness of domestic monetary policy" (Belke and Rees, 2014). With much of foreign borrowing being dollar denominated, US macroeconomic policies directly affect the macroeconomic policies of emerging markets. Further to this, factors such as sovereign credit ratings issued by ratings agencies, such as Moody's, rated South African bonds at Ba1 (negative) as of 14th April 2020[29] whereas the USA sovereign rating is AAA (stable)[30]. This difference is incorporated in corporate bond yields. Radier, Majoni, Njanike and Kwaramba (2016) show that in addition to the above, "changes in equity volatility, interest rate level and the yield curve slope are significant determinants of bond yield spreads". Their study which looked at pre-2008 financial crisis, mid-crisis and post crisis found that the impact of equity volatility and interest rate level were "more pronounced during the mid-financial crisis". The study found that yield spreads increased as the quality of the credit ratings reduced. Further, it found that in comparison to the pre-crisis period, the yield spreads during the financial crisis were higher. The highest, however, were during the period after the crisis.

Aside from the health problems brought about by the pandemic, COVID-19 has brought about economic damage the world over. This disaster has hit emerging market economies hardest. Capital flight was significant during the period February to March as investors put funds in safer assets[31]. Emerging market currencies such as the Brazilian real (BRL) and the South African rand (ZAR) dropped substantially. This is because periods of disaster and uncertainty drive demand for safe haven assets like US Dollar denominated assets and result in disinvestment in foreign denominated assets (Gupta, Suleman and Wohar, 2019). This effect can be largely attributed to the effect that disaster risk has on financial markets through the changes in consumption patterns and investment growth (Barro, 2009; Wachter, 2013).

Disinvestment further exacerbates disasters. However, when the risk of disaster increases, it is expected that the rates of return will reduce because of "precautionary saving". This further increases chances of government default and, therefore, greater returns are expected for holding government bonds (Wachter, 2013). The risk of default is mostly seen in emerging markets, however, in developed countries what is seen, following the increase in demand for precautionary savings, is the fall in yields of less risky assets (Gourio, 2012). Gupta et al., (2019) finds, using a causality-in-quantiles test, that these disaster risks only affect the volatility of 10-year US government bonds and not their returns.

There are various factors affecting bonds in emerging markets and the coronavirus presents a further opportunity to test these hypotheses. Considering the cause of the crisis and the resultant

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[29] https://www.moodys.com/credit-ratings/South-Africa-Government-of-credit-rating-686830

[30] https://www.moodys.com/credit-ratings/United-States-of-America-Government-of-credit-rating-790575

[31] http://www.oecd.org/coronavirus/policy-responses/COVID-19-and-global-capital-flows-2dc69002/

effects, the reactions to the crisis could differ for bond markets and the related returns. The research being undertaken shows the impact that COVID-19 has had on the risk in the countries being investigated and whether the theories mentioned above still hold as most of the research was done looking at disasters brought about by economic related factors and not a pandemic.

2.2.2. Factors affecting emerging market stock returns

The reactions of international stock markets to the external shock, the coronavirus, and how this could have impacted stock markets in emerging markets could be because of financial linkages. The understanding of the correlation and volatility spillover effects, of developed nations and ripple effects on developing nations, is critical to the research being carried out.

There are many factors that affect stock markets and their volatility. The increased international capital flows and globalisation over the past two decades have heightened financial market linkages across nations globally (Chen, 2018). The financial crisis of 2008 showed how volatility spillovers affect many countries during periods of great economic uncertainty (Zhang et al., 2013). A study of the dynamic behaviours and contributing factors of volatility spillovers across G7 stock markets found that after major market crisis events, "the volatility spillovers will significantly increase". It also stated that, following the end of the crisis period, there is a reduction of the level of volatility (Su, 2020). The research further found that the uncertainty based off economic policies and global prices of oil have profound impacts on long-term volatility spillovers. The spillovers are exacerbated by international stock market co-movements that are plausibly linked to existing trade linkages and co-ordination of macroeconomic policies (Morana, 2008).

An analysis of returns, volatility spillovers and their determinants in emerging Asian and MENA countries quantified the main variables affecting the extent of shock spillovers and the study found that the foreign portfolio investment, bilateral trade and distance are all significant in explaining the spillover effects from developed markets to emerging markets. This, however, is a premise that has been argued is not a factor with all emerging markets. African stock markets, with the exception of Egypt and South Africa, were found not to be significantly affected by world stock markets or those of each other; therefore, the matter of distance or proximity, might only become a factor for active and highly integrated financial markets (Alagidede, 2008).

Portfolio diversification has been one attractive factor that has caused investment flows into emerging markets. Balanced investor profiles which include diversified portfolios, more especially those with long-term investments, help increase market resilience to external shocks (Park et al., 2019). However, research such as that of Syriopoulos and Roumpis (2009) show potential co-movements and volatility effects especially during markets with extreme turbulence may weaken the potential long-run benefits of diversification. It would be necessary to point out though that this study focused on a comparison of developed economies and that of the Bulkan states.

Various studies have been done to research how market volatility has affected BRICS nations in comparison to developed nations. Li et al., (2012) and Zhang et al., (2013) both agree that the 2008 financial crisis had a permanent effect on the correlation between BRICS nations stock market returns and those of developed nations. The latter found that 70% of correlations "have their correlation trends elevated significantly during the financial crisis". The change in economic and financial landscape that brought the BRICS nations to the fore of global trade has tended to affect the "risk-return relationship of internationally diversified portfolios for different global blocks" (Mensi et al., 2017).

This correlation could be further influenced by investor sentiments. Post the 2018 financial crisis, the behaviour of investors was considered to be a critical factor determining changes in the stock market (Parveen, Satti, Subhan and Jamil, 2020). Baker, Wurgler and Yuan, (2012) suggests that investor sentiment in developed markets can have a "contagious effect on stock return behaviour in other markets". The focus of this study was limited to G7 countries and so it does not wholly confirm if this affects emerging market economies. Their research does, however, qualify that sentiment by explaining that "capital flows are a key mechanism through which global sentiments develop". The study by Debata, Dash and Mahakud, (2018) does give greater insights on the effect of investor sentiment on emerging markets, by providing evidence, using time series data from two aggregate emerging stock market indices, that sentiments from developed markets are an important determinant of emerging stock market liquidity.

News and announcements play a significant role in informing sentiment and subsequently impacting stock returns (Su, Lu and Yin, 2019). For example, Lin, Engle and Ito (1994) cite how, following Black Monday in the October 1987 market crash, traders in Tokyo sold their stocks without first assessing the fundamental effect on the stocks that they carried. Boyd, Jagannathan and Hu (2003), through examining the impact of announcements regarding unemployment numbers on the S&P 500 from 1948-1995, found that high levels of unemployment increases stock prices during economic expansion but results in a lower stock price during a market contraction. The authors hypothesised that “higher unemployment predicts both lower interest rates and lower corporate profits.” A major factor of the coronavirus has been worldwide lockdowns. This resulted in a major reduction in air travel globally and with many people working from home, also drastically affected local travel by road. As a result, oil prices plummeted. Changes in the oil price or news about oil affects stock returns and this effect can be positive or negative depending on which sector the stock is in (Narayan, 2017).

The USA plays a central role in the development of the global economy. Announcements and uncertainty in the USA affect stock returns in other parts of the world (Nikkinen and Sahlström, 2001; Su, Lu and Yin, 2019). Economic policy uncertainty (EPU) in the US has a significant effect on market participants due to its impact on financial risk (Li and Peng, 2017). With diversification and the liberalisation of many emerging market economies like India and China, many institutional investors have their finances spread across the globe (Sainy, 2016). With international linkages, the likely effect of EPU shocks is that they drive co-movement of stock market returns in different nations (Li and Peng, 2017). The certainty in economic policies also plays a significant role. For example, expansionary monetary policy increases the prospects of future cash flows or results in the decrease of the discount factor due to the lower interest rate and as a result, increases stock returns (Thorbecke, 1997).

Along with macroeconomic policy, macroeconomic factors also have an effect on stock returns. In emerging markets, for example, the exchange rate has a major impact on stock returns (Thenmozhi and Radha, 2008). Assuming the exchange rate is a proxy for economic strength, the falling exchange rate could alarm investors and negatively impact stock returns. Furthermore, economic conditions such as inflation and interest rates could also influence the level of investments made (Flannery, 2002). This is a factor that is mainly attributable to emerging markets.

Lastly, and greatly applicable to the coronavirus, is the effect of disaster on stock returns. The uncertainty brought about by disaster as well as the real damage caused by a disaster result in a decline in employment, output and investments and subsequently stock prices (Gourio, 2012). It has also been proposed that events that affect the global economy result in international stock markets displaying characteristics of co-movement (Madura, 2006). Most research around contagion has been done around financial crises such as the US market crash of 1987, the Asian crisis of 1997 and the 2008 Global Financial Crisis of 2008. Lee, Lu and Shih (2018) researched the effect of natural disasters and financial crises and the empirical results are as follows:

"The empirical results find that the contagion effects created by the 3.11 earthquake in Japan and the Sichuan earthquake in China on the stock markets of the neighbouring Asian countries, South Korea and Hong Kong were stronger than those on other countries. In the global financial tsunami, the country affected by the US stock market was the Philippines. With Hurricane Katrina, the country affected by the US stock market was Hong Kong, whose economy is in a pivotal global position. In the South Asian tsunami, only the US stock market was influenced by Indonesia's stock market. Because the disaster occurred in a moderately developed region, the disaster did not have contagion effects on other countries. Finally, regarding the European debt crisis, this study did not detect any contagion effect in the sample stock markets."

The research also found that the stronger the economy of the country was, where the disaster originated, the more the countries that trade with it were affected. This would be more applicable if the coronavirus were centred on China alone. With China having a significant impact on global trade, the closure of its borders and the limitations on production imposed by lockdown measures would affect many world economies. However, COVID-19 being a global pandemic means that these theories could fall short in explaining the results. This, consequently, provides a gap in the literature that this research adds to.

2.3.Financial Contagion

Financial contagion can be defined as an increase of significance in cross-market linkages after a shock to a financial market or a group of markets. This spread of shock is mostly on the downside. It has been studied extensively and has mostly been associated with significant crises. The causes of contagion have been generally studied along two categories. Donbusch et al., (2000) proposes that one involves a financial crisis that has no links to macroeconomic fundamentals and is "solely the behaviour of investors or other financial agents. An example of this would be the failure of one emerging market government to honour its debt obligations, resulting in the loss of confidence in the ability of other countries in the region to honour their debts, leading to capital flight. The second cause of contagion emphasises volatility spillovers resulting from the "normal interdependence among market economies" (Calvo, Izquierdo and Loo-Kung, 2006) (Zhang, Zhuang, Lu and Wang, 2020). Considering the research being undertaken, the major focus of this study is the latter. The coronavirus caused immense volatility and the trade links and macroeconomic similarities have made countries more vulnerable to these volatility spillovers (Donbusch et al., 2000).

With increased trade, globalisation and financial linkages, the level of contagion "among developed and emerging markets has increased" (Balli, Hajhoj, Basher and Ghassan, 2017). A series of crises in the 1990s, including that of the Asian crisis, and the 2008 financial crisis suggest that crises have a tendency of spilling over from one market to another (Baek and Jun, 2011; Aloui, Aïssa and Nguyen, 2011). The degree of co-movement of asset returns is a widely used criterion to test for contagion. A result with "significant increase in co-movement during crisis periods is provided as evidence of contagion (Baek and Jun, 2011). However, if there is a historical cross-correlation between markets, then it would follow that a shock in one market will have an "expected change in given magnitude in the other market."[32]

Huygherbaert and Wang (2010), in their research which span from 1992 to 2003, examined the long run equilibrium relationship among the East Asian stock markets and the impulse responses to shocks. They show that prior to the crisis, the Asian markets bore no "long-run equilibrium relationship". The market integration strengthened, however, during the crisis. This was not found to be a permanent effect. Mensi et al., (2014) using a quantile regression approach, taking into consideration the period from 1997 to 2013, showed that for BRICS nations their stock markets exhibit dependence with the commodity and stock markets. This study further agrees with Li, Zhang and Du, (2012) and Zhang, Li and Yu (2013) that this dependency was further influenced by the 2008 financial crisis.

Considering this is more recent research to that of Huygherbaert and Wang (2010), we can conclude that as globalisation and trade links have increased, there is a greater permanency of contagion effects. This research will not seek to prove this hypothesis with regards to the effects brought about by the coronavirus, simply due to the period that the research seeks to cover (July 2019 to June 2020).

The understanding of contagion and its drivers is, however, critical to the study being undertaken as similarities of market reactions could be drawn from the review of studies done on contagion. The study being proposed has a significant difference from the research evidence provided above. The coronavirus effect on financial markets has not been because of finance related shocks or a natural disaster, but a pandemic. The review of sources linked to pandemic based contagion is covered below.

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[32] https://www.elibrary.imf.org/view/IMF024/15840-9781451974201/15840-9781451974201/15840-9781451974201_A003.xml?redirect=true [Accessed 30.08.2020]

2.4.The Effect of pandemics on financial markets

This area of research is rapidly evolving. This is mainly because, in modern times, there has not been a pandemic that has had global ramifications to the extent that can be compared to the coronavirus, including the Spanish flu (Baker et al., 2020). The Spanish flu had greater mortalities and resulted in higher deaths among the working age population. The infections and death rate of the COVID-19 pandemic, however, seem not to be the main cause of the significant economic damage. The effects of the current pandemic seem to be partly because the information about the pandemic is swifter and richer than with any pandemic before it.

Furthermore, containment policies have resulted in reduced labour flows and also reduced the flow of customers to businesses resulting in major revenue declines (Baker et al., 2020). However, Gormsen and Koijen (2020) points out that while pandemics may spread quicker in the highly integrated environment of the 21st century and cause sharp economic contraction, the real economic consequences are felt one to two years later. It could therefore be that future research done into the economic effect of pandemics could find more similarities between COVID-19 and the Spanish flu.

The impact of pandemics and epidemics are bound to increase due to globalisation (Pike et al., 2014). The economic impact of pandemics is not expected to be the same and this is also the case with the pandemics themselves. These differences thus necessitate careful analysis before any policies are implemented (Stephens, 2017).

In the last two decades MERS, SARS and the Ebola virus have been the most devastating pandemics that have impacted various economies. With each pandemic being isolated to a particular region, the economic and social effects have not been felt on the global scale. Additionally, the comparisons done with the influenza pandemics of 1957-1958 as well as that of 1968, that affected the US, show that those pandemics had greater mortality rates than COVID-19, thus far. However, their effects to the US stock markets pale in comparison to the effects of the current pandemic (Baker et al., 2020).

In comparing the case of Ebola in West Africa and the MERS virus of South Korea, Stephens (2017) points out that West Africa required international responses both “to contain the virus and to mitigate its economic impacts”. South Korea, on the other hand, was able to both contain the virus and institute economic recovery. For South Korea, the economic effects were more pronounced than the social effects as the country witnessed a 40% decline in tourism due to the virus.

The effects of the viruses mentioned above did not reach a global scale. The effects of the coronavirus, on the other hand, is being compared to those seen in the 2008 financial crisis. Unlike the 2008 financial crisis, the American economy had been performing well before the shock. With the 2008 crisis there had been “structural problems in the US economy” (Sharif, Aloui and Yarovaya, 2020). Baker et al., (2020) points out that before COVID-19, no infectious disease outbreak had made a “sizeable” contribution to the volatility of the US stock markets. Business closures and other restrictions on the commercial activities of businesses as well as the highly encouraged social distancing measures have played a major role in influencing this volatility (Baker et al., 2020). Stock prices of companies in industries that could perpetuate virus transmission such as accommodations, transportation and entertainment exhibit the greatest exposure to the pandemic and as a result, witness the highest declines in market value (Alfaro, Chari, Greenland and Schott, 2020). Alfaro et al., (2020) further highlight that daily predictions of infections and their trajectories have a much greater influence on price volatility than the actual reported numbers of deaths and infections.

A few studies have been undertaken looking at the effects the coronavirus. Haddad, Moreira, and Mui, (2020) have studied the disruptions in debt markets during the COVID-19 crisis. The research found that though the disruptions were large and comparable to that of 2008, thus far, there are two major differences in dimensions. Firstly, the disruptions appeared within a matter of days in comparison to the months it took for the US mortgage crisis to have a similar effect. Just as quickly as effects appeared, they disappeared quickly following the unprecedented responses by the Fed. Secondly, the investment grade bond prices severely deteriorated while during the 2008 crisis “disruptions were more pronounced in more illiquid asset classes”. Haddad et al (2020), however, only covers bonds trading in the US markets and therefore would not assist in understanding how these factors affected bonds in other regions.

Baker et al., (2020) propose that policy responses to COVID-19 provide the “most compelling explanation for its unprecedented impact on the stock market. Zhang, Hu and Ji (2020) postulates that the non-conventional interventions with regards to policy, such as the unlimited QE policy in the US result in further uncertainty and market volatility. Sharif et al.,(2020), using US data from Q1 2020, found “unprecedented sensitivity of the US stock market, the US economic policy uncertainty and the US geopolitical risk to the combined shocks of the COVID-19 and oil volatility shocks”.

Studying six economies, namely the USA, UK, China, Italy, Spain and Turkey, over a 16 year period ending 3rd April 2020 (end of sample period), Gunay (2020) found that China, experienced structural breaks earliest in the pandemic which most was likely because of the pandemic originating from there. The research further found that the unconditional correlation coefficients increased by around 10% between the following markets: China and the US, Turkey and the US, Turkey and Italy and Turkey and Spain. The Turkish stock market (XU100) emerged as having the highest strengthened co-movement with other countries which seems to be an indication of its vulnerability against the transmission of non-systematic risk.

With greater vulnerability seen in emerging markets, investors have sought to invest in safer assets. Before the pandemic hit US shores, stock markets were generally calm. Once the virus hit the US, it began to implement lockdown measures. In response to the US decision on 12th March which severely restricted travel from Europe, the EU also instituted lockdown measures, and this resulted in a worldwide decline of stock markets by 10% or more (Gormsen and Koijen, 2020; Baker et al., 2020). Because stocks experience higher volatility and are seen as riskier than bonds, the flow of funds is often diverted from stocks to bonds, more especially in turbulent markets (Gunay, 2020) to longer term US government and German bonds. The initial monetary policies instituted in the US resulted in the yield on 30-year treasury bonds decreasing by almost one percent. This drove up prices of 30-year bonds up by almost 30% (Gormsen and Koijen, 2020).

2.5.Summary

The coronavirus has resulted in great volatility in asset prices. Mensi et al., (2014) states that "changes in the global economic factors could be a channel through which fluctuations in the world's economic and financial conditions are transmitted to the BRICS stock markets and affect their growth". Herd behaviour is a likely transmitter of market volatility. Understanding the role that financial integration has in the propagation of the coronavirus effects across global capital markets is an important area of study.

Most research around contagion has been done around financial crises such as the US market crash of 1987, the Asian crisis of 1997 and the 2008 GFC. The research of Lee, Lu and Shih (2018) which looked at the effect of natural disasters on financial markets also aimed at showing the contagion effect of disasters. This research helps to set the base for the research being undertaken as COVID-19 has been somewhat of a global disaster. Gunay (2020) provides more specific insights into the effects of a pandemic by looking at the USA, UK, China, Italy, Spain and Turkey, over a period of 16 years, to understand the co-movement of their individual markets during the pandemic. The research only goes as far as establishing the role that financial contagion may have played in informing the changes in capital asset prices following the COVID-19 outbreak.

This study seeks take the research further by providing a comparative analysis of the effects of COVID-19 on bond yields and stock returns in developed and emerging markets, and thus, address a gap in the research undertaken thus far. The research also seeks to provide insights into the effects of financial contagion during the COVID-19 pandemic.

CHAPTER 3 - METHODOLOGY

This research aims to primarily understand and ascertain the impact of the COVID-19 pandemic on the performance of capital markets in both developed (looking specifically at the USA, UK, Sweden, Singapore, New Zealand and Italy) and emerging markets with the BRICS nations as well as South Korea as a proxy for emerging markets. The research further hopes to establish the role that financial contagion may have played in informing the initial changes in capital asset prices in developed and developing markets following the outbreak of the pandemic in China.

3.1.Data and Sampling

With regards to specific stock markets, the research looks at the: S&P 500 (US), FTSE 100 (UK), FTSE MIB (Italy), Nasdaq Stockholm AB (Sweden), SGX (Singapore), NZX (New Zealand), JSE Top 40 (SA), Bovespa (Brazil), S&P BSE Sensex (India), Shanghai Composite Index (China), the MOEX Russia Index (Russia) and the Korea Exchange (South Korea) in the study of the equities aspect of the research. For each of the countries mentioned, the research focuses on the 10-year treasury bond yields. This is due to the 10-year note having greater investor preference and demand than bonds with longer maturities such as 30-year bonds, more especially with regards to futures contracts (Jones, 2000). Further, in investigating the effects of scheduled macroeconomic announcements on prices, trading volumes and bid-ask spreads, Balduzzi, Elton, and Green (2001), found that the 10-year note experienced the most volatility. This greater volatility makes it a more suitable for this study, which relies on price movements to identify the effects of COVID-19.

One of the reasons for choosing the specific developed countries was that they were initially some of the worst hit countries. With regards to the US, it is also central to global economic policies and, with major capital flowing from and to the US (for instance, UNCTAD data[33] shows that in 2019, the US was the largest recipient of FDI flows and is also a major source country for FDI); thus, it would assist us to understand if contagion played a part in the transfer of shocks to asset prices in different countries, following the outbreak's initial effect in the Chinese markets. Of the countries being researched, Sweden did not implement lockdown measures and it would, therefore, be interesting to see if its capital assets experienced similar

[33] https://unctad.org/en/Pages/DIAE/FDI%20Statistics/FDI-Statistics-Bilateral.aspx [Accessed 30.08.2020]

effects as other countries[34]. To properly identify the role of COVID-19 on the capital markets, this study also investigates two developed countries in the South, Singapore and New Zealand which did not appear to have been as severely affected as those in the North.

The choice of the BRICS countries was mainly because they are "major recipients of global investments and capital flows and are among the main global consumers of commodities" (Mensi et al., 2014). Secondly, members of the BRICS bloc also represent Asia, Africa, and Latin America. Though not exhaustive, by any measure, this choice should give us insights into the possible effect of contagion across continents. In aiming to understand the overall effects on emerging markets, the research has included South Korea which has been touted as one of the more successful cases in managing the virus[35] due to its quick and early management through nationwide testing.

This research focuses entirely on the effects of COVID-19 without the inclusion of other periods, like the Global Financial Crisis, unlike recent studies such as Gunay (2020). The period covered will, therefore, be from 1st July 2019 to 30th June 2020. 2019 had been a good year for stock and bond returns[36] and the inclusion of the 6-month period prior to the pandemic will enable the research to show the impact of the virus thus far. The first half of 2020 includes the first wave, the global lockdowns, and the period with the majority of the macroeconomic policies that impacted the sample economies.

Data are observed on daily frequency for the period mentioned above. The sample construction involves daily data of COVID-19 deaths/infections as well as daily stock return/bond yield data which are available for all the countries being observed. This is because the effects on volatility from the changes and announcements brought about through COVID-19 are seen daily and, therefore, a higher frequency could result in the research losing some valuable information.

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[34] https://www.bloomberg.com/news/articles/2020-06-24/sweden-s-epidemiologist-says-world-went-mad-imposing-lockdowns [Accessed 30.08.2020]

[35] https://www.weforum.org/agenda/2020/03/south-korea-COVID-19-containment-testing/ [Accessed 30.08.2020]

[36] https://www.bloomberg.com/opinion/articles/2019-09-10/stock-market-is-acting-stranger-than-usual [Accessed 30.08.2020]

3.2.Empirical Analysis

3.2.1. Events studies

In order to understand how the coronavirus impacted stock and bond yields, the research begins with an events study using major news and policy announcements related to COVID-19 to establish their impact on returns. This is similar to the model used by Baker et al., (2020) and Gormsen and Koijen (2020). Their studies are, however, limited in scope and do not compare the effects in developed markets with those in emerging markets.

The event study uses cumulative returns during the period between January 2020 and June 2020 for both bond yields and stock returns in the specific countries being researched. It should be noted that China had cases before this date, but they were more widely reported in the year of observation. Similar research done such as that of Gormsen and Koijen (2020) and Phan and Narayan (2020) begin their research period in January. This is largely due to the fact that major data sources such as WHO, ECDC and John Hopkins University have the earliest data reporting date as 31st December 2019[37]. It is due to these reasons that the research begins its observations in January.

The initial event study looks at the announcements pertaining to 1st COVID-19 related infection in 2020, 1st death as a result of COVID-19 as well as the first announcements of partial or full lockdowns in the countries under investigation (Table 1). The second study will observe the effect of the first European lockdown and US policy announcements which had global ramifications (Table 2). US policy pronouncements are preferred for this study, rather than individual country pronouncements, because in most cases, pronouncements at the individual country level were made the same day as, or very closely after, the lockdown announcement or amidst worsening infection announcements. For example, countries like Spain, France, and the UK all instituted lockdown measures as well as stimulus package announcements within a day of each other, during the period 10th March to 17th March 2020 (Phan and Narayan, 2020). Because this tendency is observed across many countries, country-level economic policy pronouncements were, therefore, largely anticipated by the market or where they potentially effected markets, such effects were likely distorted by the confounding effects of lockdown announcements.

[37] https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-COVID-19-cases-worldwide [Accessed: 23.10.2020]

Only one stock exchange per country is used (refer to Table 1) and for bond yields, the 10-year Treasury bond yields are used.

Table 1 Event Study 1- The major COVID 19 events

Country	Stock Index	1st COVID-19 Infection announced	1st Death announced	Lockdown announced
Brazil	Bovespa	26-Feb-20	18-Mar-20	24-Mar-20
China	Shanghai Composite	03-Jan-20	11-Jan-20	23-Jan-20
India	BSE Sensex	30-Jan-20	13-Mar-20	25-Mar-20
Italy	FTSE MIB	31-Jan-20	23-Feb-20	22-Feb-20
New Zealand	NZX	28-Feb-20	29-Mar-20	26-Mar-20
Russia	MOEX	01-Feb-20	27-Mar-20	30-Mar-20
Singapore	SGX	24-Jan-20	22-Mar-20	03-Apr-20
South Africa	JSE Top 40	05-Mar-20	31-Mar-20	16-Mar-20
South Korea	Korea Exchange	20-Jan-20	21-Feb-20	*
Sweden	Nasdaq Stockholm AB	01-Feb-20	12-Mar-20	*
United Kingdom	FTSE 100	01-Feb-20	07-Mar-20	23-Mar-20
United States	S & P 500	21-Jan-20	01-Mar-20	11-Mar-20

The major COVID-19 events consist of 1st infection reported, 1st death and initial announcement of partial or full lockdown measures. * Both South Korea and Sweden never instituted lockdown measures.

Table 2 Event Study 2-Material COVID-19 Related News and Policy Announcements

Affected Country	Announcement Date
Italy	*22nd February 2020*
First announcement of Lockdown in Eurozone	
USA	*15th March 2020*
Following the declaration of a national emergency on 13th March, the Fed slashed interest rates by 100 basis points to near zero and further announced large scale asset purchases and launched coordinated swap lines with 5 major foreign central banks	
USA	*9th April 2020*
Fed rolls out a $2.3 trillion emergency lending effort to bolster local government and small and medium sized businesses.	

Average cumulative abnormal returns

Following the representation of cumulative returns, the research then analyses the average cumulative abnormal returns (ACAR) forming a comparison between emerging and developed markets. With ACAR, we pick out the two events that seem to have the most significant effects in event study 1 and 2.

For the calculation of abnormal returns, the research employs the Single-Index Model. The computation is for the window around the event date which we take to be 16 days in total (10 days before the event and 5 days after the event). Under the Single-Index Model, the expected daily return, $E(R_{jt})$ for stock/bond market j on day t is calculated as follows:

$$E(R_{jt}) = \alpha_j + \beta_j R_{mt} \qquad (1)$$

Where α_j and β_j are estimated using the intercept and slope functions, respectively, and R_{mt} is the daily market return on day t. The market return used for the calculation of bond returns is the Vanguard International Bond Index return and the Vanguard Emerging Market Bond Index return for developed and emerging markets, respectively. For these estimations, the bond returns for each country are estimated using Equation (5) as the prices for each bond are obtained. For the stock returns, the markets assumed are the MSCI World Index for developed countries and the MSCI Emerging Market Index returns for the emerging markets.

In estimating the abnormal returns of the specific events, we employ a similar method to the one used by Suwanna (2012) where:

$$AR_{jt} = R_{jt} - E(R_{jt}) \qquad (2)$$

After obtaining the abnormal returns for each countries' stock market for each period, the cumulative abnormal returns are then calculated by adding the daily AR, over the event period as follows:

$$CAR_{jt} = \sum_{t=T_1}^{T_2} AR_{jt} \qquad (3)$$

The arithmetic average cumulative abnormal return for the developed and emerging bond and stock markets are then computed as the average of the cumulative returns in equation (3).

3.2.2. Regression analysis

Observing the effect of COVID-19 using the events study enables us to assess the effects on bond yields and stock returns. The deficiency of an events study, more especially for stock returns, is that unlike a natural disaster, which is a single event with the consequences happening after the fact, the pandemic happens over a period of time and does not peak at its beginning (Al-Awadhi, Alsaifia, Al-Awadhib, Alhammadic, 2020 and Ashraf, 2020). The research, therefore, includes a regression analysis to further investigate how COVID-19 and other market characteristics affected asset returns.

The econometric model is specified in equation (4):

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t \qquad (4)$$

The dependent variable r represents stock return/bond yields while the subscript t represents the day. α represents the constant term whilst the term $Covid19_{t-1}$ represents various indicators, which are defined under the Identification Strategy. Unlike Al-Awadhi et al., 2020 which takes firm level characteristics such as daily market-to-book ratio and the natural log of daily market capitalisation, we take the term X_{t-1} to represent a vector of market specific characteristics. The characteristics, therefore, include change in exchange rates, equity returns when estimating the bond model, and bond yields when estimating the equity model; spread between yields on ten-year Treasury bonds and three-month Treasury bills (liquidity spread); spread between ten-year Treasury bonds and AAA-rated corporate bonds[38] of more-or-less similar maturity (quality spread), and oil price changes (Chen, Roll and Ross, 1986).

As with, Topcu and Gulal (2020), exchange rates are described as national currency units per US Dollar. Exchange rates are a necessary macroeconomic variable for this model due to the immense volatility witnessed during the COVID-19 pandemic. Research by Ajayi and Mougoue (1996) in studying the short run effects of exchange rates in the US and UK found that an increase in the stock prices caused both currencies to depreciate. It would, therefore, be necessary to control for exchange rate changes considering that the sample includes both developed and developing nations. The direction of causality, however, does tend to be mixed (Olugbenga, 2012). Therefore, due to the possible cross-causality in this regression, equation (4) is first tested using OLS regression and then the generalised method of moments IV approach is used for robustness check (Baum, Schaffer and Stillman, 2003). When the regressions are estimated using the GMM estimations, the instrumental variables used include all the variables mentioned above in their original form (unscaled and undemeaned), an additional variable, Bitcoin which has been a much talked about investment alternative during

[38] For the AAA-rated corporate bond, Moody's Seasoned AAA Corporate Bond Yield is used as the source data.

the pandemic[39] as well as a constant, following Ferson and Harvey (1994). For both estimation methods the number of lags which are chosen are based on the Schwarz Bayesian Information Criterion (SBIC).

As shown in the subscripts in Equation (4), time series data regression approaches are used. The regression is performed several times, each time with a different proxy for the $Covid19$ term.

Identification strategy

$Covid19$ takes various forms as follows:

1. Daily deaths normalized by the country's population by using a per million adjustment;
2. Daily infections normalized by the country's population by using a per million;
3. A dummy variable taking the value of zero before the first infection and 1 thereafter.

When $Covid19$ takes the form of (1) and (2), the analysis begins on the day when the first infection/death is recorded. For the dummy variable regressions under definitions (3), time series data is used starting 1 July 2019 and ending 30 June 2020 – the full sample period for this study. For robustness checks, each of the foregoing regressions is estimated using time series data of each country.

The Table below captures the COVID-19 related observations that are used as inputs for this model. The daily data was collected from the European Centre for Disease Prevention and Control. It consists of observations of number of deaths per unit of the national population reported in each of the countries mentioned below and covers the period 1st January 2020 to 30th June 2020 in its entirely but for each country the observations begin on the specific day the first infection was reported. With regards to daily stock, Treasury bills, and Treasury bond data and exchange rate information that is to be used, the information is being drawn from *EquityRT*, Yahoo! Finance and FRED Economic Data. It should be noted that for China, no Treasury bill data is available for the period under research in order to compute its liquidity spread[40]. With regards to the oil price, the WTI Crude oil price will be used as a measure. To

[39] https://www.bloomberg.com/opinion/articles/2020-12-01/bitcoin-is-the-tulipmania-that-refuses-to-die [Accessed: 05.12.2020]

[40] https://fred.stlouisfed.org/series/IR3TTS01CNM156N [Accessed: 01.11.2020]

get a consistent sample, where there is more than one stock market in a country, we use only the major stock market.

Table 3 Regression observations

Country	**Stock Index**	**Day of 1st COVID-19 Confirmed Case in 2020**	**Number of Observations in regressions (1) and (2)**
Brazil	Bovespa	26-Feb-20	90
China	Shanghai Composite	03-Jan-20	126
India	BSE Sensex	30-Jan-20	106
Italy	FTSE MIB	31-Jan-20	108
New Zealand	NZX	28-Feb-20	88
Russia	MOEX	01-Feb-20	86
Singapore	SGX	24-Jan-20	113
South Africa	JSE Top 40	05-Mar-20	84
South Korea	Korea Exchange	20-Jan-20	117
Sweden	Nasdaq Stockholm AB	01-Feb-20	89
United Kingdom	FTSE 100	01-Feb-20	105
United States	S & P 500	21-Jan-20	116

This Table reports the countries, its specific stock market index, the date when first COVID-19 case was confirmed in a country and the number of data observations from each country starting from 1st Jan to 30th June 2020.

All returns are computed using continuous time compounding. For stocks, oil, and exchange rates we shall use:

$$r = LN(Pt) - LN(Pt - 1) \qquad (5)$$

where *LN* is the natural log and r is the return. This calculation means that we shall lose one observation and end up with *n-1* time periods. For the various bonds and Treasury bills, the nominal daily yield is obtained as:

$$r = (1 + k)^{1/365} - 1 \qquad (6)$$

where k is the annualized yield. The data is thereafter demeaned to ensure that all the data is mean centred as well as scaled by dividing each observation by its standard deviation. This procedure is done for all the variables except the variables measuring COVID-19 in its different forms.

3.2.3. Measuring contagion

When dealing with financial linkages, the Pearson Correlation Coefficient model is a widely used measure of dependence. This is because of its ability to measure the strength of the association between two variables. A deficiency of this model as pointed out by Mensi et al., (2014), is that it "draws no distinction between dependence during up and down markets or between large and small stock prices."

To measure market integration, we begin by calculating the conditional correlation. This paper employs the vector autoregressive (VAR-1) model for the estimation of the conditional mean of returns. The mean equation shown below follows that of Ling and Gurjeet (2010),

$$r_t = c + \varphi_{i,t-1} r_{i,t-1} + \varepsilon_{it} + \theta \varepsilon_{i,t-1}, \varepsilon_t | \Omega_{t-1} \sim N(0, H_t) \qquad (7)$$

Where r_t is a two-dimensional vector of asset returns, c is a two-dimensional vector of constants, ε_t is an error terms vector, Ω_{t-1} is the matric of the residual term and H_t is the conditional variance-covariance matric of the error term on information set available at time t-1.

The conditional covariance matrix, H_t, is estimated in this research using a multivariate GARCH model, more specifically, the BEKK model. This is because, when modelling time varying volatilities, it appears a more natural framework as it accounts for cross sectional information[41].

The study adopts the BEKK (Baba, Engle, Kraft, and Kroner) model, which was proposed by Engle and Kroner (1995) and is specified below:

$$H_t = C_0 C_0^* + \sum_{k=1}^{K} . \sum_{i=1}^{q} A_{ki}^* \varepsilon_{t-i} \varepsilon_{t-i}^* A_{ki} + \sum_{k=1}^{K} . \sum_{j=1}^{q} B_{kj}^* H_{t-j} B_{kj} \qquad (8)$$

The quadratic nature of the terms on the right side of the equation ensure the "positive definiteness of the covariance matrix (Brooks, 2014). The parameter vector C_0^* is an upper triangular matrix. A and B represent N x N parameter matrices. The diagonal elements in the parameter matrix B measures the effect of lagged volatility (Ling and Gurjeet, 2010) and the off-diagonal elements capture the cross-market or spillover effects (Zhang, Paya and Peel,

[41] http://sfb649.wiwi.hu-berlin.de/fedc_homepage/xplore/tutorials/xfghtmlnode67.html [Accessed 01.10.2020]

2009). The summation limit K determines the generality of the process. The multivariate GARCH model employed in this research, the BEKK GARCH (1,1) model indicates that:

$$H_t = \begin{bmatrix} C_{11} & \cdots & C_{1,k} \\ \vdots & & \vdots \\ C_{1,k} & \cdots & C_{k,k} \end{bmatrix} +$$

$$\begin{bmatrix} A_{11} & \cdots & A_{1,k} \\ \vdots & & \vdots \\ A_{1,k} & \cdots & A_{k,k} \end{bmatrix}^* \begin{bmatrix} \varepsilon_{1,t-1}^2 & \cdots & \varepsilon_{1,t-1}\varepsilon_{k,t-1} \\ \vdots & & \vdots \\ \varepsilon_{k,t-1}\varepsilon_{1,t-1} & \cdots & \varepsilon_{k,t-1}^2 \end{bmatrix} \begin{bmatrix} A_{11} & \cdots & A_{1,k} \\ \vdots & & \vdots \\ A_{1,k} & \cdots & A_{k,k} \end{bmatrix} +$$

$$\begin{bmatrix} B_{11} & \cdots & B_{1,k} \\ \vdots & & \vdots \\ B_{1,k} & \cdots & B_{k,k} \end{bmatrix}^* H_{t-1} \begin{bmatrix} B_{11} & \cdots & B_{1,k} \\ \vdots & & \vdots \\ B_{1,k} & \cdots & B_{k,k} \end{bmatrix} \tag{9}$$

The existence of high correlation would provide evidence of integration and, therefore, confirm the effects of financial contagion. High ARCH effect will confirm existence of spillover effects and large GARCH effects will represent the persistence of volatility. This would denote that the effects of today’s shocks remain for many periods in the future. Bekaert and Harvey (1995) propose that it would be flawed to assume that high correlation provides evidence of integration as correlation could be as a result of similar industry characteristics in individual markets. However, Corsettia, Pericoli and Sbracia (2005) find that a failure in distinguishing “between common and country specific components of market returns induces a bias towards the null hypothesis ‘no contagion’”. This research uses market return variables and, therefore, make this model viable for testing for financial contagion.

Following the BEKK GARCH estimations, graphs showing the conditional correlations for sample of the chosen countries are provided. These are estimated using a Dynamic Conditional Correlation model (DCC). The model is specified as follows:

$$H_t = D_t R_t D_t \tag{10}$$

Where D_t is a diagonal matrix consisting of the conditional standard deviations on the leading diagonal; R_t is the conditional correlation matrix of the standardised residuals and is allowed to be time varying (Brooks, 2014; Engle, 2002).

CHAPTER 4 - EMPIRICAL RESULTS

This chapter presents the summary statistics, the results from the empirical investigations, as well as the interpretations of the results. The various models earlier presented, will allow for the research to answer how the coronavirus outbreak affected performance (returns and risk) of the capital assets in both emerging and developed markets as well as what role financial contagion played in the evolution of capital asset prices during the COVID-19 outbreak. Inferences are drawn from the results and comparisons are also made with similar research that has been conducted in the recent past.

4.1.Preliminary Analysis

4.1.1. Stock Market Returns

Table 4 presents a summary of the stock market index returns for the respective countries and their autocorrelations. The correlation matrix for the returns are reported in Table 5. As seen in Table 4, New Zealand had the highest mean daily return over the research period with Singapore reporting the lowest mean daily return at -0.104%. This could be indicative of the stock market reaction over the period. Singapore's economy was hard hit by both supply-side and demand-side shocks. Sectors like manufacturing and wholesale trade which form a large part of their economy were affected by supply chain disruptions[42]. With Singapore being a financial hub in Asia and with its proximity to China, the pull back of FDI could have therefore been more significant than in other countries. With regards to New Zealand, however, their ability to "crush the curve"[43] by June 2020 could have resulted in greater investor confidence, resulting in higher mean returns.

All the countries' index returns exhibit negative skewness and are leptokurtic, therefore, not exhibiting the qualities of a normal distribution. Brooks (2014) highlights that this should be expected for financial asset returns. The Jacque-Bera statistic for all the returns are highly significant at the 1% level and so we can reject the null hypothesis of a normal distribution. Considering the period being researched, this would be expected as extreme volatility, which has been a significant characteristic of markets in 2020, would result in outliers that would cause the curve to be highly peaked.

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[42] Impact of the COVID-19 Pandemic on the Singapore Economy (mti.gov.sg) [Accessed: 07.12.2020]

[43] New Zealand takes early and hard action to tackle COVID-19 (who.int) [Accessed: 07.12.2020]

Table 4 Descriptive statistics for stock returns

Panel A: Summary Statistics

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Brazil	-0,00033	0,02707	-1,54826	15,42755	1783,85***
China	-0,00008	0,01069	-1,91184	15,53374	1867,40***
India	-0,00049	0,01974	-1,53770	16,53837	2096,11***
Italy	-0,00042	0,02135	-3,47339	33,31561	10519,32***
New Zealand	0,00031	0,01683	-0,20160	13,06817	1104,15***
Russia	-0,00008	0,01536	-0,95562	13,61903	1266,03***
Singapore	-0,00104	0,01527	-0,74157	10,28934	601,76***
South Africa	-0,00017	0,01831	-1,05413	10,96201	737,74***
South Korea	-0,00078	0,02184	-0,05987	9,82704	507,02***
Sweden	0,00005	0,01761	-1,43751	11,83363	938,49***
UK	-0,00075	0,01722	-1,30298	13,96591	1381,58***
USA	0,00017	0,02095	-0,88385	13,06191	1134,99***

Panel B: Autocorrelation

	$\rho 1$	$\rho 2$	$\rho 3$	$\rho 4$	$\rho 5$	$\rho 7$	$\rho 14$
Brazil	-0,268[a]	0,181[a]	0,043	-0,021	0,137[a]	0.272a	0.129a
China	-0,078	0,055	0,061	-0,108[a]	0,034	0.045	0.046
India	-0,108[a]	0,032	0,049	-0,029	0,226[a]	0.145a	0.021
Italy	-0,068	0,249[a]	0,098	0,051	0,077	0.097	0.050
New Zealand	0,11[a]	0,202[a]	0,007	0,045	-0,017	0.022	0.006
Russia	-0,047	0,153[a]	0,078	0,194[a]	-0,088	0.091	-0.046
Singapore	-0,01	0,198[a]	0,119[a]	-0,064	0,227[a]	-0.006	0.091
South Africa	-0,077	0,095	0,14	0,035	0,074	0.163a	0.178a
South Korea	-0,094	0,186[a]	0,114[a]	-0,043	0,033	-0.047	0.086
Sweden	-0,04	-0,012	0,023	0,046	0,086	0.194a	0.140a
UK	-0,015	0,039	-0,007	0,059	0,068	0.217a	0.166a
USA	-0,357[a]	0,266[a]	-0,03	-0,105	0,144[a]	0.372a	0.225a

[a] indicates that the autocorrelation is significantly different from zero. *** indicates that the reported value is statistically significant at the 1% level.

Positive autocorrelation of the returns implies a predictability in returns. For example, following positive average returns, we would anticipate positive average returns in the future. In Panel B, we note that return autocorrelations are high for some countries in the sample. Brazil, India, New Zealand, and the USA show positive first order autocorrelation (above

10%). This could be because of investors decisions to rebalance their portfolios due to fears of possible economic collapse following the spate of the lockdowns being instituted by various countries. Thus, many investors could have chosen to withdraw their investments from certain financial markets such as stocks and rather invest in safer bond markets. During crises foreign investors resort to “positive feedback strategies” and engage in herding as a result of the lack of information and uncertainty (Kim and Wei, 2002) which could be a plausible explanation for investor reactions during COVID-19.

Further, Vermeulen (2013) shows that during financial crises, investors actively rebalance their portfolios in favour of markets that have a low correlation with their existing invested market. As seen in Table 5, the correlation between many markets was high, for example, the USA and Brazil, Singapore and South Korea, and Italy and Sweden. This would, therefore, add credence to the abovementioned findings. With such high correlations, lack of information about COVID-19 and how economies could react would only add fuel to the herding mentality.

Table 5 Correlation matrix for stock returns

	Brazil	China	India	Italy	New Zealand	Russia	Singapore	South Africa	South Korea	Sweden	UK
China	0,27										
India	0,48	0,45									
Italy	0,67	0,28	0,51								
New Zealand	0,41	0,33	0,46	0,48							
Russia	0,41	0,23	0,40	0,62	0,44						
Singapore	0,49	0,57	0,71	0,53	0,58	0,35					
South Africa	0,63	0,47	0,58	0,71	0,59	0,61	0,68				
South Korea	0,34	0,54	0,58	0,37	0,48	0,26	0,82	0,60			
Sweden	0,65	0,36	0,50	0,84	0,48	0,62	0,59	0,74	0,41		
UK	0,69	0,35	0,54	0,84	0,52	0,68	0,58	0,78	0,46	0,88	
USA	0,79	0,27	0,39	0,69	0,38	0,42	0,43	0,64	0,28	0,70	0,74

4.1.2. Bond Market Yields

Table 6 presents a summary of daily bond yields for the 10-year government bonds for the respective countries. Panel B of the same Table highlights their autocorrelations. The high autocorrelation noted in the series could be as a result of the behaviour of investors during the COVID-19 market turmoil. Piljak (2013) finds that macroeconomic factors play an important role in explaining co-movement in bond returns over time. The research also postulates that macroeconomic factors have a “have a higher relative importance than global factors” in influencing co-movement. the correlation matrix in Table 7 shows, for example, a negative correlation between the UK and South Africa (-0.76). considering the local factors such as BREXIT for the UK and the Moody’s downgrades for South Africa were occurring during the same period as the COVID-19 ‘first wave’, it would seem like domestic factors, coupled with the global uncertainty around the pandemic could explain this relationship in bond yields.

With regards to the bond yields skewness measure, only Brazil, South Africa, South Korea and Russia exhibit negative skewness. This implies that many of the values in the series are lower than the mean. Brazil and South Africa are the only countries whose returns statistics are leptokurtic. The returns of the remaining countries are clearly platykurtic (Kurtosis<3). The p-value of the Jacque-Bera statistic is significant at the 1% and 5% levels for all the countries except Italy and Russia. For the remaining nations’ bond yields, we can reject the null hypothesis of a normal distribution.

The autocorrelations are high for all the countries being researched. There is positive first order autocorrelation and this persists to the 14th lag for all the countries. This implies a high level of predictability with daily bond yields.

Table 6 Descriptive statistics for bond yields

Panel A: Summary Statistics	**Mean**	**Std. Dev.**	**Skew**	**Kurt**	**Jarque-Bera**
Brazil	0,00019	0,00001	1,72341	7,73366	374,31***
China	0,00008	0,00001	-0,56707	1,90493	27,13***
India	0,00017	0,00001	-0,78581	2,75102	27,64***
Italy	0,00004	0,00001	0,25360	2,65906	4,08
New Zealand	0,00003	0,00001	-0,29886	2,30312	9,20***
Russia	0,00017	0,00002	0,25973	2,54727	5,18*
Singapore	0,00004	0,00001	-0,88793	2,30398	39,72***
South Africa	0,00023	0,00002	1,61934	4,85728	152,16***
South Korea	0,00004	0,00000	0,04308	2,26319	6,01**
Sweden	0,00000	0,00000	-0,66396	2,72157	20,10***
UK	0,00001	0,00001	-0,27866	1,77725	19,71***
USA	0,00004	0,00001	-0,51922	1,63302	32,17***

Panel B: Autocorrelation							
	ρ1	*ρ2*	*ρ3*	*ρ4*	*ρ5*	*ρ7*	*ρ14*
Brazil	0,936[a]	0,868[a]	0,813[a]	0,744[a]	0,689[a]	0,591[a]	0,321[a]
China	0,989[a]	0,978[a]	0,97[a]	0,962[a]	0,953[a]	0,934[a]	0,870[a]
India	0,964[a]	0,934[a]	0,903[a]	0,87[a]	0,836[a]	0,808[a]	0,685[a]
Italy	0,955[a]	0,901[a]	0,863[a]	0,823[a]	0,788[a]	0,701[a]	0,528[a]
New Zealand	0,968[a]	0,93[a]	0,903[a]	0,885[a]	0,865[a]	0,801[a]	0,643[a]
Russia	0,981[a]	0,954[a]	0,921[a]	0,888[a]	0,849[a]	0,772[a]	0,573[a]
Singapore	0,984[a]	0,966[a]	0,951[a]	0,933[a]	0,917[a]	0,881[a]	0,788[a]
South Africa	0,986[a]	0,97[a]	0,951[a]	0,928[a]	0,904[a]	0,850[a]	0,685[a]
South Korea	0,96[a]	0,924[a]	0,893[a]	0,864[a]	0,836[a]	0,773[a]	0,521[a]
Sweden	0,964[a]	0,919[a]	0,874[a]	0,82[a]	0,767[a]	0,671[a]	0,414[a]
UK	0,965[a]	0,929[a]	0,897[a]	0,865[a]	0,83[a]	0,770[a]	0,647[a]
USA	0,986[a]	0,97[a]	0,957[a]	0,945[a]	0,932[a]	0,899[a]	0,807[a]

[a] indicates that the autocorrelation is significantly different from zero. ***, **, * indicates that the reported value is statistically significant at the 1%, 5% and 10% level, respectively.

Table 7 Correlation matrix for bond yields

	Brazil	China	India	Italy	New Zealand	Russia	Singapore	South Africa	South Korea	Sweden	UK
China	-0,47										
India	-0,19	0,68									
Italy	0,52	-0,42	-0,41								
New Zealand	-0,30	0,72	0,66	-0,18							
Russia	0,42	0,23	0,50	0,08	0,36						
Singapore	-0,24	0,81	0,83	-0,38	0,85	0,60					
South Africa	0,62	-0,83	-0,49	0,47	-0,46	-0,02	-0,59				
South Korea	-0,22	0,37	0,36	-0,06	0,56	-0,13	0,36	-0,02			
Sweden	-0,13	0,15	-0,06	0,30	0,44	-0,37	0,03	0,04	0,67		
UK	-0,30	0,81	0,77	-0,24	0,91	0,36	0,89	-0,55	0,61	0,37	
USA	-0,39	0,91	0,80	-0,37	0,84	0,40	0,94	-0,76	0,40	0,17	0,92

4.2.Event Study

To examine how each country reacts to COVID-19 and its related announcements, cumulative daily stock returns and bond yield data are initially used to graphically illustrate the effects. In the first event studies, three events are taken into consideration: the date of first infection (yellow line), the date of first death (red line), and the country's initial lockdown announcement (blue line). The specific dates are tabulated in Table 1. Event study 2 looks at how three specific events affected each country. These include: the first announcement of lockdown in the Eurozone, more specifically in Italy on the 22nd of February 2020, the slashing of interest rates by the US Federal Reserve (Fed) on 15th March 2020 and finally the announcement on 9th April of a roll out of $2.3 trillion stimulus package by the Fed.

The initial part of the event study looking at cumulative returns is then followed by an analysis of average cumulative abnormal returns (ACAR) as stipulated in the methodology. The ACAR is calculated for the two significant events in event study 1 and 2.

4.2.1. Event Study 1-Emerging Markets

Similar to the results attained by Aizenman, Jinjarak, Lee and Park (2016), which found consistently negative effects on stock returns as a result of global crisis, this research finds that all emerging markets have their stock returns affected by the pandemic. Aizenman et al., (2016) also noted that, during the global financial crisis, that bond markets tended to be more resilient. This is explained by a flight-to-safety. This is that investors take greater positions in less risky assets during periods of turmoil. With all the stock returns in the emerging markets, we see that the significant fall in returns occurs between March and April 2020. This is important because it clearly shows that the first death announcements in each country was probably not the trigger of the fall in stock market fortunes. For example, with South Africa in Figure 5 and India in Figure 4, the change in return direction is either long after or long before the 1st death is reported.

Lockdown reports seemed to be the main contributor to uncertainty as seen with the sudden sharp drop in stock returns in China (Shanghai Composite) in Figure 5. Having been the first nation to announce lockdown and being the source of the pandemic, two significant declines are noted within the first three months of 2020. Following the initial lockdown announcement, the market seemed to absorb the information and we, therefore, see a similarly sharp rise in returns within the month of February. However, the pattern witnessed in all the other countries' returns is not lost on China. The significant decline that affected all the other markets in mid-March also affected returns on the Chinese stock index.

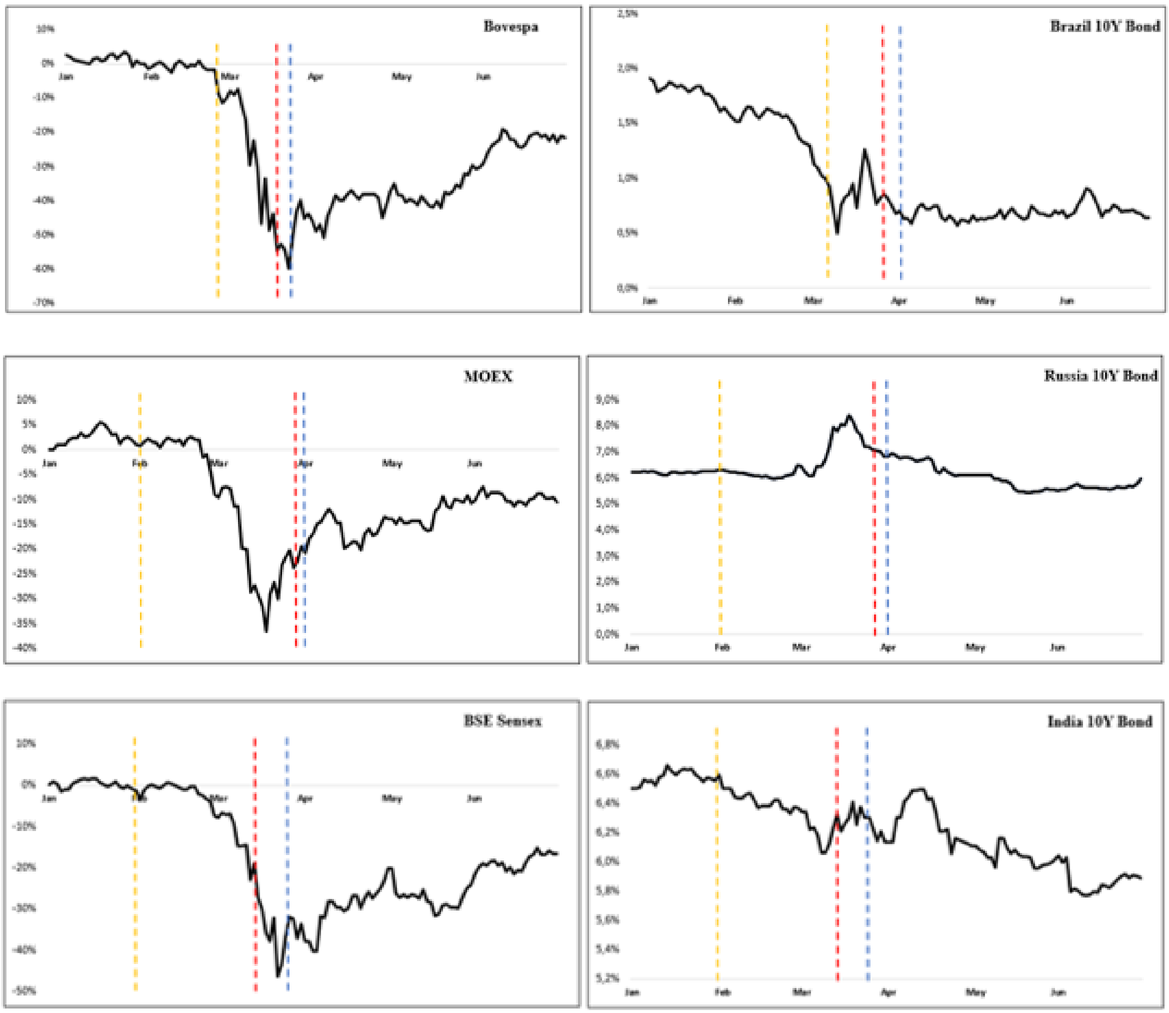
Country specific lockdown as a source of declined returns is, however, unsupported by the return declines in South Korea (Figure 5). South Korea never announced a lockdown, but this did not shield returns on the Korea Exchange as significant return losses are witnessed in spite of their decision to not announce a lockdown. This would, therefore, provide support to financial contagion playing a significant role in informing asset prices as the stock market rout during this period in all the countries occurred around the same period. the related events affecting the different markets is delved into in event study 2.

With regards to bond yields, Brazil, Russia, India, and South Africa all see significant fluctuations between March and April. However, it must be noted that Brazil and India were witnessing declines in bond yields even before any country specific announcements were made. South Africa and Russia see positive return effects during the main period of turmoil. This could signify investors reallocation of assets to more secure bonds. With the case of South Africa, the increase in risk premia following the announcement of an investment downgrade by Moody's on 23rd March would have also had a significant effect.

Li and Zou (2008) find relatively small volatility in China's Treasury bond returns as a result of macroeconomic policy and information shocks. This could be part of the reason why we do not see significant changes in the Chinese bond market yields. Further, China's fixed income securities have, in the recent past, offered attractive real yields compared to many of its global counterparts[44]. The continued demand for these securities could be another reason why a significant shock to returns is not witnessed.

[44] https://www.ubs.com/global/en/asset-management/insights/china/2019/china-2020-market-outlook.html [Accessed: 10.11.2020]

Figure 4 Cumulative daily stock and bond yields (Brazil, Russia, India)



The yellow lines refer to the first COVID-19 infection in the country. The red line refers to the first death and the blue line represents the initial lockdown announcement.

Figure 5 Cumulative daily stock and bond yields (China, South Africa, South Korea)

The yellow lines refer to the first COVID-19 infection in the country. The red line refers to the first death and the blue line represents the initial lockdown announcement.

Average cumulative abnormal returns

Based on the initial study above, the research further analyses the average cumulative abnormal returns to understand the effect of first infection (Figure 6 and 7) and the lockdown (Figure 8 and 9). ACAR is calculated using the average cumulative abnormal returns of the emerging market countries' during a particular event window. For this study, an event window of 16 days has been chosen (-10,0,5); 10 days prior to the event and 5 days after the event date. The shorter windows are chosen due to the closeness of other related COVID-19 events that, if a longer window were chosen, could distort the results. Further, the lockdown calculation of ACAR for the emerging markets does not include returns of South Korea, as they never instituted lockdown measures.

The average cumulative abnormal returns when testing for the effect of *first infection* of 0.4% for bond yields (Figure 6) and -1.4% for stock returns (Figure 7) are statistically significant at 1% (using a t-test). With stock returns, the decline in abnormal returns begins a day before the announcement. This could speak to the uncertainty of the effects of the virus beginning to affect investors as they began to hear news of infections in other countries. Bond yields appear to be less sensitive to first infection announcement than stock returns. This is likely due to the continued demand for fixed income due to them providing attractive real yields as well as investors seeing them as safer and more secure assets during periods of turmoil.

Figure 6 Average cumulative abnormal returns (bond yields) -1st infection

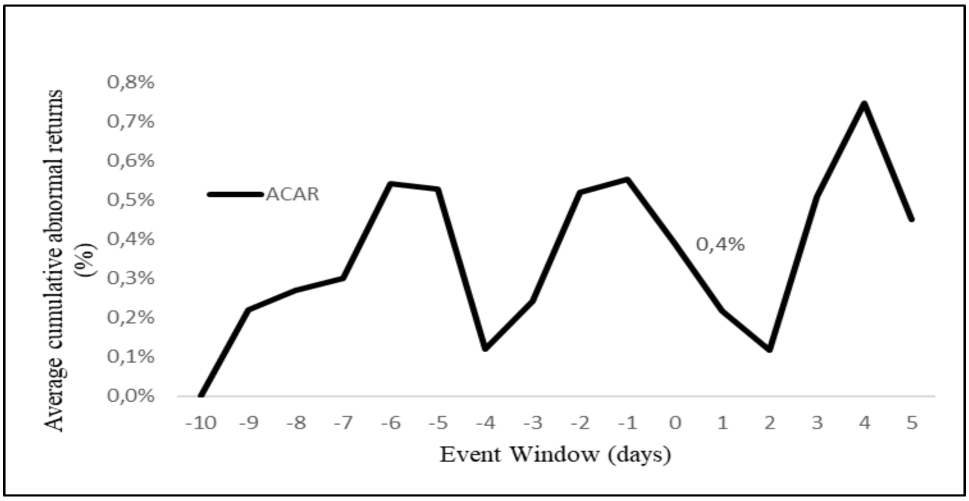
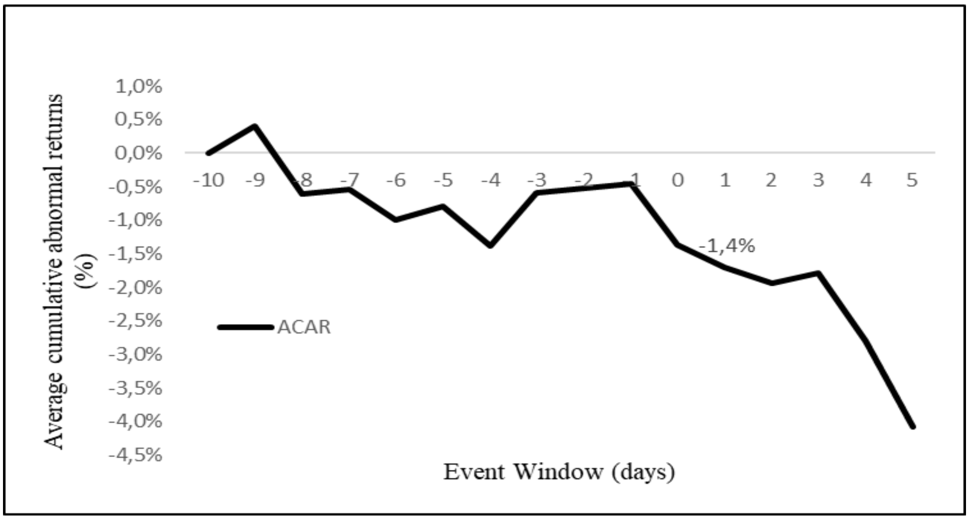


Figure 7 Average cumulative abnormal returns (stock returns) -1st infection



The average cumulative abnormal returns as a consequence of *lockdown* are shown below in Figure 8 and 9. The abnormal returns for both stocks and bonds are statistically significant at 1% (using a t-test). Under this event, and consistent with our anecdotal observations (see the descriptive statistics section), both abnormal bond yields (-3.3%) and stock returns (-4.6%) are negative. The negative effect on bond yields in emerging markets was possibly because the lockdown announcements may have triggered rebalancing of portfolios by investors, shorting equities and replacing them with long positions in bonds – causing an increment in bond prices. However, it is important to notice that the initial reaction to the announcement of lockdowns was an increment in bond yields of 1.8% (significant at 1% using a t-test), consistent with the observation that investor sentiment falls during periods of turmoil, resulting in divestments (Kräussl, 2005).

Figure 8 Average cumulative abnormal returns (bond yields) -lockdown

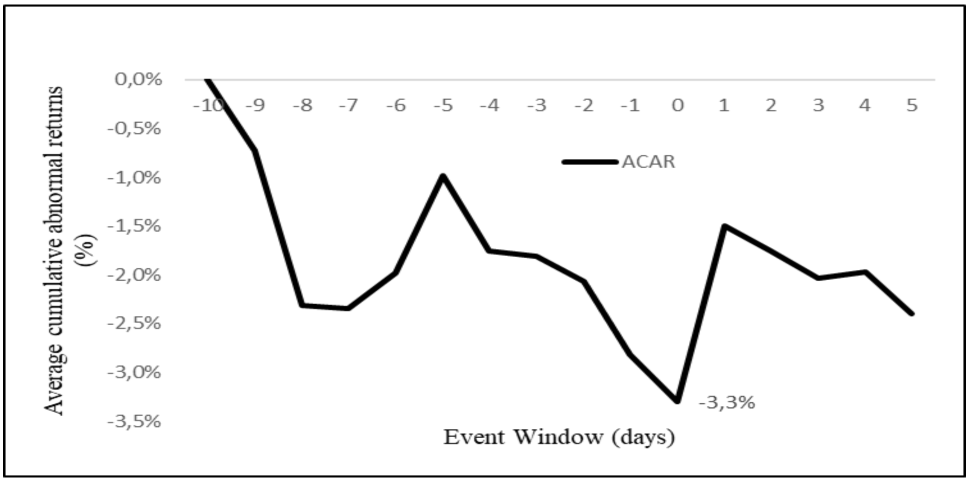
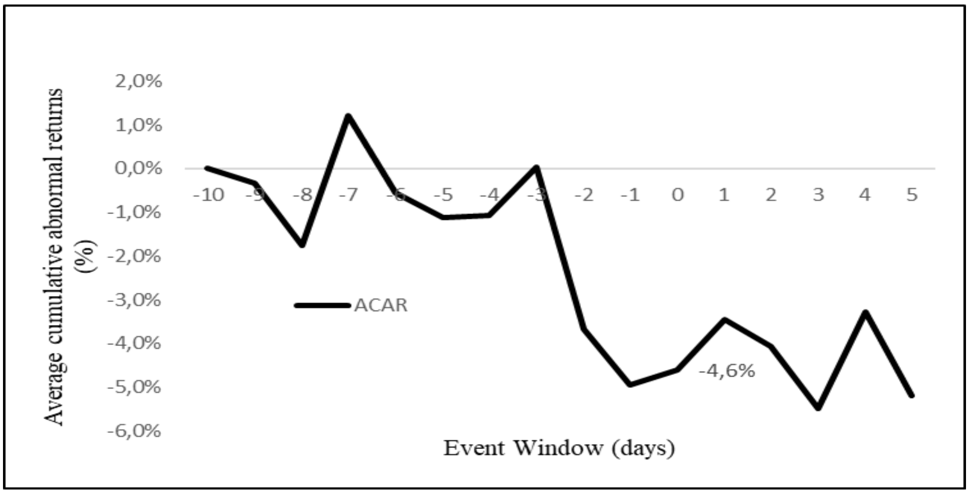


Figure 9 Average cumulative abnormal returns (stock returns) -lockdown



4.2.2. Event Study 1-Developed Markets Study

Figure 10 and 11 show the cumulative daily bond and stock returns of developed markets. The announcement of a lockdown in Italy had immediate consequences as the FTSE MIB (Figure 10) returns plummeted. This announcement presented the Eurozone and the rest of the world with the possible severity of the crisis. Unlike the non-significant contagion effects of the eurozone crisis (Aizenman et al., 2016), the announcement was one of the triggers that resulted in the market volatility witnessed in the following months.

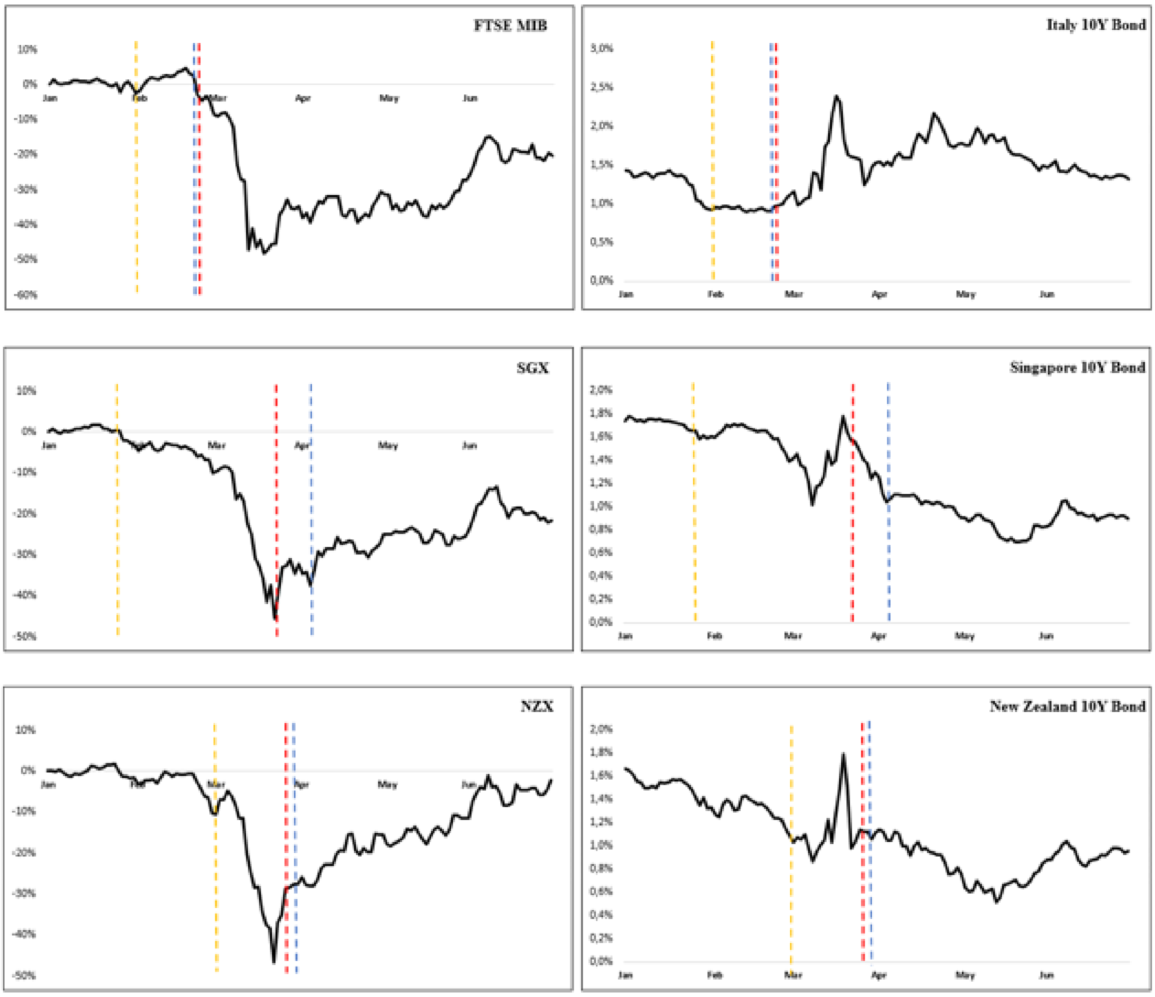
Italy's management of the crisis was significantly different from that of New Zealand. Though New Zealand's initial lockdown and first death announcements are later, we see a sharp increase and similarly sharp decline in yields in a significantly short period. This could speak to the confidence regained in the market as a result of the highly heralded management of the crisis[45].

Sweden (Figure 11), early on, made a decision to not have any lockdowns. This decision does not seem to have negatively impacted their returns as it had a similar V-shaped stock returns graph as that of other nations that did institute lockdown measures. This, therefore, supports a notion that herd behaviour rather than market efficiency may have had a larger influence on investor decision-making as a result of uncertainty rather than policy measures that were being instituted as a result of COVID-19 such as lockdowns.

Though shocks are witnessed with regards to bond yields, they generally appear to continue on the pre-COVID-19 trajectory. For all the countries, sharp spikes are seen between March and April, however, we see a return to the previous trajectory in a much shorter period than that of stocks. This highlights the investment decision to safeguard returns through bonds due to their relative return consistency.

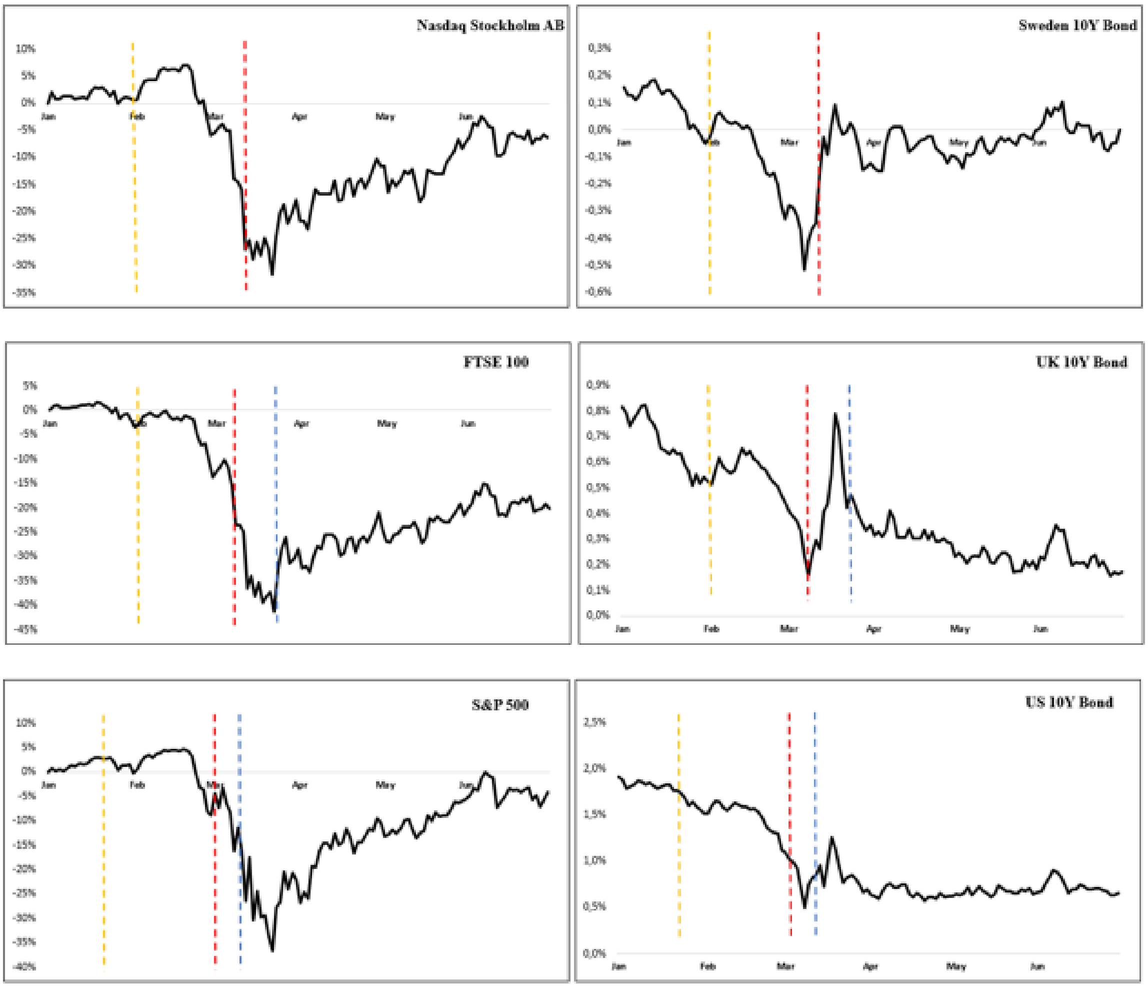
[45] https://www.who.int/westernpacific/news/feature-stories/detail/new-zealand-takes-early-and-hard-action-to-tackle-COVID-19 [Accessed: 11.11.2020

Figure 10 Cumulative daily stock and bond yields (Italy, Singapore, New Zealand)



The yellow lines refer to the first COVID-19 infection in the country. The red line refers to the first death and the blue line represents the initial lockdown announcement.

Figure 11 Cumulative daily stock and bond yields (Sweden, UK, USA)



The yellow lines refer to the first COVID-19 infection in the country. The red line refers to the first death and the blue line represents the initial lockdown announcement.

Average cumulative abnormal returns

The abnormal returns for the developed markets, as a result of the first infection, were 0.9% for bonds (Figure12) and -2.7% for stocks (Figure 13). These results are both statistically significant at 1% (using a t-test). The positive returns in bonds in comparison to stocks does support the notion of reallocation of funds and portfolio rebalancing during the period of uncertainty. The ACAR calculations for bonds and stocks for developed markets exclude those of Sweden with regards to the lockdown as Sweden, like Korea, did not institute any lockdown measures. Prior to the 1st infection announcement, fear had already begun to grip investors as we see that stocks had already began to slump. We also see an upward trend in bond yields as a result of the coronavirus fears.[46]

Figure 12 Average cumulative abnormal returns (bond yields)- 1st infection

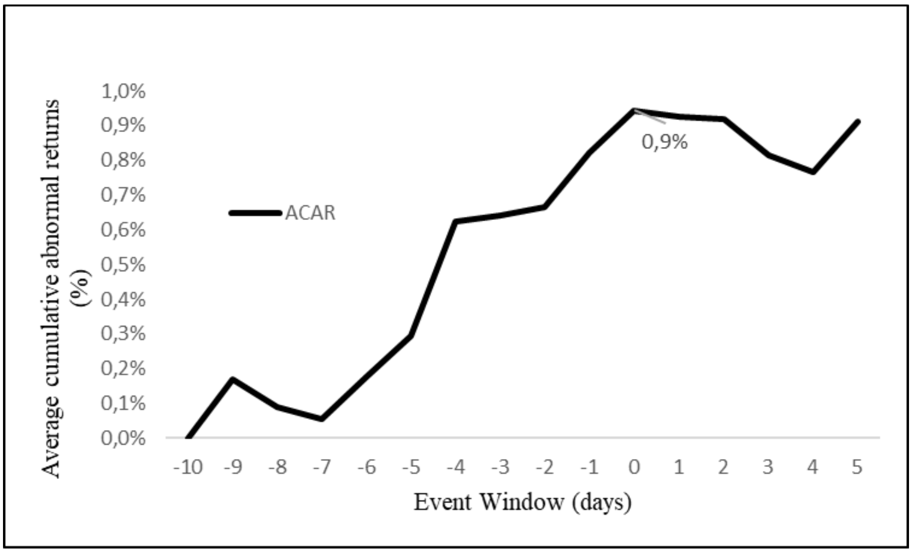
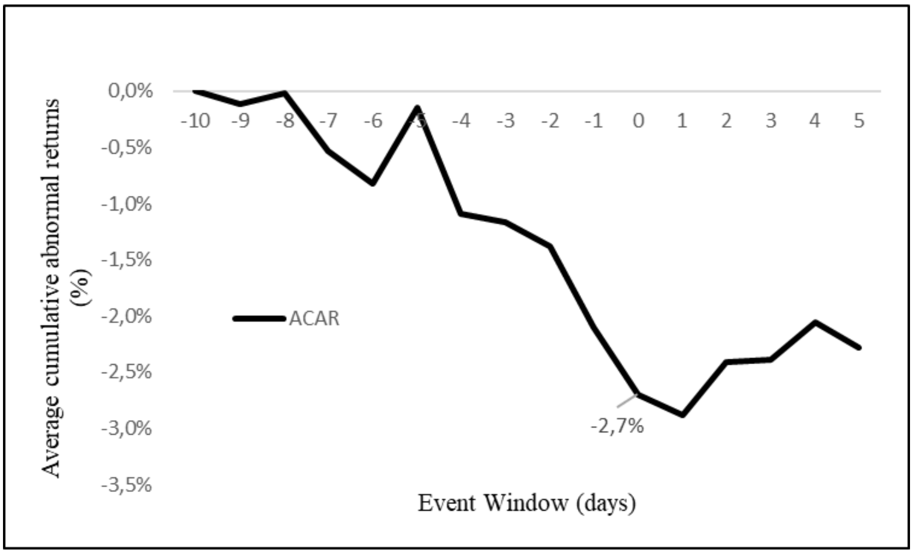


Figure 13 Average cumulative abnormal returns (stock returns)- 1st infection



Average cumulative abnormal bond yields rose by 2.2% in the ten days leading up to the lockdown announcement (Figure 14). For, stocks, we see a decline of -8% in abnormal returns during the same period (Figure 15). This is also significantly higher than the effect of the first infection noted above (-2.7%). This shows that lockdowns had a significant effect on returns in developed markets. Unlike the effect in emerging market of negative returns on

[46] U.S. Futures Dip as Virus Spreads; Treasuries Rise: Markets Wrap (bloombergquint.com) [Accessed: 24.12.20]

bonds (Figure 8), we see that abnormal returns are positive in developed markets. This relationship highlights the decision by investors to rebalance portfolios with much safer assets such as bonds during financial crises (Vermeulen, 2013).

Figure 14 Average cumulative abnormal returns (bond yields)- lockdown

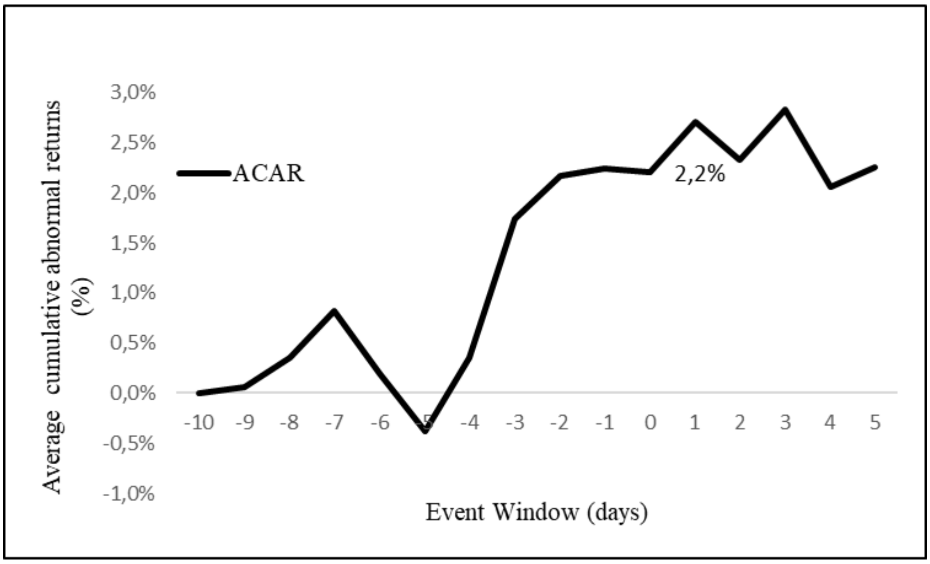
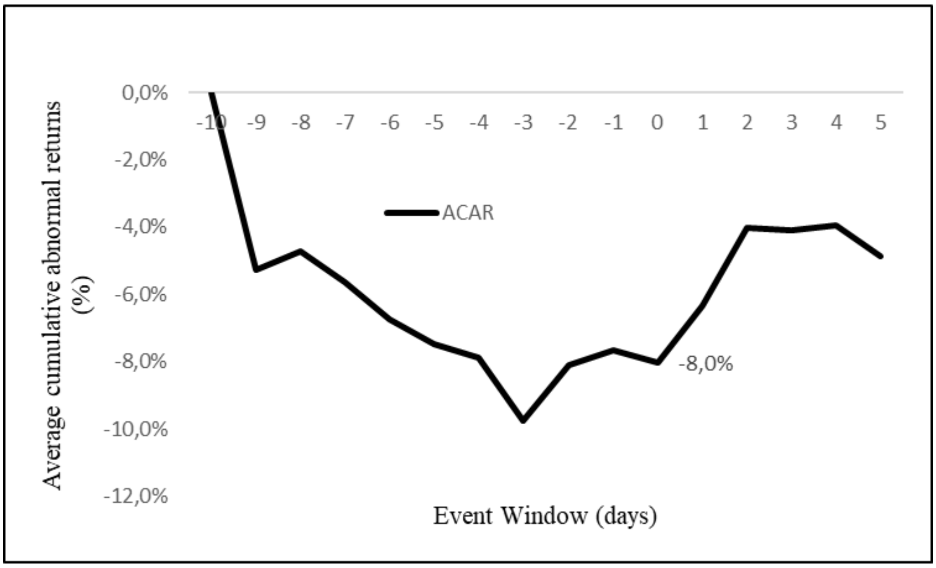


Figure 15 Average cumulative abnormal returns (stock returns)- lockdown



4.2.3. Event Study 2- Material COVID-19 Related News and Policy Announcements

For financial contagion to be seen as evident, a particular event must occur in one country and this event should then have a “disruptive” effect on other markets. If, however, investors draw their capital from other countries that are experiencing the same problem, which in this case would be represented by COVID-19 and subsequent policy decisions in their individual countries, then this would be termed as a demonstration effect rather than contagion (Yago, 2003). The event study below (Figure 16) rules out the demonstration effect and fails to reject the null hypothesis of financial contagion. This is, however, much more visible in stock market returns.

The announcement of the initial lockdown in Italy does not seem to have had demonstrable effect on bond markets, both in emerging and developing markets. In fact, the announcement by the Fed to slash interest rates resulted in much more significant volatility in the bond markets in developed countries, with Italy having the greatest upward spike in yields. In search of safety, investors are expected to invest in government bonds. However, the pandemic has shown that the inverse relationship did not hold as investors put their funds into assets such as gold. Another factor is that many investors pulled their funds out of stocks at large and placed them into specific stocks known as FAANGs (Facebook, Amazon, Apple, Netflix and Google)[47].

For the emerging markets, only Brazil and Russia show significant jumps. These jumps appear to be affected by other factors outside the Fed decision as they appear to peak after the announcement. So, with bond yields, financial contagion seemed to have greater effects on other developed countries, having originated in the USA, but did not have a significant effect on emerging market bond yields.

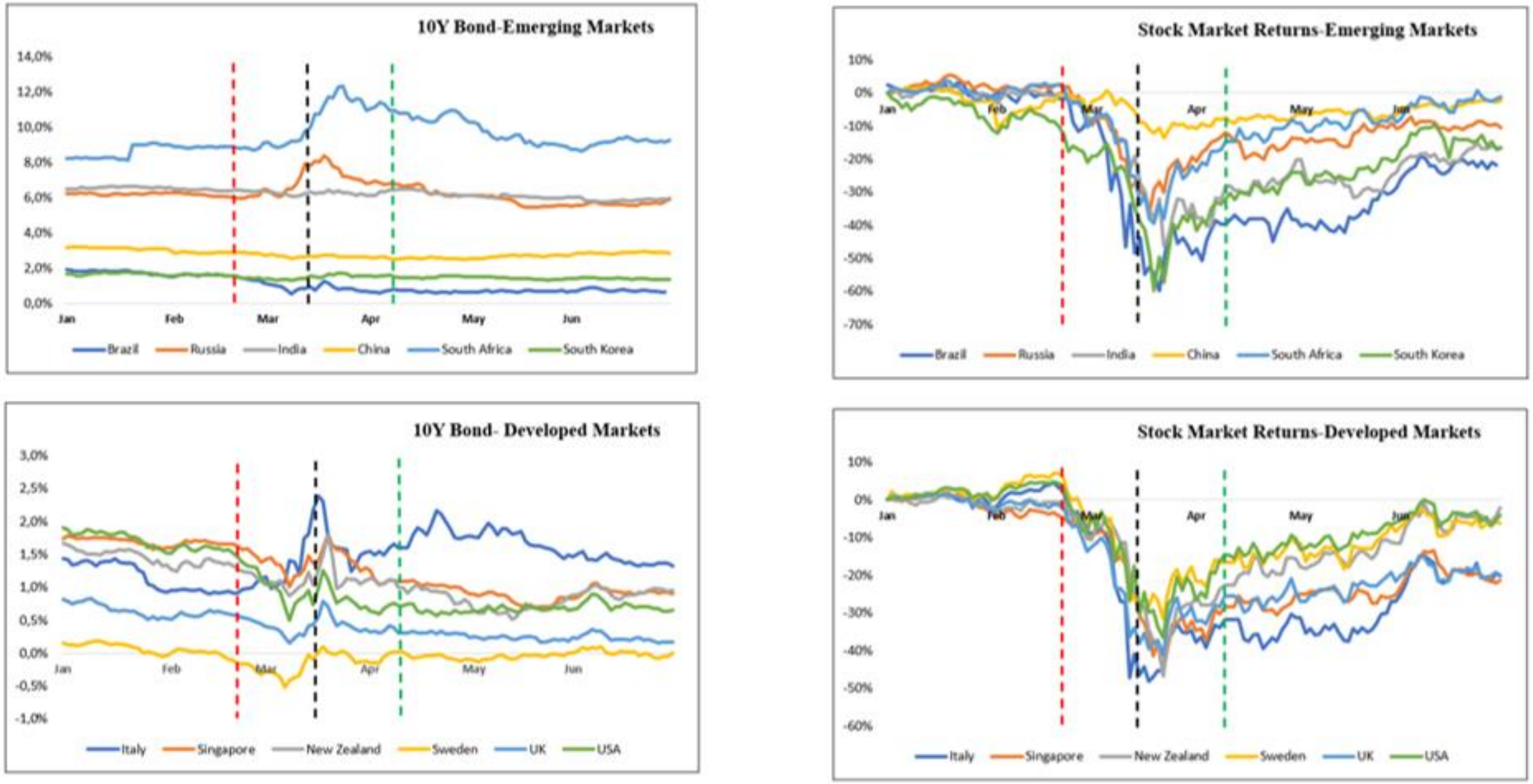
As evidenced from the Stock Market Return-Emerging Markets graph (Figure 16), following the lockdown announcement in Italy, all the stock markets exhibit major declines. As the virus originated from China, assumptions could be made that the decline in stock returns originated from there. This is easily refutable. The Wuhan lockdown on 23rd January only significantly affected returns on the Shanghai Composite and is why China experienced structural breaks earliest in the pandemic (Gunay, 2020). The evidence of the insignificance of the Wuhan lockdown on other markets is further supported by Gormsen and Koijen (2020) as they showed how the S&P500 and the EuroStoxx 50 continued to exhibit positive returns up until the announcement of a lockdown in Italy.

Italy seemed to be the source of the volatility that resulted in the decline of stock market returns globally and it is on this premise that further test using ACAR is done below. The US

[47] Prepping portfolios for next market storm? Not just gold and govvies | Reuters [Accessed: 24.12.20]

Fed announcement of their decision to adjust interest rates resulted in an upward turn of markets globally. Following the announcement both emerging and developed markets alike, exhibited positive returns. As the announcement regarding the stimulus package was in line with the earlier decision by the Fed, the market continued to react positively and thus further affected returns positively. Based on this, the Fed decision is the second event tested using average cumulative abnormal returns in both developed and emerging markets.

Figure 16 Comparative study of cumulative bond yields and stock returns



The red line represents the initial announcement of lockdown in Italy on 22nd February 2020. The black line represents the announcement by the FED to adjust interest rates and the green line represents the announcement of the USD2.3trillion stimulus package.

Average abnormal cumulative returns

Figure 17 and 18 represent ACAR results for stocks and bonds in emerging markets (EM) while Figure 19 and 20 are the ACAR results for the financial assets in developed markets (DM). For the abnormal returns in bond markets (Figure 17 and 19) the returns are statistically significant at 1% (using a t-test). However, this is not the case for the results of the stock returns as they are statistically insignificant. Though Armitrage (1995) does caution that there is a likelihood of insignificant abnormal returns if the returns exhibit significant cross correlation over time, we take this result to mean that, though the results show that on day zero (the announcement date) abnormal returns do plummet, with -5.2% with 5 days of the event for emerging markets and -5.1% in developed markets, the actual lockdown event did not cause the stock market declines but rather the herding behaviour in different markets as a result of uncertainty.

With bond yields, we do see a rise to 1.3% in emerging markets (Figure 17) and -0.6% in developed markets (Figure 19). Following the announcement however, we see a sharp increase in abnormal returns in the developed markets and for emerging markets, they seem to peak at day zero and begin to decline immediately after that. Once again, this seems to speak to the effect of rebalancing in developed markets and flight to safety from emerging market assets with the implied risk of uncertainty.

Andritzky, Bannister and Tamirisa (2007) postulate that where there is transparency and understanding, announcement effects tend to matter less to investors. With the uncertainty around the virus, China's secrecy[48], and the uncertainty of how emerging markets would handle the virus we see an increase in yield to 1.3% (Figure 17) on the day of the announcement. Following the announcement, we see abnormal returns begin to decline from the peak at day 0. This is consistent with the flight to safety assumption as investors flee to bond markets for better returns and to safeguard portfolio returns.

[48] China's Secrets and Lies turned COVID-19 Into a Global Threat | U.S. Embassy & Consulates in the United Kingdom [Accessed: 08.12.2020]

Figure 17 Average cumulative abnormal returns (bond yields) for EM - Italy lockdown

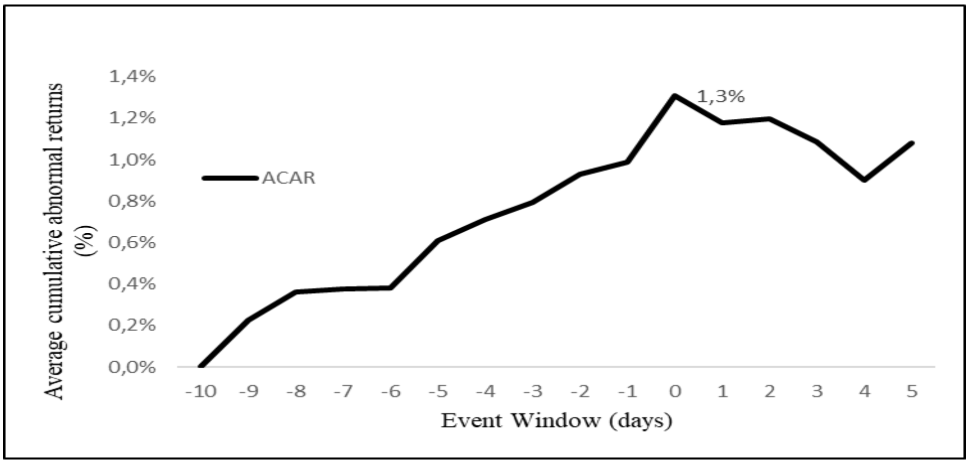


Figure 18 Average cumulative abnormal returns (stock returns) for EM -Italy lockdown

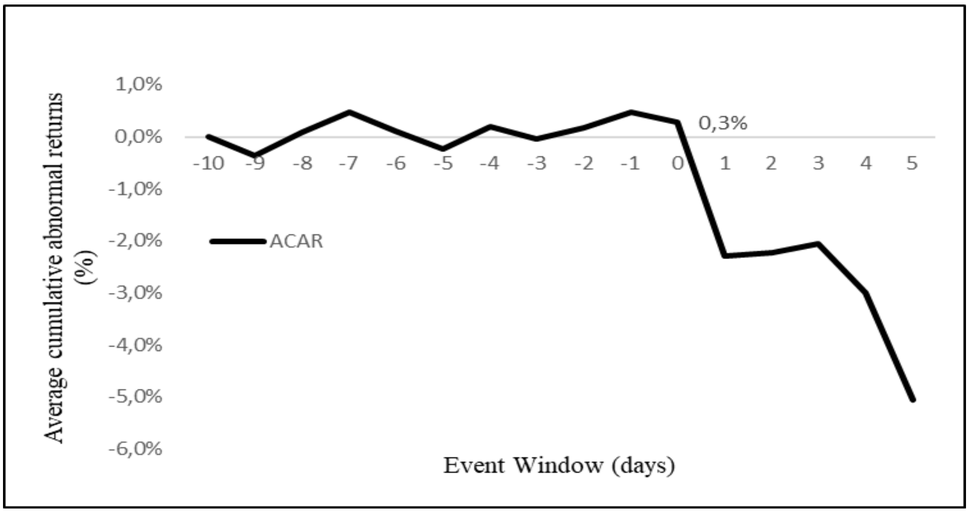


Figure 19 Average cumulative abnormal returns (bond yields) for DM - Italy lockdown

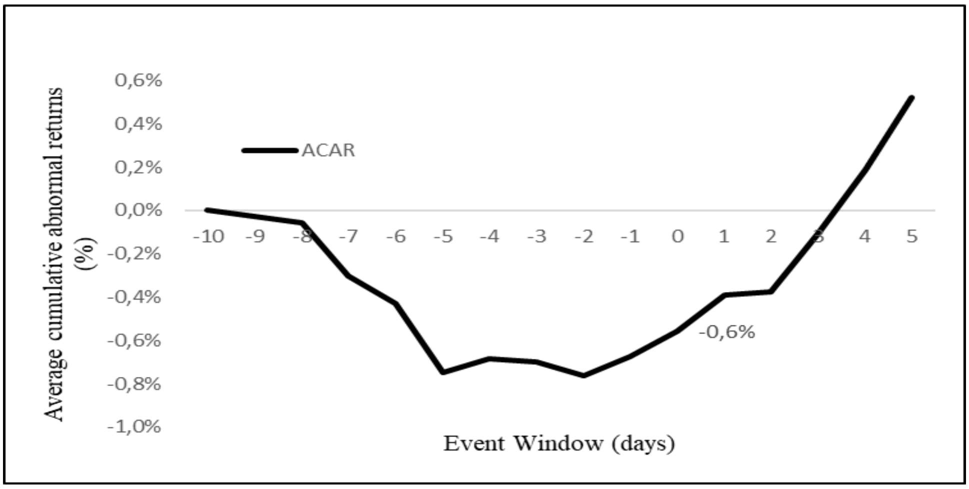
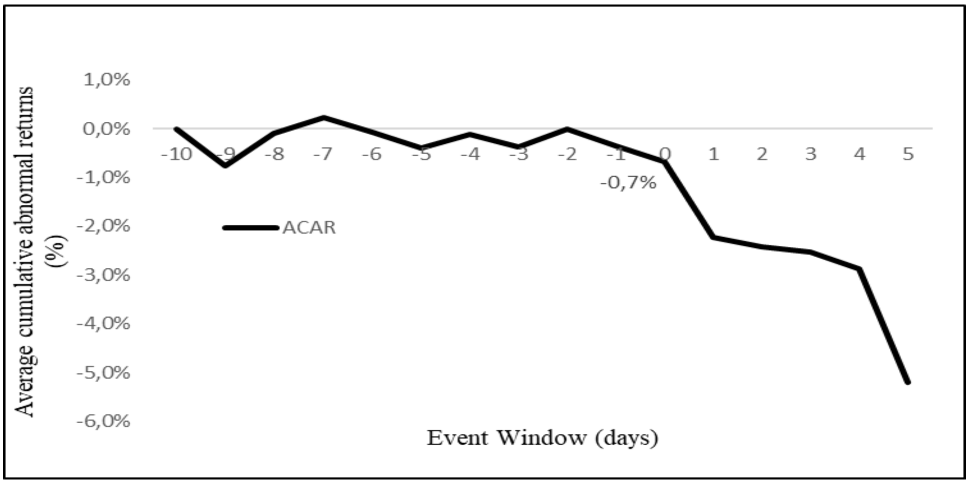
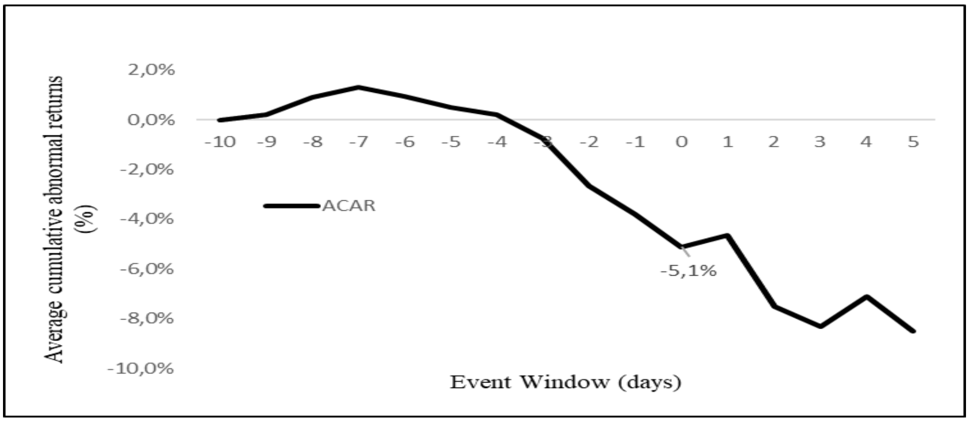


Figure 20 Average cumulative abnormal returns (stock returns) for DM -Italy lockdown



Figures 21 to 24 represent the ACAR results following the Fed announcement regarding the slashing of interest rates. Figure 21 and 22 show the ACAR results in emerging markets for bonds (-5.1%) and for stocks (-8%) whilst Figure 23 and 24 show the cumulative abnormal returns for bonds (0.9%) and stocks (-12.6%) in developed markets. All the results are statistically significant at 1% (using t-test). The results all show that the volatility around this announcement began days before the announcement was actually made. In anticipation of the announcement, investors already began to react as news outlets and economists had already began to project what would be expected[49]. This does confirm that news of the announcement did impact returns for both financial assets in emerging and developed markets.

Figure 21 Average cumulative abnormal returns (bond yields) EM -Fed Announcement



[49] Fed to cut rates again in March, but effectiveness challenged: Reuters poll | Reuters [Accessed: 08.12.2020]

Figure 22 Average cumulative abnormal returns (stock returns) EM -Fed Announcement

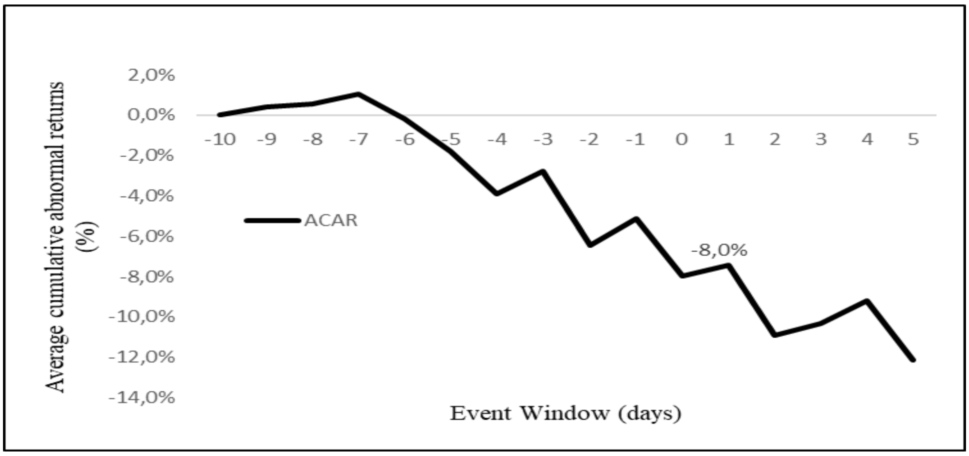


Figure 23 Average cumulative abnormal returns (bond yields) DM-Fed Announcement

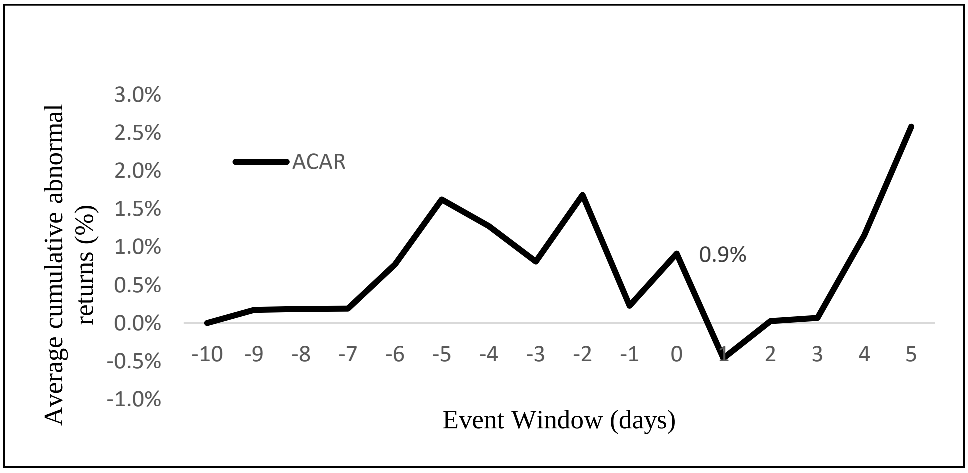
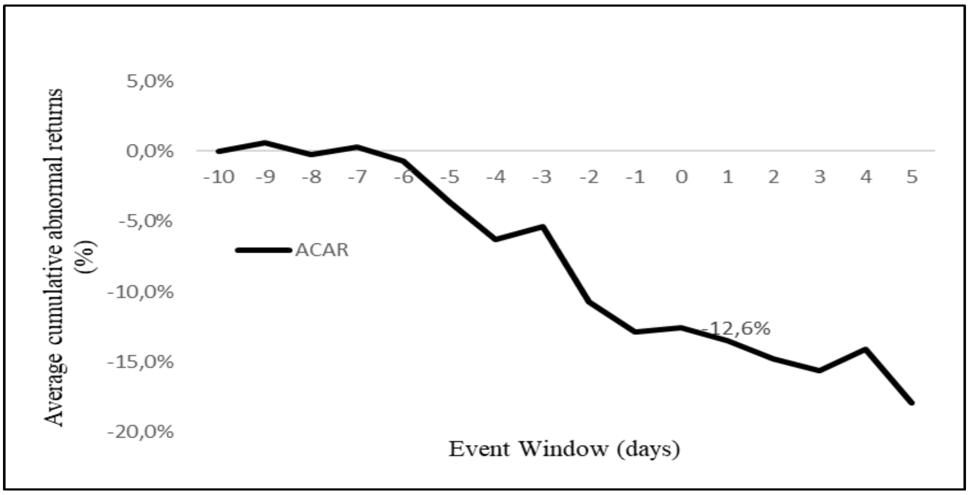


Figure 24 Average cumulative abnormal returns (stock returns) DM-Fed Announcement



4.2.4. Summary of Results

The first event study observed how 3 country-specific events affected each country. These events included the date of first infection, the date of first death, and the countries' initial lockdown announcement. The initial part of the event study, which uses the daily cumulative returns, is first observed on the emerging market countries. Using the graphs, the first infection and initial lockdown announcements are then further analysed using average cumulative abnormal returns.

As a result of first infection being reported, abnormal returns for bonds and stocks in emerging markets were 0.4% and -1.4%, respectively. The bond yields appeared to be less sensitive than stocks following the first infection announcement, most likely due to investors seeing them as safer assets during the specific period. The abnormal returns for developed markets had more significant effects with 0.9% abnormal returns for bond yields and -2.7% returns for stocks. This result opposes the theory that during periods of uncertainty bond yields have a negative relationship with stock returns (Stivers and Sun, 2002) as investors did not flee from stocks to bonds. The lockdown results for developed markets tell a different story overall, with regards to the negative relationship of stocks and bonds during turmoil, with abnormal returns in bonds up 2.2% and stocks down 8% as this highlights that bonds were not seen as safe haven asset following the lockdown announcement. However, the flight-to-safety phenomenon is evident in emerging market bonds as a result of the lockdown. The bonds exhibited negative abnormal returns of -3.3%. The first event study, therefore, highlights the significant effect that announcements of infections and lockdowns had on the market.

Event study 2 looked at 3 announcements and how they affected all the countries collectively. These events included the first lockdown announcement in the Eurozone area, in Italy, the slashing of interest rates by the Fed, and the announcement of the $2.3 trillion stimulus package. Further investigations of the effect of the first lockdown in Italy and the slashing of interest rates by the Fed are then done using average cumulative abnormal returns.

When observing the effect of the first European lockdown in Italy, we also see the negative relationship between stocks and bonds during the periods of uncertainty. However, the results for the abnormal returns for stocks in developed and emerging markets are not statistically significant, therefore, ruling this out as the source of the market volatility in the stock market. With regards to the Fed announcement, all the ACAR results show that volatility began days before the announcement was made. This shows that investors had already began to react to news of the impending announcement in anticipation with emerging markets assets seeing financial asset declines in both bond yields (-5.1%) and stocks (-8.0%).

This shows that herding rather than market efficiency was driving market behaviour and therefore, not supportive of the semi-strong form market efficiency as postulated by Fama (1970).

4.3.Regression Results

The regression results presented in the following tables are predictive in nature. This is because the regression makes use of lagged values of the independent variables as regressors. The current values of the dependent variables are regressed against lagged values of the independent variables. If the relationship between the dependent variable and the specific independent variables is statistically significant (1%, 5% and 10% levels), then it can be inferred that the known values of the regressors inform future values of the dependent variable.

R-squared is a goodness of fit statistic. It enables us to measure how well the specific regression model fits the data. That is, how well the independent variables explain the variations in the dependent variable. A model where R-squared is closer to 1 show that the model explains nearly all the variability of the dependent variable about the mean. The opposite is true if R-squared is closer to 0 (Brooks, 2014).

4.3.1. Empirical Results of Regression Analysis Using OLS

Table 8 shows an OLS regression with stock returns as the dependent variable. Infections of COVID-19 ($COVID19_{inf}$) are only statistically significant for New Zealand and the USA at 1% and 5% levels, respectively. This shows that the number of infections, whether rising or falling, was not a defining factor in determining stock market returns for most of the countries researched. With regards to New Zealand, its management of the pandemic[50] which resulted in them "crushing the curve" would be one of the major reasons for significant relationship between the stock market returns and the number of infections. The coefficients being positive mean that an increase in COVID-19 infections would result in an increase in returns. This is in direct conflict with research done earlier in the pandemic (Ashraf, 2020) that found that infections were negatively related to stock returns. One reason for the differing conclusions could be that their research periods ended in mid-April 2020 which, as seen from the events study above, was during the beginning of the stock markets V-shaped recovery.

Returns on oil as measured by X_{wti} highlights that the volatility in the oil markets was the second most significant factor affecting returns as seen by the coefficient estimates of Brazil (-0.19), Singapore (0.22),

[50] https://www.who.int/westernpacific/news/feature-stories/detail/new-zealand-takes-early-and-hard-action-to-tackle-COVID-19 [Accessed: 11.11.2020]

and South Korea (0.24). However, the R-squared values are low for the majority of the models with China and Italy recording the lowest (5%). This shows that the independent variables do not provide high return predictability for stock returns. With regards to China, it should also be noted that no Treasury bill data is available for the period under research in order to compute its liquidity spread.

Table 8 Regression of stock returns on COVID-19 (Form-Infections) and other variables

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	*COVID19$_{dth}$*	X_{qs}	X_{ls}	X_{br}	X_{ex}	X_{wti}	R^2
Brazil	0,36	0,01	0,55	0,14	-0,03	-0,04	-0,19*	0,13
	(0.47)	(1.59)	(1.57)	(0.43)	(-0.13)	(-0.33)	(-1.92)	
China	0,69	0,001	0,01		-0,14	0,16	0,08	0,04
	(0.87)	(0.43)	(0.09)		(-0.95)	(1.57)	(0.94)	
India	0,66	0,11*	0,15	0,11	0,35	-0,09	0,126	0,09
	(1.04)	(1.67)	(1.24)	(0.71)	(1.20)	(-0.77)	(1.29)	
Italy	-1,06*	-0,002	-0,42	0,15	0,41	0,09	0,10	0,05
	(-1.71)	(-0.22)	(-1.51)	(0.42)	(1.25)	(0.79)	(1.01)	
New Zealand	-0,43	0,11***	0,07	0,04	-0,65**	0,02	0,10	0,15
	(-0.46)	(2.68)	(0.54)	(0.19)	(-2.35)	(0.16)	(0.94)	
Russia	-0,82	0,01	-0,53*	-0,03	0,65**	-0,03	0,15	0,08
	(-0.25)	(0.69)	(-1.72)	(-0.16)	(2.12)	(-0.28)	(1.45)	
Singapore	-0,24	0,002	-0,02	-0,04	0,07	0,25**	0,22**	0,10
	(-0.31)	(0.65)	(-0.15)	(-0.40)	(0.31)	(2.30)	(2.32)	
South Africa	-1,42*	0,01**	-0,01	0,53	0,48	0,09	0,11	0,18
	(-1.71)	(1.92)	(-0.02)	(1.59)	(1.08)	(0.70)	(1.08)	
South Korea	0,287	0,042	0,14	0,32	0,30	0,08	0,24***	0,14
	(0.45)	(0.65)	(0.96)	(1.55)	(1.46)	(0.80)	(2.65)	
Sweden	0,284	-0,001	0,06	0,07	0,40	-0,08	-0,07	0,06
	(0.35)	(-0.39)	(0.38)	(0.09)	(0.63)	(-0.75)	(-0.71)	
UK	-1,43	0,0084	-0,17	0,11	0,08	0,19	0,04	0,07
	(-1.62)	(1.30)	(-1.43)	(0.71)	(0.35)	(1.56)	(0.38)	
USA	-2,24	0,01**	-0,42*	-0,41	0,57	-0,28**	-0,09	0,12
	(-1.41)	(2.25)	(-1.89)	(-1.35)	(1.47)	(-2.50)	(-1.03)	

The Table reports OLS estimation results and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses). *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The dependent variables are the daily stock returns of the respective countries main stock exchange. The explanatory variables include the lagged values of: COVID19$_{inf}$ representing the per million COVID infections, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{br} the daily bond yields, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. R^2 is the coefficient of determination.

The effects of COVID related deaths on stock returns are significantly different from those reported above that relate to number of infections. Deaths are only significant in one of the countries (Brazil) as affecting stock return variability. Of note, however, is how both deaths and infections do not significantly affect returns in China considering that it was the source of the pandemic.

Table 9 Regression of stock returns on COVID-19 (Form-Deaths) and other variables

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	*COVID19_{dth}*	X_{qs}	X_{ls}	X_{br}	X_{ex}	X_{wti}	R^2
Brazil	0,40	0,15**	0,43*	-0,10	0,13	0,02	-0,11	0,20
	(0.76)	(2.32)	(1.87)	(-0.42)	(0.78)	(0.31)	(-1.58)	
China	1,00	0,02	0,03		-0,20	0,15	0,07	0,04
	(1.12)	(0.29)	(0.25)		(-1.21)	(1.40)	(0.90)	
India	1,12	1,32	0,21	0,07	0,16	-0,07	0,12	0,09
	(1.34)	(1.08)	(1.53)	(0.33)	(0.55)	(-0.48)	(0.99)	
Italy	-0,99	0,01	-0,29	0,11	0,44	0,10	0,09	0,06
	(-1.46)	(0.21)	(-0.96)	(0.28)	(1.31)	(0.82)	(0.86)	
New Zealand	0,41	0,34	0,06	0,04	-0,11	-0,04	-0,10	0,02
	(0.25)	(0.31)	(0.19)	(0.13)	(-0.23)	(-0.11)	(-1.03)	
Russia	0,331	-0,417	-0,80*	0,01	0,92	0,01	0,00	0,08
	(0.11)	(-0.85)	(-1.79)	(0.10)	(1.45)	(0.09)	(0.01)	
Singapore	-1,927	-0,55	-0,44**	0,00	0,75**	-0,13	0,02	0,16
	(-1.37)	(-0.29)	(-2.43)	(0.01)	(2.55)	(-1.09)	(0.21)	
South Africa	-0,68	0,033	-0,63	0,06	0,70	0,10	0,07	0,06
	(-0.53)	(0.09)	(-0.53)	(0.23)	(0.66)	(1.06)	(0.82)	
South Korea	0,90	-1,82	0,17	0,11	0,56*	0,10	0,23**	0,16
	(1.09)	(-0.42)	(0.98)	(0.45)	(1.78)	(0.82)	(2.32)	
Sweden	-0,07	0,01	0,01	-0,43	0,00	-0,12	-0,14	0,05
	(-0.07)	(0.22)	(0.05)	(-0.56)	(-0.01)	(-1.16)	(-1.34)	
UK	-2,99	0,051	-0,30	0,28	-0,42	0,23*	-0,02	0,07
	(-1.45)	(1.07)	(-1.52)	(1.04)	(-0.87)	(1.73)	(-0.16)	
USA	-0,0288	0,082	-0,54*	-0,29	-1,29	-0,29**	-0,09	0,17
	(-0.02)	(1.05)	(-1.95)	(-0.51)	(-1.50)	(-2.19)	(-0.87)	

The Table reports OLS estimation results and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses). *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The dependent variables are the daily stock returns of the respective countries main stock exchange. The explanatory variables include the lagged values of: $COVID19_{dth}$ representing the per million COVID deaths, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{br} the daily bond yield, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. R^2 is the coefficient of determination.

Al-Awadhi et al., (2020) had earlier found that stock returns on the Hang-Seng and Shanghai Composite had been negatively affected by both COVID related deaths and infections. This research does not support their conclusion and the differing results are due to the time limitations of earlier research.

Though China had experienced structural breaks early in the pandemic as a result of deaths and infections, this negative relationship subsided over time, as seen by the research results in Table 9.

Table 10 uses the dummy variable to represent the first day in each country that COVID-19 infections were reported. It would, therefore, speak more to reports of infections rather than actual numbers reported and signify if reports and announcements of infections had a greater explanatory effect on stock returns than the daily reported numbers. This model, as well as all the other models using the dummy variable to follow, use time series data from 1st July 2019 to 30th June 2020. Reports of COVID-19 infections in this case, affected Brazil (-0.68) at a 1% significance level and affected South Africa (-0.49) but the coefficient estimate is not rejected only at a 10% significance level. The negative coefficients mean that reports of COVID-19 have a negative effect on returns.

Changes in exchange rates and oil prices had more significant effect on stock returns. Returns in China, Singapore and the USA all show a 1% level of significance with regards to the predictability of exchange rates on returns. Exchange rate appreciation gives a positive message to the market and as a result there is an increase in capital flows (Ahmad, Rehman and Raoof, 2010). The results in Table 10 are, therefore, supported by the literature as the Chinese Yuan and US Dollar were two of the currencies that generally strengthened during this period[51] and as a result probably saw increased capital flows to their respective stock markets.

Table 10 Regression of stock returns on COVID-19 (Form-dummy variable) and other variables

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	Intercept	$COVID19_{dum}$	X_{qs}	X_{ls}	X_{br}	X_{ex}	X_{wti}	R^2
Brazil	1,11**	-0,68***	0,35**	0,079	-0,06	-0,03	-0,15**	0,06
	(2.24)	(-2.74)	(2.02)	(0.88)	(-0.44)	(-0.41)	(-2.53)	
China	1,66*	-0,45	0,07		-0,24*	0,17***	0,07	0,05
	(1.83)	(-1.63)	(1.01)		(-1.86)	(2.80)	(1.13)	
India	0,87**	-0,20	0,15**	0,01	-0,05	-0,08	0,11*	0,05
	(2.06)	(-0.95)	(2.21)	(0.22)	(-0.49)	(-1.28)	(1.74)	
Italy	-0,31	-0,138	-0,13	-0,14	0,29**	0,03	0,09	0,03
	(-0.66)	(-0.62)	(-0.92)	(-1.01)	(1.99)	(0.53)	(1.47)	
New Zealand	0,256	-0,227	0,03	0,03	-0,15	0,12*	0,14**	0,05
	(0.58)	(-0.76)	(0.42)	(0.27)	(-1.31)	(1.95)	(2.27)	
Russia	0,39	0,149	-0,31**	-0,09	0,32**	-0,04	0,16***	0,05
	(0.46)	(0.87)	(-2.19)	(-1.32)	(2.05)	(-0.64)	(2.60)	

[51] http://www.oecd.org/coronavirus/policy-responses/COVID-19-and-global-capital-flows-2dc69002/ [Accessed: 11.11.2020]

Singapore	0,180	-0,241	0,01	-0,03	-0,08	0,19***	0,21***	0,09
	(0.36)	(-1.17)	(0.15)	(-0.44)	(-0.68)	(3.16)	(3.43)	
South Africa	0,048	-0,49*	-0,08	0,06	0,36	0,10	0,16***	0,07
	(0.11)	(-1.85)	(-0.26)	(0.46)	(1.58)	(1.61)	(2.66)	
South Korea	0,32	-0,25	0,04	0,11	-0,02	0,11*	0,26***	0,10
	(0.70)	(-1.25)	(0.49)	(0.92)	(-0.30)	(1.75)	(4.39)	
Sweden	0,12	0,03	0,03	0,11	-0,02	-0,02	-0,02	0,01
	(0.27)	(0.12)	(0.33)	(0.74)	(-0.13)	(-0.35)	(-0.28)	
UK	-0,68	-0,211	-0,11*	0,14*	-0,03	0,15**	0,05	0,04
	(-1.42)	(-0.91)	(-1.65)	(1.83)	(-0.32)	(2.39)	(0.82)	
USA	0,191	-0,34	-0,08	-0,01	-0,12	-0,20***	-0,08	0,06
	(0.24)	(-1.51)	(-0.73)	(-0.10)	(-0.79)	(-3.23)	(-1.35)	

The Table reports OLS estimation results and uses time series data covering the period 1st July 2019 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses). *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The dependent variables are the daily stock returns of the respective countries main stock exchange. The explanatory variables include the lagged values of: $COVID19_{dum}$ representing the dummy variable which takes the value of zero before the first infection and 1 after, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{br} the daily bond yields, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. R^2 is the coefficient of determination.

Table 12 represents regression results of bond yields with the COVID-19 variable being infections. Of note are the high R-squared values which are above 50% for all but China, New Zealand, South Korea, and the UK. This shows that the model explains nearly all the variability of the bond yields.

Table 11 Regression of bond yields on COVID-19 (Form-lagged Infections) and other variables

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	$COVID19_{inf}$	X_{qs}	X_{ls}	X_{sr}	X_{ex}	X_{wti}	R^2
Brazil	1,69	-0,008***	0,71***	0,31	-0,08	-0,04	-0,01	0,55
	(5.23)	(-3.82)	(5.07)	(1.66)	(-1.18)	(-0.61)	(-0.21)	
China	5,42***	-0,002	0,19***		-0,01	-0,01	-0,04	0,08
	(65.56)	(-1.03)	(3.05)		(-0.19)	(-0.19)	(-0.83)	
India	0,10	-0,19***	0,09**	-0,06	0,02	-0,02	-0,05	0,67
	(0.47)	(-13.11)	(2.30)	(-1.11)	(0.45)	(-0.41)	(-1.42)	
Italy	0,80***	0,02***	0,37***	0,53***	0,03192	-0,08**	-0,06**	0,83
	(4.35)	(9.62)	(4.45)	(5.66)	(0.99)	(-2.16)	(-2.07)	
New Zealand	-1,09***	0,06***	0,03	0,18**	-0,06429	-0,12**	-0,13***	0,31
	(-2.95)	(3.31)	(0.52)	(2.25)	(-1.35)	(-2.38)	(-3.12)	
Russia	3,51***	-0,01***	0,64***	-0,01	0,02	-0,01	-0,03	0,82
	(3.05)	(-3.86)	(7.34)	(-0.09)	(0.51)	(-0.26)	(-0.90)	
Singapore	0,83**	-0,01***	0,18***	0,05	-0,02	-0,14***	-0,04	0,58
	(2.62)	(-8.42)	(4.04)	(1.45)	(-0.60)	(-3.14)	(-1.02)	
South Africa	1,72***	-0,01**	1,19***	-0,31***	0,002	-0,03	-0,004	0,78

	(11.54)	(-2.53)	(11.82)	(-2.90)	(0.04)	(-0.65)	(-0.11)	
South Korea	-0,89***	-0,16***	-0,29***	-0,31***	0,03	0,01	0,05	0,38
	(-3.33)	(-6.58)	(-4.81)	(-3.58)	(0.84)	(0.29)	(1.16)	
Sweden	0,51***	0,002**	-0,03	1,02***	0,03	-0,03	-0,03	0,77
	(2.90)	(2.41)	(-0.61)	(15.78)	(1.17)	(-1.11)	(-0.91)	
UK	-1,33***	-0,01***	-0,13**	-0,21***	0,04	-0,07	-0,04	0,30
	(-3.74)	(-2.52)	(-2.48)	(-3.09)	(0.87)	(-1.42)	(-0.80)	
USA	3,64***	-0,01***	0,33***	0,08	0,02	0,03	-0,01	0,78
	(19.25)	(-11.90)	(7.45)	(1.05)	(0.84)	(0.97)	(-0.41)	

The Table reports OLS estimation results and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses). *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The dependent variables are the daily stock returns of the respective countries main stock exchange. The explanatory variables include the lagged values of: $COVID19_{inf}$ representing the per million COVID infections, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{sr} the daily stock returns, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. R^2 is the coefficient of determination.

COVID infections had a highly significant effect on bond yields. With Brazil for example, the quality spread as well as COVID infections had a 1% level of significance. This is supported by the fact that Brazil had major sale of bonds by non-residents as a result of the COVID-19 pandemic[52].

The effect of COVID infections and the quality spread on bond yield predictability is significant for the US, UK, Brazil, and India. This finding is consistent with the study of Thenmozhi and Nair (2014), who not only confirmed that macroeconomic variables significantly affect bond yields in developed markets such as the US and the UK but also found that their "explanatory power is relatively high" in emerging markets such as Brazil and India.

Given the flight to safety phenomenon earlier discussed in the research, it would be expected that the coefficients of COVID-19 for developed countries such as the UK and the USA should be negative. During periods of high volatility and uncertainty, stock returns and bond yields are expected to exhibit little relation and possibly even negative relation (Stivers and Sun, 2002). However, during COVID-19, investors sought safety in assets such as gold (Ji, Zhang and Zhao, 2020). Further to that, the shutdown of the economy for an indefinite period as evidenced by the initial lockdowns, resulted in high cash flow risk for investors. Investors who used leverage to have larger positions were faced with margin calls and therefore had to offload their most liquid assets, bonds[53].

[52] http://www.oecd.org/coronavirus/policy-responses/COVID-19-and-global-capital-flows-2dc69002/ [Accessed:11.11.2020]

[53] COVID-19 almost broke the bond market. Then the Fed stepped in. (jpmorgan.com) [Accessed: 08.12.2020]

When COVID-19 takes the form of deaths (Table 13) under bond yields, for the US and Brazil, a fall in the number of deaths results in a positive effect on future bond yields. This, however, is different from the results of Italy, South Korea, Sweden and the UK which have positive coefficients, with varying statistical significance, which, in essence, would mean that the increase in death rates positively affects bond yields. The striking thing to note here is how different the COVID-19 responses were for each of the 4 latter countries.

Table 12 Regression of bond yields on COVID-19 (Form-lagged deaths) and other variables

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	$COVID19_{dth}$	X_{qs}	X_{ls}	X_{sr}	X_{ex}	X_{wti}	R^2
Brazil	1,96***	-0,19***	0,79***	0,25	-0,26***	0,004	-0,02	0,61
	(5.63)	(-3.53)	(5.31)	(1.14)	(-2.89)	(0.05)	(-0.29)	
China	5,36***	-0,05	0,18***		-0,02	-0,02	-0,03	0,09
	(66.44)	(-1.35)	(3.28)		(-0.31)	(-0.35)	(-0.69)	
India	-0,41	-2,43***	0,08	-0,01	-0,02	-0,08	-0,09**	0,37
	(-1.20)	(-5.89)	(1.51)	(-0.11)	(-0.33)	(-1.33)	(-2.02)	
Italy	0,55**	0,08***	0,17	0,59***	0,04	-0,09**	-0,08**	0,68
	(2.47)	(5.92)	(1.62)	(5.45)	(1.07)	(-2.31)	(-2.05)	
New Zealand	1,04**	-0,52	0,41***	0,24**	0,05	-0,03	-0,05	0,67
	(2.18)	(-1.52)	(6.24)	(2.61)	(1.14)	(-0.89)	(-1.53)	
Russia	2,77***	-0,18	0,62***	0,08***	0,01	0,07**	-0,02	0,92
	(4.38)	(-1.56)	(12.71)	(3.49)	(0.26)	(2.39)	(-1.22)	
Singapore	-0,90	-0,32	0,07	0,036	0,01	0,03	-0,04	0,08
	(-1.67)	(-0.43)	(1.04)	(1.14)	(0.31)	(0.68)	(-1.01)	
South Africa	1,14***	-0,08	1,10***	-0,06	0,004	0,01	0,03	0,94
	(11.07)	(-1.06)	(21.67)	(-0.94)	(0.15)	(0.55)	(1.34)	
South Korea	-1,51***	6,12***	-0,13**	0,29***	-0,01	-0,07*	0,02	0,41
	(-6.47)	(4.73)	(-2.36)	(3.73)	(-0.18)	(-1.81)	(0.55)	
Sweden	0,66***	-0,02*	0,02	0,56***	-0,02*	-0,01	0,05	0,38
	(4.04)	(-1.69)	(0.63)	(5.54)	(1.73)	(-0.42)	(-0.71)	
UK	-3,10***	0,03***	-0,26***	0,05	0,0002	-0,06*	-0,07**	0,48
	(-9.93)	(2.89)	(-6.95)	(0.66)	(0.01)	(-1.70)	(-2.47)	
USA	1,23***	-0,04***	-0,04	0,027	0,01	0,04**	-0,02	0,35
	(5.42)	(-4.00)	(-1.06)	(0.35)	(0.61)	(2.33)	(-1.51)	

The Table reports OLS estimation results and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses). *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The dependent variables are the daily stock returns of the respective countries main stock exchange. The explanatory variables include the lagged values of: $COVID19_{dth}$ representing the per million COVID deaths, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{sr} the daily stock returns, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude;. R^2 is the coefficient of determination.

South Korea had appeared to have great control of the virus early on, with nationwide testing and no formal lockdowns. Italy had been the first epicentre in Europe and had been seen to poorly manage the crisis. The UK had to institute numerous lockdowns and seemed to have not managed the crisis well, with the government also having to deal with the BREXIT matter concurrently[54]. Sweden was the European exception on how to tackle the virus. The country decided to not have any lockdowns. The result had been that their fatality rate, adjusted for population size, was larger than Denmark and Norway, but their economy was hit in a much less significant way to most European nations[55].

Italy (0.08) and South Korea (6.12) report statistically significant (1%) positive COVID-19 death coefficients. This would mean that an increase in deaths would result in an increase in yields. This show that deaths had a significant effect on investor perception. For South Korea, this could be possibly as a result of investors having thought that South Korea had the virus under control[56] and increasing death tolls being a departure from this assumption and therefore negatively impacting perception and consequently investment decisions. With Italy, higher death rates signified continued failure to have the virus under control, negatively impacting investments.

Many of the countries also adjusted their monetary policy during the period. The adjustments downwards eased rates and helped protect domestic balance sheets and, for some, stimulated lending. However, this also significantly affected capital outflows. Therefore, rather than infections directly affecting bond yields, the policies formed as a result of COVID-19 significantly affected returns. This is supported by the similarity in results between Table 12 where COVID is represented by infections per million and Table 14 where COVID is represented by a dummy variable.

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54 https://www.reuters.com/article/us-britain-eu-economy-idUSKBN26Q0HD [Accessed: 14.11.2020]

55 https://www.bloomberg.com/opinion/articles/2020-10-20/europe-s-approach-on-tackling-COVID-19-looks-like-sweden-s [Accessed: 12.11.2020]

56 How South Korea Successfully Managed Coronavirus - WSJ [Accessed: 24.12.2020]

Table 13 Regression of bond yields on conditioning variables (COVID-19 Form-dummy variable)

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	$COVID19_{dum}$	X_{qs}	X_{ls}	X_{sr}	X_{ex}	X_{wti}	R^2
Brazil	2,67***	-0,52***	1,01***	-0,10*	-0,08**	-0,04	-0,02	0,63
	(14.45)	(-3.56)	(17.04)	(-1.79)	(-2.07)	(-1.11)	(-0.56)	
China	6,85***	-1,83***	0,11***		-0,01	0,04	-0,01	0,78
	(169.21)	(-29.59)	(3.68)		(-0.41)	(1.24)	(-0.25)	
India	1,99***	-1,55***	0,24***	-0,05	-0,03	-0,02	-0,07*	0,66
	(9.44)	(-19.91)	(6.44)	(-1.23)	(-0.71)	(-0.48)	(-1.93)	
Italy	0,76***	0,32***	0,31***	0,62***	0,05	-0,072**	-0,06**	0,79
	(3.62)	(3.24)	(5.18)	(13.53)	(1.52)	(-2.52)	(-2.13)	
New Zealand	1,65***	-2,04***	0,15***	0,38***	-0,05	-0,07*	-0,12***	0,66
	(6.92)	(-18.56)	(3.91)	(7.20)	(-1.37)	(-1.92)	(-3.24)	
Russia	1,75***	-0,68***	0,81***	0,00	0,03	-0,01	-0,06**	0,84
	(5.31)	(-12.41)	(31.17)	(0.11)	(0.95)	(-0.55)	(-2.49)	
Singapore	2,11***	-1,42***	0,22***	0,06**	-0,04	-0,14***	-0,11***	0,71
	(8.78)	(-18.67)	(5.93)	(1.96)	(-1.22)	(-4.25)	(-3.32)	
South Africa	1,43***	-0,06	1,06***	-0,12***	-0,01	-0,04*	-0,02	0,89
	(17.46)	(-0.66)	(23.01)	(-2.87)	(-0.37)	(-1.71)	(-1.06)	
South Korea	0,48	-1,41***	-0,03	0,78***	-0,02	-0,08	-0,06	0,35
	(1.25)	(-9.88)	(-0.40)	(9.31)	(-0.29)	(-1.45)	(-1.21)	
Sweden	0,51**	0,85***	0,21***	0,96***	0,04	-0,07**	-0,06*	0,74
	(2.35)	(8.22)	(4.65)	(23.36)	(1.07)	(-2.14)	(-1.71)	
UK	0,66**	-1,73***	-0,01	0,20***	0,01	-0,05	-0,08**	0,61
	(2.18)	(-18.31)	(-0.34)	(4.34)	(0.27)	(-1.12)	(-1.99)	
USA	5,05***	-1,07***	0,46***	-0,003	-0,003	0,07***	-0,07***	0,83
	(38.14)	(-15.23)	(12.85)	(-0.09)	(-0.13)	(2.86)	(-2.61)	

The Table reports OLS estimation results and uses time series data covering the period 1st July 2019 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses). *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The dependent variables are the daily stock returns of the respective countries main stock exchange. The explanatory variables include the lagged values of: $COVID19_{dum}$ representing the dummy variable which takes the value of zero before the first infection and 1 after, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{sr} the daily stock returns, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. R^2 is the coefficient of determination.

4.3.2. Robustness Test Using Generalised Method of Moments (GMM)

This paper employs the Newey-West (1987) estimation of GMM to ensure that estimated standard errors of parameters and t-statistics are robust to heteroskedasticity and autocorrelation. The kernel lags are set to equal 4 and take into consideration the lag structure of the dataset in this research. When undertaking the GMM estimations, three diagnostic tests of the results are provided, namely: Root Mean Square Error (RMSE), Adjusted R-squared (Adj-R^2) and the J-statistic.

If the RMSE is large, it would mean that the model does not account for the other significant features that would affect the results. The Adjusted R-squared takes care of one of the shortcomings of R-squared which is its inability to drop if 'noisy' regressors are added to the regression. It accounts for the loss of degrees of freedom that is linked to increasing the number of variables (Brooks, 2014). The J-statistic is Hansen's (1982) test of overidentifying restrictions. A low J-statistic would indicate a good model. However, when the J-statistic is too low, it would suggest an extremely good model which would be cause for concern. The instrumental variables used include unscaled and undemeaned values of all the variables (bond yield/stock return, COVID-19 variable, liquidity spread, quality spread, exchange rate returns and oil return) as well as an additional variable, Bitcoin which has been a much talked about investment alternative during the pandemic[57].

Table 15 below shows the results of the unconditional model with stock returns as the dependent variable. Brazil, India, Russia, South Africa and the USA have positive COVID infection coefficients that are statistically significant though none are statically significant at the 1% level. This shows that COVID-19 infections exert a weak influence on most stock market returns. The USA's stock markets have significant effects on global stock market returns and are the main exporters of volatility worldwide (Ling and Gurjeet, 2010). Though COVID-19 infections may not directly impact individual stock returns based on country specific variables, there remains the possibility of these shocks being transmitted to other stock markets. For the majority of the stock markets, the J-statistic produces right tailed p-values between 0.1 and 0.9 and therefore, fail to reject the model's overall goodness of it. However, for New Zealand (0.09), South Korea (0.05) and Singapore (0.05) the *p*-value's result in the rejection of the model's goodness of it. Though each country's returns are regressed by the same variables, each countries' data differs, and this therefore leads to the model not fitting perfectly in all instances, for all the nations.

Thenmozhi and Radha (2008) postulate that the exchange rate impact on stock returns is substantial. Assuming that the exchange rate is a proxy for economic strength, the falling exchange rate could alarm investors and negatively impact stock returns. This factor is said to mainly be attributable to emerging

[57] https://www.bloomberg.com/opinion/articles/2020-12-01/bitcoin-is-the-tulipmania-that-refuses-to-die [Accessed: 05.12.2020]

markets. A fall in the value of exchange rates in the US is seen to yield opposing results as seen through the negative coefficient.

Table 14 GMM Results for the unconditional model, daily stock returns (COVID-19 Form-Infections)

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	$COVID19_{inf}$	X_{qs}	X_{ls}	X_{br}	X_{ex}	X_{wti}	*RMSE*	*Adj-R²*	*J-Stat*
Brazil	0,39	0,01**	0,49*	0,10	0,04	0,08	-0,12**	1,50	0,05	1,51
	(0.67)	(1.94)	(1.72)	(0.45)	(0.18)	(1.15)	(-2.13)			[0.22]
China	1,46	0,004	0,01		-0,33	0,17	0,06	1,06	0,02	1,93
	(1.12)	(1.00)	(0.08)		(-1.13)	(1.21)	(0.69)			[0.16]
India	0,67	0,11*	0,14	0,10	0,35	-0,09	0,13	1,39	0,03	0,10
	(1.05)	(1.96)	(1.09)	(0.54)	(1.39)	(-0.60)	(1.21)			[0.75]
Italy	-0,88	-0,002	-0,39	0,07	0,41	0,04	0,08	1,43	-0,015	0,96
	(-1.35)	(-0.33)	(-1.46)	(0.32)	(1.21)	(0.36)	(0.76)			[0.33]
New Zealand	0,32	0,09*	0,12	-0,10	-0,43	0,01	0,09	1,47	0,07	2,96
	(0.28)	(1.77)	(0.64)	(-0.28)	(-1.64)	(0.05)	(0.69)			[0.09]
Russia	-1,72	0,01**	-0,45**	-0,17	0,68**	-0,06	0,15	1,37	0,05	0,003
	(-1.39)	(2.31)	(-2.04)	(-0.94)	(2.53)	(-0.55)	(1.09)			[0.96]
Singapore	-0,27	0,004	-0,01	-0,04	0,10	0,29*	0,22	1,38	0,05	2,91
	(-0.32)	(1.35)	(-0.04)	(-1.61)	(0.44)	(1.75)	(1.43)			[0.09]
South Africa	-1,24*	0,01**	-0,19	0,37	0,58	0,07	0,16	1,43	0,10	0,77
	(-1.88)	(2.16)	(-0.39)	(1.61)	(1.44)	(0.61)	(1.39)			[0.38]
South Korea	-0,01	0,062	0,07	0,34	0,29	0,06	0,31*	1,30	0,08	3,78
	(-0.01)	(0.83)	(0.39)	(1.45)	(1.00)	(0.50)	(1.76)			[0.05]
Sweden	0,19	-0,001	0,05	-0,05	0,34	-0,13	-0,05	1,40	-0,003	1,17
	(0.26)	(-0.59)	(0.29)	(-0.09)	(0.83)	(-1.01)	(-0.67)			[0.28]
UK	-1,51*	0,006	-0,19*	0,04	-0,02	0,14	0,06	1,42	0,00	1,10
	(-1.97)	(1.32)	(-1.81)	(0.28)	(-0.10)	(1.15)	(0.46)			[0.29]
USA	-2,12	0,01*	-0,36	-0,30	0,51	-0,24*	-0,02	1,36	0,06	1,13
	(-1.31)	(1.82)	(-1.55)	(-0.96)	(1.32)	(-1.97)	(-0.27)			[0.29]

The Table reports GMM estimation results for the unconditional model for daily returns and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses) which are robust to heteroscedasticity and autocorrelation. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. J-statistic, with it's probability in square brackets, is Hansen's (1982) test of overidentifying restrictions. The dependent variables are the daily stock returns of the respective countries' main stock exchange. The explanatory variables include the lagged values of: $COVID19_{inf}$ representing the per million COVID infections, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{br} the daily bond yields, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. *Adj-R²* is the coefficient of determination and the *RMSE* is the root mean squared error.

The interpretation of results in Table 16 would give us similar conclusions of those in Table 15 as only Brazil and the USA show statistical levels of significance for the COVID deaths variable. That along with changes in oil prices, as represented by X_{wti}, results in model of Brazil's stock market being the only one of two with an Adj-R^2 value above 10% and with a large *p*-value of 0.80, the J-statistic fails to reject the overall goodness of fit for the model. As Brazil is a net oil exporter, the significant volatility of oil prices has not been lost on them and the reduced demand has had a major impact on stock returns.

The literature affirms propositions that for oil-exporting economies, a rise in oil prices has a positive effect on stock returns (Park and Ratti, 2008). The increase in oil prices having a positive effect on stock returns, however, is predicated on the fact that the increased prices are as a result of greater demand, which then outweighs the negative cost effects on oil prices. In this case, stock markets react favourably (Degiannakis, Filis and Arora, 2017), In the case of Brazil (Table 15,16 and 17), we see a negative coefficient for oil returns in relation to stock returns. The income effect has not come into effect as increased prices have not necessarily been as a result of substantial increases in demand as many airlines remain grounded and reduced domestic demand, as seen by many countries as a result of lockdown. These factors, including other external shocks of reduced foreign demand have resulted in “Brazil’s sharpest recession on record.”[58]

Table 15 GMM Results for the unconditional model, daily stock returns (COVID-19 Form-deaths)

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	*COVID19$_{dth}$*	*X_{qs}*	*X_{ls}*	*X_{br}*	*X_{ex}*	*X_{wti}*	*RMSE*	*Adj-R^2*	*J-Stat*
Brazil	0,41	0,15***	0,45*	-0,10	0,12	0,02	-0,11**	0,88	0,13	0,06
	(0.92)	(2.69)	(1.82)	(-0.54)	(0.76)	(0.45)	(-2.16)			[0.80]
China	0,79	0,01	0,03		-0,15	0,11	0,08	1,23	-0,001	2,10
	(1.24)	(0.28)	(0.41)		(-1.26)	(1.02)	(0.96)			[0,15]
India	0,96	1,10*	0,21	0,04	0,02	-0,12	0,10		0,01	1,24
	(1.37)	(1.78)	(1.43)	(0.15)	(0.07)	(-0.67)	(0.72)			[0.26]
Italy	-0,84	0,0061	-0,30	0,06	0,38	0,03	0,08	1,52	-0,014	1,05
	(-1.24)	(0.15)	(-1.19)	(0.24)	(0.90)	(0.26)	(0.82)			[0.31]
New Zealand	0,77	0,23	0,14	0,08	-0,17	-0,04	-0,10	0,79	-0,08	1,94
	(0.49)	(0.75)	(0.57)	(0.76)	(0.62)	(0.73)	(0.37)			[0.16]
Russia	0,77	-0,499	-0,78	0,00	0,86	0,00	-0,0001	0,90	-0,02	0,17
	(0.35)	(-1.52)	(-1.52)	(-0.02)	(1.51)	(-0.03)	(-0.001)			[0.68]
Singapore	-0,96	0,82	-0,06	-0,02	-0,25	0,29	0,24	1,51	0,03	2,80
	(-0.85)	(0.58)	(-0.36)	(-0.56)	(-0.84)	(1.53)	(1.49)			[0.09]
South Africa	-0,73	0,025	-0,70	0,04	0,78	0,11	0,06	0,91	-0,04	0,83
	(-0.65)	(0.07)	(0.42)	(0.89)	(1.00)	(1.53)	(0.50)			(0.36)
South Korea	1,03	-2,65	0,18	0,06	0,58	0,10	0,24	1,39	0,10	2,17
	(1.32)	(-0.68)	(0.95)	(0.36)	(1.63)	(0.70)	(1.37)			[0.14]
Sweden	-0,41	0,01	-0,07	-0,67	-0,03	-0,15	-0,11	1,28	-0,04	1,29
	(-0.46)	(0.32)	(-0.40)	(-1.19)	(-0.07)	(-1.10)	(-1.44)			[0.26]
UK	-2,41	0,04	-0,27	0,18	-0,31	0,20	0,02	1,45	-0,008	0,98
	(-1.29)	(0.82)	(-1.42)	(1.08)	(-0.85)	(1.47)	(0.14)			[0.32]
USA	-0,10	0,066	-0,46**	-0,25	-1,02	-0,25**	-0,03	1,47	0,10	1,28
	(-0.05)	(1.17)	(-2.02)	(-0.41)	(-1.32)	(-2.15)	(-0.38)			[0.25]

58 https://www.worldbank.org/en/country/brazil/publication/COVID-19-in-brazil-impacts-policy-responses [Accessed:11.11.2020]

The Table reports GMM estimation results for the unconditional model for daily returns and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses) which are robust to heteroscedasticity and autocorrelation. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. J-statistic, with it's probability in square brackets, is Hansen's (1982) test of overidentifying restrictions. The dependent variables are the daily stock returns of the respective countries' main stock exchange. The explanatory variables include the lagged values of: $COVID19_{dth}$ representing the per million COVID deaths, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{br} the daily bond yields, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. $Adj\text{-}R^2$ is the coefficient of determination and the *RMSE* is the root mean squared error.

Using the dummy variable to represent the emergence of COVID-19 in each country, the GMM estimations are recorded in Table 17 below. The estimations here reject the null hypothesis of infections impacting stock returns. With high RMSE and all the values of Adjusted R-squared being below 10%, we can conclude that the independent variables and more especially COVID-19 deaths, do not significantly impact stock returns.

Table 16 GMM Results for the unconditional model, daily stock returns (COVID-19 Form-dummy variable)

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	$COVID19_{dum}$	X_{qs}	X_{ls}	X_{br}	X_{ex}	X_{wti}	*RMSE*	$Adj\text{-}R^2$	*J-Stat*
Brazil	0,87	-0,48	0,27	0,05	0,02	0,04	-0,10*	0,97	0,03	1,12
	(1.46)	(-1.31)	(1.29)	(0.43)	(0.12)	(0.75)	(-1.88)			[0.29]
China	1,69**	-0,47**	0,08		-0,25***	0,16**	0,06	0,97	0,03	1,86
	(2.54)	(-2.08)	(1.15)		(-2.61)	(2.56)	(0.84)			[0.17]
India	0,85	-0,17	0,15	0,01	-0,05	-0,08	0,11	0,97	0,02	0,03
	(1.39)	(-0.84)	(1.47)	(0.16)	(-0.41)	(-0.89)	(1.07)			[0.85]
Italy	-0,33	-0,044	-0,13	-0,15	0,27	0,01	0,08	0,98	-0,002	0,75
	(-0.63)	(-0.18)	(-0.81)	(-1.06)	(1.28)	(0.08)	(0.83)			[0.38]
New Zealand	0,28	0,300	0,06	-0,14	-0,03	0,08	0,12	0,98	0,01	3,29
	(0.29)	(0.51)	(0.41)	(-0.74)	(-0.16)	(1.05)	(0.95)			[0.07]
Russia	0,90	0,091	-0,33*	-0,09	0,30	-0,08	0,16	0,97	0,03	0,44
	(0.88)	(0.46)	(-1.74)	(-0.82)	(1.36)	(-0.78)	(1.19)			[0.51]
Singapore	0,40	-0,39	0,04	-0,03	-0,14	0,19	0,20	0,95	0,07	3,54
	(0.51)	(-1.56)	(0.35)	(-1.19)	(-0.86)	(1.72)	(1.43)			[0.06]
South Africa	-0,05	-0,36	-0,13	0,02	0,40	0,09	0,17*	0,96	0,05	0,12
	(-0.12)	(-1.18)	(-0.41)	(0.12)	(1.31)	(1.65)	(1.72)			[0.72]
South Korea	0,13	-0,19	0,01	0,11	-0,05	0,10	0,22	0,95	0,07	3,68
	(0.15)	(-0.80)	(0.04)	(0.86)	(-0.75)	(1.35)	(1.28)			[0.06]
Sweden	0,09	0,06	0,02	0,10	-0,04	-0,04	-0,01	0,99	-0,02	0,56
	(0.20)	(0.32)	(0.24)	(1.14)	(-0.47)	(-0.43)	(-0.17)			[0.45]
UK	-0,78	-0,109	-0,12	0,11	-0,03	0,13	0,06	0,98	0,01	0,88
	(-1.18)	(-0.44)	(-1.32)	(1.23)	(-0.36)	(1.61)	(0.63)			[0.34]
USA	-0,05	-0,29	-0,11	0,00	-0,08	-0,15*	-0,03	0,97	0,03	1,04
	(-0.05)	(-1.51)	(-0.71)	(0.03)	(-0.50)	(-1.79)	(-0.47)			[0.31]

The Table reports GMM estimation results for the unconditional model for daily returns and uses time series data covering the period 1st July 2019 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses) which are robust to heteroscedasticity and autocorrelation. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. J-statistic, with it's probability in square brackets, is Hansen's (1982) test of overidentifying restrictions. The dependent variables are the daily stock returns of the respective countries' main stock exchange. The explanatory variables include the lagged values of: $COVID19_{dum}$

representing the dummy variable which takes the value of zero before the first infection and 1 after, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{br} the daily bond yields, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. *Adj-R*^{2} is the coefficient of determination and the *RMSE* is the root mean squared error.

Portfolio theory postulates that the return demanded by the agent for an investment is dependent on the risk and the expected return on the particular asset. COVID-19 has resulted in increased risk as a result of increasing uncertainty of the damage done to economies worldwide. Default risk is, therefore, one of the factors affecting bond yields and quality spreads.

As governments increasing adopt stringent monetary policy measures, investors require higher risk premia to invest in bonds (Ling and Gurjeet, 2010). The nexus between quality spreads and bond yields is visible in Table 18 below. Quality spread as a predictive variable of bond yields is highly significant in 8 of the 12 countries sampled. China and India’s bond yields are the only ones of the emerging markets whose predictability is not affected by quality spread. Though liquidity generally plays a small role in affecting bond yields its role is heighted during times of crisis (Codogno, Favero and Missal, 2003; Pagano and von Thadden, 2004). The heightened role is visible as the coefficient of X_{ls} is statistically significant at 1% and 5% level for 5 of the countries.

The direct effect of COVID infections as represented by $COVID19_{inf}$ is highly significant. Coefficients of 8 out of the 12 countries are statistically significant at the 1% level. This highlights how strongly COVID infections exert a strong influence on bond yields. The reported Adjusted R-squared for the majority of the models are closer to one representing the goodness of fit of the independent variables. For Italy and the USA, however, the reported p-values for the J-statistic are above 0.9. This would mean that for these models we do not fail to reject the model’s goodness of fit.

Table 17 GMM Results for the unconditional model, daily bond yields (COVID-19 Form-Infections)

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	*COVID19$_{inf}$*	*X_{qs}*	*X_{ls}*	*X_{sr}*	*X_{ex}*	*X_{wti}*	*RMSE*	*Adj-R^2*	*J-Stat*
Brazil	1,69***	-0,01**	0,73***	0,30	-0,07	-0,04	-0,01	0,88	0,52	0,02
	(5.45)	(-2.47)	(3.66)	(1.23)	(-0.97)	(-0.78)	(-0.23)			[0.89]
China	4,76***	0,01***	-0,05		0,01	0,02	-0,02	0,34	0,52	0,86
	(55.95)	(6.91)	(-1.33)		(0.41)	(0.91)	(-0.81)			[0.35]
India	0,08	-0,19***	0,083	-0,06	0,02	-0,02	-0,05	0,48	0,65	0,27
	(0.19)	(-5.72)	(1.19)	(-0.97)	(0.64)	(-0.49)	(-1.18)			[0.61]
Italy	0,79***	0,02***	0,36***	0,54***	0,03	-0,08**	-0,07*	0,44	0,82	0,01
	(2.82)	(5.82)	(2.82)	(2.97)	(1.35)	(-2.13)	(-1.87)			[0.93]
New Zealand	-1,16**	0,06***	0,02	0,21*	-0,06	-0,13**	-0,14***	0,61	0,25	0,25
	(-2.17)	(3.78)	(0.22)	(1.98)	(-0.98)	(-2.45)	(-2.78)			[0.62]
Russia	3,11***	-0,01***	0,65***	0,02	0,02	0,02	-0,02	0,49	0,80	0,53
	(4.19)	(-4.67)	(9.56)	(0.59)	(0.42)	(0.42)	(-0.60)			[0.47]
Singapore	0,96	-0,01***	0,20*	0,05***	-0,02	-0,13***	-0,04	0,57	0,55	0,11
	(1.37)	(-4.07)	(1.95)	(4.82)	(-0.52)	(-3.45)	(-1.11)			[0.74]
South Africa	1.62***	-0,005**	1,20***	-0,28***	0,01	-0,01	0,01	0,48	0,75	0,64
	(9.51)	(-2.41)	(13.71)	(-3.06)	(0.25)	(-0.12)	(0.46)			[0.42]
South Korea	-0,95**	-0,16***	-0,30***	-0,31**	0,03	0,005	0,06*	0,54	0,35	2,84
	(-2.39)	(-5.32)	(-3.95)	(-2.47)	(1.25)	(0.14)	(1.82)			[0.09]
Sweden	0,66***	0,002**	0,02	1,01***	0,08***	-0,02	-0,03	0,38	0,74	2,41
	(2.99)	(2.52)	(0.34)	(10.48)	(2.76)	(-1.01)	(-1.28)			[0.12]
UK	-1,34**	-0,01	-0,11*	-0,17	0,05	-0,07*	-0,02	0,61	0,24	0,86
	(-2.41)	(-1.40)	(-1.92)	(-1.37)	(1.42)	(-1.69)	(-0.47)			[0.35]
USA	3.65***	-0,01***	0,33***	0,08	0,02	0,03	-0,01	0,34	0,76	0,003
	(10.48)	(-8.00)	(4.46)	(1.12)	(1.26)	(1.01)	(-0.55)			[0.95]

The Table reports GMM estimation results for the unconditional model for daily returns and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses) which are robust to heteroscedasticity and autocorrelation. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. J-statistic, with it's probability in square brackets, is Hansen's (1982) test of overidentifying restrictions. The dependent variables are the daily bond yields of the respective countries' 10Y bond. The explanatory variables include the lagged values of: *COVID19$_{inf}$* representing the per million COVID infections, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{sr} the daily stock returns, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. *Adj-R^2* is the coefficient of determination and the *RMSE* is the root mean squared error.

Table 18 GMM Results for the unconditional model, daily bond yields (COVID-19 Form-deaths)

$$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$$

Country	*Intercept*	*COVID19$_{dth}$*	*X_{qs}*	*X_{ls}*	*X_{sr}*	*X_{ex}*	*X_{wti}*	*RMSE*	*Adj-R^2*	*J-Stat*
Brazil	2.03***	-0,12	0,93***	0,08	-0,21**	0,02	-0,01	0,83	0,55	1,30
	(6.57)	(-1.61)	(6.50)	(0.34)	(-2.12)	(0.38)	(-0.28)			[0.25]
China	5,32***	-0,04	0,18**		-0,02	-0,03	-0,03	0,69	0,05	0,25
	(34.78)	(-0.65)	(2.08)		(-0.48)	(-0.48)	(-0.63)			[0.62]

India	-0,33	-2,49**	0,10	-0,02	-0,01	-0,08**	-0,09*	0,62	0,31	0,25
	(-0.52)	(-2.26)	(0.84)	(-0.24)	(-0.39)	(-2.00)	(-1.98)			[0.62]
Italy	0,53*	0,08***	0,16	0,60***	0,04	-0,10***	-0,07*	0,51	0,66	0,04
	(1.86)	(4.12)	(1.10)	(3.56)	(1.48)	(-2.81)	(-1.91)			[0.84]
New Zealand	1,00	-0,49*	0,41***	0,24*	0,04*	-0,03	-0,04*	0,32	0,63	0,58
	(2.49)	(-1.75)	(7.89)	(2.32)	(1.83)	(-0.77)	(-1.84)			[0.45]
Russia	2,70***	-0,17	0,62***	0,08***	0,02	0,08**	-0,03*	0,21	0,92	0,43
	(4.45)	(-1.34)	(12.39)	(2.67)	(0.62)	(2.40)	(-1.84)			[0.51]
Singapore	-1,02	-1,63**	0,02	0,05***	-0,06	-0,10*	-0,11***	0,63	0,11	0,01
	(-0.98)	(-2.34)	(0.13)	(3.84)	(-1.07)	(-1.77)	(-2.82)			[0.91]
South Africa	1,15***	-0,08	1,10***	-0,06	0,003	0,01	0,03	0,20	0,94	0,06
	(11.46)	(-1.32)	(16.83)	(-1.11)	(0.13)	(0.63)	(1.49)			[0.80]
South Korea	-1,48***	6,21***	-0,13	0,28***	-0,01	-0,07**	0,02	0,46	0,37	0,03
	(-3.97)	(4.38)	(-1.63)	(2.91)	(-0.22)	(-2.12)	(0.46)			[0.85]
Sweden	0,60**	-0,01	0,01	0,53***	0,05**	-0,02	-0,03	0,32	0,32	1,76
	(2.55)	(-1.66)	(0.16)	(4.12)	(2.03)	(-0.64)	(-0.75)			[0.18]
UK	-3,09***	0,03***	-0,26***	0,05	0,001	-0,060	-0,07**	0,40	0,44	0,01
	(-8.75)	(2.97)	(-5.43)	(0.67)	(0.03)	(-1.33)	(-2.24)			[0.93]
USA	1,26**	-0,03***	-0,04	0,018	0,02	0,04**	-0,03	0,19	0,29	2,49
	(2.46)	(-3.46)	(-0.86)	(0.11)	(1.52)	(2.34)	(-1.51)			[0.11]

The Table reports GMM estimation results for the unconditional model for daily returns and uses time series data covering the period 1st January 2020 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses) which are robust to heteroscedasticity and autocorrelation. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. J-statistic, with it's probability in square brackets, is Hansen's (1982) test of overidentifying restrictions. The dependent variables are the daily bond yields of the respective countries' 10Y bond. The explanatory variables include the lagged values of: $COVID19_{dth}$ representing the per million COVID deaths, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{sr} the daily stock returns, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. $Adj\text{-}R^2$ is the coefficient of determination and the *RMSE* is the root mean squared error.

Similar to the recent finding of Andries, Ongena and Sprincean (2020) we find that COVID deaths and related policy interventions result in increased uncertainty amongst investors of European government bonds. Table 19 (above) shows that Italy and the UK have coefficients with a significance level of 1%. Increased government interventions in policies, both monetary and non-pharmaceutical interventions, as a result of the increased death rates, have resulted in increased risk premia in the bonds issued by these European nations. The reported *p*-value of the J-statistic for the UK, is however, one of the two (with Singapore being the second) that are above 0.9 and therefore result in the rejection of the model's goodness of fit for these two countries,

The US also shows that COVID deaths have a significant effect on their bond return predictability. This can be related to the numerous interventions taken by the US Fed to slash interest rates to stimulate borrowing and subsequently economic growth. As death rates increase and the virus causes more economic damage as a result of lockdowns to curb the death rates, the markets anticipate further rate cuts and stimulus packages. The J-statistic for the US yields a right-tailed *p*-value of 0.11 failing to reject the model's goodness-of-fit at any level of significance.

Once again, the Adj-R^2 for China (Table 19 above) shows that these variables do not aid in being able to predict future bond yields. Though the coefficient for quality spread is statistically significant at 1% level, the predictability of the model remains weak. For South Africa, which has an Adj-R^2 of 94%, quality spread (X_{qs}) was the predominant variable, strongly predicting future bond yields. This is significant as this could speak to the effect, not of policies instituted by the African sovereign, but the risk premia of bonds as a result of its Moody's downgrade. With a *p*-value of 0.80, the J-statistic for South Africa, fails to reject the overall goodness-of-fit for the model.

In Table 20 below, where COVID is represented by the dummy variable, the Adj-R^2 values are above 50% for all the countries except South Korea (33%). The coefficients of the dummy variable are significant at the 1% level for 9 of the countries. This is linked to the effect of the virus, not in numbers infected, but rather its presence in the country. The majority of the countries have a negative coefficient, signifying that a reduction in number infected have a positive effect on returns. It is, therefore, not the numbers per million but rather the presence of COVID-19 that results in aiding the predictability of bond yields. Of the 12 countries, the p-values of the J-statistic are above 0.9 for 4 of them (Brazil, Singapore, Sweden and the USA) signifying a rejection of the model's goodness-of-fit for these countries' returns.

Table 19 GMM Results for the unconditional model, daily bond yields (COVID-19 Form-dummy variable)

$r_t = \alpha + \beta Covid19_{t-1} + \gamma X_{t-1} + \varepsilon_t$

Country	*Intercept*	*COVID19$_{dum}$*	*X_{qs}*	*X_{ls}*	*X_{sr}*	*X_{ex}*	*X_{wti}*	*RMSE*	*Adj-R^2*	*J-Stat*
Brazil	2,66***	-0,52**	1,01***	-0,09*	-0,08	-0,04	-0,02	0,61	0,62	0,004
	(9.55)	(-2.19)	(11.46)	(-1.86)	(-1.43)	(-0.87)	(-0.43)			[0.95]
China	6,86***	-1,82***	0,11		-0,01	0,04*	-0,01	0,46	0,78	0,08
	(80.49)	(-13.92)	(1.62)		(-0.36)	(1.68)	(-0.23)			[0.77]
India	2,05***	-1,55***	0,25**	-0,05	-0,03	-0,02	-0,07*	0,58	0,65	0,02
	(3.42)	(-8.84)	(2.32)	(-1.09)	(-0.66)	(-0.61)	(-1.70)			[0.88]
Italy	0,84	0,28	0,34**	0,62***	0,04	-0,07	-0,06*	0,45	0,79	0,12
	(1.61)	(1.00)	(2.22)	(7.45)	(1.41)	(-1.45)	(-1.67)			[0,72]
New Zealand	1,64***	-2,04***	0,15*	0,38***	-0,05	-0,08	-0,12**	0,58	0,65	0,02
	(3.09)	(-10.93)	(1.68)	(4.22)	(-0.77)	(-1.63)	(-2.39)			[0.89]
Russia	1,94***	-0,72***	0,79***	0,01	0,02	-0,004	-0,06	0,40	0,83	0,20
	(4.02)	(-7.32)	(18.22)	(0.29)	(0.38)	(-0.10)	(-1.39)			[0.65]
Singapore	2,09**	-1,42***	0,22	0,07***	-0,04	-0,15***	-0,11***	0,59	0,71	0,00
	(2.48)	(-7.92)	(1.63)	(4.10)	(-0.83)	(-2.91)	(-2.91)			[0.96]
South Africa	1,42***	-0,11	1,05***	-0,10*	-0,002	-0,02	-0,01	0,33	0,89	0,27
	(10.79)	(-0.85)	(13.28)	(-1.96)	(-0.08)	(-0.89)	(-0.37)			[0.60]
South Korea	0,47	-1,40***	-0,03	0,77***	-0,01	-0,07*	-0,06*	0,80	0,33	0,02
	(0.73)	(-5.12)	(-0.23)	(3.92)	(-0.35)	(-1.76)	(-1.88)			[0.88]
Sweden	0,52	0,85***	0,21*	0,95***	0,04	-0,07**	-0,06*	0,51	0,73	0,00
	(0.92)	(3.35)	(1.96)	(12.16)	(1.23)	(-2.29)	(-1.74)			[0.97]
UK	0,65	-1,73***	-0,02	0,20*	0,01	-0,05	-0,08**	0,62	0,60	0,02
	(1.22)	(-7.41)	(-0.22)	(1.79)	(0.36)	(-1.12)	(-2.30)			[0.88]
USA	5,03***	-1,08***	0,45***	-0,002	0,00	0,08*	-0,07**	0,41	0,83	0,01
	(10.55)	(-5.12)	(3.39)	(-0.07)	(-0.14)	(1.73)	(-2.09)			[0.93]

The Table reports GMM estimation results for the unconditional model for daily returns and uses time series data covering the period 1st July 2019 to 30th June 2020. The two values reported in the body of the Table are, respectively, the coefficient of the explanatory variable and its corresponding t-statistic (in parentheses) which are robust to heteroscedasticity and autocorrelation. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. J-statistic, with it's probability in square brackets, is Hansen's (1982) test of overidentifying restrictions. The dependent variables are the daily bond yields of the respective countries' 10Y bond. The explanatory variables include the lagged values of: *COVID19$_{dum}$* representing the dummy variable which takes the value of zero before the first infection and 1 after, X_{qs} is the quality spread defined as the spread between ten-year treasury bonds and AAA-rated corporate bonds, X_{ls} the liquidity spread defined as the spread between yields on ten year treasury bonds and three-month treasury bills, X_{sr} the daily stock returns, X_{ex} the exchange rate returns and X_{wti} the return on WTI Crude. *Adj-R^2* is the coefficient of determination and the *RMSE* is the root mean squared error.

4.3.3. Summary of Results

Using both OLS and GMM estimation methods, this study has enabled us to see what effects COVID-19, in its various forms, and other macroeconomic variables have on predicting bond and stock returns. We find that overall, the lagged values of oil returns and stock returns/bond yields have the weakest effects on predicting bond yields/stock returns. We, further, find that the dependent variables have greater predictability power in bond yields than in stock returns.

With regards to COVID-19 infections, it is clear that New Zealand's management of the virus has had direct effects on both the stock market and bond yields. However, this is the only country that this can be said of. When COVID takes the form of infections, it does not significantly affect the stock returns. US stock markets affect global stock markets and are the main exporters of volatility worldwide (Ling and Gurjeet, 2010). As a result, since COVID-19 infections do exert stronger influence on their stock returns, though it may not affect others to the same degree, the volatility spill over could influence and possibly play a greater role in predicting global stock market volatility.

Brazil stands out as having been affected the most by COVID-19 deaths. The significant variables that have a predictive effect on stock returns on the Bovespa are COVID related deaths and oil returns. As Brazil is a net oil exporter, the significant volatility of oil prices as well as lockdown effects due to spikes in death rates in their densely populated poorer regions as well as demand shocks resulted in stock market returns having had a hard time recovering. For Brazil, both deaths and infections attain a level of significance in all models. With bond yields, European countries have also been affected significantly by COVID related deaths. Increased government interventions in policies, both monetary and non-pharmaceutical, as a result of death rates, have resulted in increased risk premia in the bonds issued by European countries.

4.4.Contagion Results

The models below enable us to determine the direction of transmission of volatility. The first two tables (Table 21 and 22) highlight the estimation coefficients for conditional mean returns for stock returns and then for bond yields. Table 23 and 24 summarise the results of the MVGARCH models for stock returns and bond yields, respectively.

4.4.1. Mean Return Spillovers

In table 21, India ($\varphi_{3,3}$), South Africa ($\varphi_{5,5}$), and the USA ($\varphi_{12,12}$) are the only countries with diagonal values that are statistically significant. This means that only their stock returns depend on their own history which suggests the existence of their own spillovers during the sample period. All the mean return spillovers are negative and high which is indicative of a downward shift in these markets. The diagonal values of the remaining countries are insignificant which shows that their returns do not depend on their own previous returns.

There are significant cross mean spillovers in each country. Cross mean spillovers from the Indian stock market are evident in all the markets. The Indian stock market is, however, most significantly affected by the US stock returns (0.2954). The lockdown announcement in Italy seemed to have been the source of volatility, however, as seen in Table 20, its cross mean spillovers are only significant for Brazil (-0.2471) at the 10% level and India (-0.4278) at the 1% significance level. The results further show that South Africa's volatility is mainly transmitted by other developing countries except China. This result seems to be the case for Brazil as well, with the exception of mean spillovers from Singapore (0.6620) and Italy (-0.2471).

Mean spillover effects from the USA only affect 5 countries (India=0.2954, China=0.1198, South Korea=0.2396, Singapore=0.2083, and Sweden=0.1966) at the 1% and 5% significance levels. With India and China being mainly responsible for the cross mean spillovers of the other sample countries, the USA's transmission of volatility seems to be indirect and its most significant mean spillover effect is on its own returns.

The fact that of the countries being sampled (Table 21), only India ($\varphi_{3,3}$), South Africa ($\varphi_{5,5}$), and the USA ($\varphi_{12,12}$) reported their own spillovers supports various research which postulates that where own volatility spillovers are insignificant, the conditional volatility of returns are "imported" (Theodossiou and Lee, 1993). Many papers propose that the USA is the main transmitter of this volatility (Theodossiou and Lee, 1993; Vo and Tran, 2020). Considering that 5 out of the 11 countries have significant cross mean spillovers from the USA including China and India, these results further confirm the findings of earlier researchers.

Table 20 Estimated Coefficients for Conditional Mean Return Equations (Stock Returns)

$r_t = c + \varphi_{i,t-1} r_{i,t-1} + \varepsilon_{it} + \theta \varepsilon_{i,t-1}, \varepsilon_t | \Omega_{t-1} \sim N(0, H_t)$

	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
	BRAZIL=1		RUSSIA=2		INDIA=3		CHINA=4		SOUTH_AFRICA=5		SOUTH_KOREA=6	
c	0,0003	0,0015	0,0002	0,0009	-0,0007	0,0011	-0,0001	0,0006	0,0000	0,0011	-0,0012	0,0011
φ_{i1}	-0,1299	0,0987	0,1298**	0,0590	0,0869	0,0726	-0,0161	0,0418	0,1383**	0,0692	0,1220	0,0743
φ_{i2}	0,5108***	0,1445	-0,0089	0,0864	0,2284**	0,1063	0,1479**	0,0612	0,3551***	0,1014	0,5291***	0,1088
φ_{i3}	-0,5195***	0,1137	-0,2911***	0,0680	-0,3004***	0,0836	-0,1672***	0,0481	-0,4001***	0,0797	-0,3755***	0,0856
φ_{i4}	-0,0999	0,1775	0,1277	0,1061	-0,0136	0,1306	-0,0836	0,0751	0,0509	0,1245	-0,0313	0,1336
φ_{i5}	-0,6827***	0,1627	-0,2487**	0,0973	-0,3107***	0,1197	-0,0947	0,0689	-0,4417***	0,1141	-0,2272*	0,1225
φ_{i6}	0,1831	0,1273	-0,0210	0,0762	-0,0627	0,0937	-0,0104	0,0539	0,1978**	0,0893	-0,0954	0,0958
φ_{i7}	-0,2471*	0,1471	0,0496	0,0880	-0,4838***	0,1082	-0,0016	0,0623	-0,1123	0,1031	0,1183	0,1107
φ_{i8}	0,6620***	0,2251	0,2429*	0,1346	0,2049	0,1656	0,0967	0,0953	0,0598	0,1579	-0,0474	0,1694
φ_{i9}	0,1326	0,1185	-0,1896***	0,0709	0,2485***	0,0872	0,0657	0,0502	0,0395	0,0831	0,3757***	0,0892
φ_{i10}	-0,1246	0,2065	0,0556	0,1235	0,2938*	0,1520	-0,0291	0,0874	0,0700	0,1448	-0,0762	0,1554
φ_{i11}	0,3437	0,2320	0,1568	0,1388	0,1671	0,1707	0,0619	0,0982	0,2513	0,1627	-0,0696	0,1746
φ_{i12}	-0,0110	0,1372	-0,0145	0,0820	0,2954***	0,1009	0,1198**	0,0581	-0,0670	0,0962	0,2396**	0,1032

	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
	ITALY=7		SINGAPORE=8		NEW_ZEALAND=9		SWEDEN=10		UK=11		USA=12	
c	0,0000	0,0013	-0,0012	0,0008	0,0005	0,0010	0,0002	0,0010	-0,0006	0,0010	0,0004	0,0012
φ_{i1}	0,1123	0,0844	0,0554	0,0520	0,0162	0,0623	0,0530	0,0659	0,1564**	0,0642	0,0484	0,0766
φ_{i2}	0,1209	0,1235	0,3071***	0,0762	0,0616	0,0912	0,1097	0,0965	0,2027**	0,0941	0,1000	0,1121
φ_{i3}	-0,3355***	0,0972	-0,3483***	0,0600	-0,2793***	0,0718	-0,4002***	0,0759	-0,4201***	0,0740	-0,3806***	0,0882
φ_{i4}	0,0049	0,1517	-0,0235	0,0936	0,1049	0,1120	-0,0325	0,1184	-0,0030	0,1155	-0,1006	0,1377
φ_{i5}	-0,3606***	0,1391	-0,1263	0,0858	-0,3064***	0,1027	-0,4659***	0,1086	-0,3837***	0,1059	-0,1797	0,1262
φ_{i6}	0,1715	0,1088	-0,0086	0,0672	0,1436*	0,0804	0,2441***	0,0850	0,2518***	0,0829	0,2672***	0,0988
φ_{i7}	-0,1459	0,1257	-0,0377	0,0776	0,0673	0,0929	-0,0273	0,0982	-0,0815	0,0957	-0,1483	0,1141
φ_{i8}	0,1896	0,1924	-0,0177	0,1187	0,1409	0,1421	0,0609	0,1502	0,0080	0,1465	0,0916	0,1746
φ_{i9}	-0,0986	0,1012	0,2539***	0,0625	-0,0598	0,0748	0,0385	0,0791	-0,0343	0,0771	0,1262	0,0919
φ_{i10}	-0,1953	0,1765	-0,0539	0,1089	0,1637	0,1304	-0,1200	0,1378	-0,0456	0,1344	-0,0845	0,1602
φ_{i11}	0,4169**	0,1983	0,1118	0,1224	0,1832	0,1465	0,3157**	0,1548	0,2444	0,1510	0,2257	0,1800
φ_{i12}	0,0878	0,1172	0,2083***	0,0723	0,1572*	0,0866	0,1699**	0,0916	0,0240	0,0893	-0,3122***	0,1064

The Table reports conditional mean return results for the period 1st July 2019 to 30th June 2020. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively

Table 21 Estimated Coefficients for Conditional Mean Return Equations (Bond Yields)

$$r_t = c + \varphi_{i,t-1} r_{i,t-1} + \varepsilon_{it} + \theta \varepsilon_{i,t-1}, \varepsilon_t | \Omega_{t-1} \sim N(0, H_t)$$

	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
	BRAZIL=1		RUSSIA=2		INDIA=3		CHINA=4		SOUTH_AFRICA=5		SOUTH_KOREA=6	
c	0,0002	0,0014	-0,0004	0,0008	-0,0007	0,0005	-0,0005	0,0006	0,0008	0,0009	-0,0003	0,0016
φ_{i1}	0,0161	0,0717	0,0317	0,0422	0,0298	0,0259	0,0049	0,0335	0,1129**	0,0451	0,1064	0,0837
φ_{i2}	0,0837	0,1083	0,3008***	0,0637	0,0772**	0,0391	0,0066	0,0506	0,2136***	0,0681	-0,1068	0,1265
φ_{i3}	0,2454	0,1712	-0,1691*	0,1007	-0,1307**	0,0618	-0,0280	0,0799	-0,0476	0,1077	-0,2310	0,1999
φ_{i4}	0,0094	0,1470	0,0603	0,0864	0,0033	0,0530	0,0354	0,0686	-0,0351	0,0924	-0,1855	0,1716
φ_{i5}	0,1162	0,1126	-0,1156*	0,0662	0,0433	0,0406	0,0452	0,0525	0,0148	0,0708	0,2751**	0,1315
φ_{i6}	-0,0331	0,0596	-0,0033	0,0350	-0,0212	0,0215	-0,0269	0,0278	-0,0003	0,0375	-0,1021	0,0696
φ_{i7}	0,0299	0,0239	0,0151	0,0140	0,0063	0,0086	0,0286***	0,0111	-0,0149	0,0150	0,0968***	0,0278
φ_{i8}	-0,0003	0,0612	-0,0452	0,0360	-0,0611***	0,0221	-0,0548**	0,0286	0,0145	0,0385	-0,0221	0,0715
φ_{i9}	0,0264	0,0309	0,0278	0,0182	-0,0011	0,0112	0,0149	0,0144	-0,0074	0,0194	-0,0082	0,0361
φ_{i10}	0,0028*	0,0016	-0,0006	0,0010	-0,0012**	0,0006	-0,0006	0,0008	0,0001	0,0010	0,0014	0,0019
φ_{i11}	-0,0423**	0,0191	0,0144	0,0112	0,0008	0,0069	0,0019	0,0089	0,0003	0,0120	0,0010	0,0223
φ_{i12}	0,0815***	0,0335	0,0424**	0,0197	0,0398***	0,0121	0,0385**	0,0156	0,0251	0,0210	0,1323***	0,0391
	ITALY=7		SINGAPORE=8		NEW_ZEALAND=9		SWEDEN=10		UK=11		USA=12	
c	-0,0017	0,0038	-0,0018	0,0019	-0,0002	0,0031	-0,0720	0,0524	-0,0045	0,0064	-0,0044	0,0040
φ_{i1}	-0,0029	0,1984	-0,1754*	0,0980	-0,5895***	0,1615	1,0082	2,7089	-0,6901**	0,3324	-0,6477***	0,2074
φ_{i2}	0,7617***	0,2997	0,2268	0,1482	0,5570**	0,2441	4,5127	4,0935	0,0482	0,5024	-0,0627	0,3134
φ_{i3}	-0,5207	0,4737	-0,0343	0,2341	-0,2064	0,3857	-15,0419**	6,4693	-1,0793	0,7939	0,2618	0,4953
φ_{i4}	0,1765	0,4066	0,2024	0,2010	0,0782	0,3310	6,4315	5,5525	0,2972	0,6814	-0,4037	0,4251
φ_{i5}	-0,3760	0,3115	0,2992*	0,1540	0,6553***	0,2536	7,412*	4,2540	1,0319**	0,5221	0,5075	0,3257
φ_{i6}	0,1188	0,1648	-0,2424***	0,0815	-0,0154	0,1342	-1,4683	2,2511	0,1512	0,2763	-0,1844	0,1724
φ_{i7}	-0,0035	0,0660	0,1435***	0,0326	0,1847***	0,0537	-0,7380	0,9012	0,3129***	0,1106	0,1785***	0,0690
φ_{i8}	-0,1997	0,1694	0,0856	0,0837	-0,1385	0,1379	0,2269	2,3134	0,3019	0,2839	-0,0679	0,1771
φ_{i9}	-0,0877	0,0855	-0,0664	0,0423	-0,1000	0,0696	-0,6295	1,1682	-0,1931	0,1434	-0,1423	0,0894
φ_{i10}	-0,0034	0,0046	0,0017	0,0022	0,0038	0,0037	-0,1302**	0,0621	0,0056	0,0076	0,0004	0,0048
φ_{i11}	0,1135**	0,0528	0,0061	0,0261	0,1281***	0,0430	-0,1585	0,7214	-0,1211	0,0885	0,0599	0,0552
φ_{i12}	-0,1832**	0,0926	0,1881***	0,0458	0,2577***	0,0754	0,5503	1,2642	0,3360**	0,1551	0,0762	0,0968

The table reports conditional mean return results for the period 1st July 2019 to 30th June 2020. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively.

Table 22 highlights the estimations of coefficients for conditional mean returns for the daily bond yields on the countries sampled. Russia ($\varphi_{2,2}$), India ($\varphi_{3,3}$) and Sweden ($\varphi_{10,10}$) have statistically significant diagonal values whereas the remaining 9 countries' bond yields do not. The own mean spillover effect is negative and high for both India and Sweden which indicates a downward drift in these bond markets.

With regards to cross mean spillovers, we find that the USA bond market is the most dominant source of volatility. Aside from Sweden and South Africa, the off-diagonal parameters representing the cross mean spillover from the USA to the other markets, are statistically significant and these results are similar to those of previous research (Hakim and McAleer, 2010).

Aside from this, the majority of the off-diagonal parameters are insignificant for the developing markets. Of the developed countries, New Zealand's returns are the most affected by cross mean spillover effects with Brazil (-0.5895), Russia (0.5570), and South Africa (0.6553) having the most significant effects as seen in Table 22 under New Zealand.

In studying the relationship between major bond markets Hunter and Simon (2005) found that while mean and volatility spillovers were evident between major international bond markets, they were found to be weaker than those evidenced in stock markets. The results in Table 22, show that Italy ($\varphi_{i,7}$) and the USA ($\varphi_{i,7}$) exert the most pressure on other developed markets but aside from this, the cross mean spillovers in developed countries seem much weaker for bonds than the effect in the stock markets, even during the pandemic.

4.4.2. BEKK Estimation Results

The MVGARCH BEKK model enables us to determine the direction of transmission of volatility. The diagonal values indicate own mean spillovers (ARCH effects) in the matrix A and the diagonal values in the matric B indicate persistence in its own conditional volatility which are the GARCH effects.

With the stock markets highlighted in Table 23, all the diagonal vectors, except for India ($A_{3,3}$), Sweden ($A,_{10,10)}$ and the USA ($A_{12,12}$), are statistically significant. This indicates that the presence of stock returns own volatility spillovers respond significantly to their own volatility from previous periods. Further, with regards to the presence of GARCH effects, that is, the persistence of volatility, all the markets, except for China ($B_{4,4}$), exhibit dependence on their own volatility in the previous period.

Table 22 BEKK Estimations (Stock Returns)

$$\boldsymbol{H_t} = \boldsymbol{C} + \boldsymbol{A}'\,(\boldsymbol{\varepsilon_{t-1}}\boldsymbol{\varepsilon}'_{t-1})\,\boldsymbol{A} + \mathrm{B}'\boldsymbol{H_{t-1}}\mathrm{B}$$

	Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error
	BRAZIL=1			RUSSIA=2			INDIA=3			CHINA=4			SOUTH_AFRICA=5			SOUTH_KOREA=6	
C(1,1)	0,0027***	0,0005	C(2,1)	0,0023***	0,0007	C(3,1)	-0,0012*	0,0006	C(4,1)	0,0034***	0,0008	C(5,1)	0,0051***	0,0007	C(6,1)	0,0038***	0,0014
C(2,1)	0,0023***	0,0007	C(2,2)	0,0029***	0,0004	C(3,2)	-0,0009*	0,0005	C(4,2)	-0,0016	0,0012	C(5,2)	0,0007	0,0008	C(6,2)	0,0028***	0,0011
C(3,1)	-0,0012*	0,0006	C(3,2)	-0,0009*	0,0005	C(3,3)	0,0025***	0,0005	C(4,3)	0,0025**	0,0010	C(5,3)	0,0024***	0,0007	C(6,3)	0,0041***	0,0009
C(4,1)	0,0034***	0,0008	C(4,2)	-0,0016	0,0012	C(4,3)	0,0025**	0,0010	C(4,4)	0,0012	0,0013	C(5,4)	-0,0002	0,0011	C(6,4)	-0,0004	0,0017
C(5,1)	0,0051***	0,0007	C(5,2)	0,0007	0,0008	C(5,3)	0,0024***	0,0007	C(5,4)	-0,0002	0,0011	C(5,5)	0,0000	0,0024	C(6,5)	0,0000	0,0041
C(6,1)	0,0038***	0,0014	C(6,2)	0,0028***	0,0011	C(6,3)	0,0041***	0,0009	C(6,4)	-0,0004	0,0017	C(6,5)	0,0000	0,0041	C(6,6)	0,0000	0,0010
C(7,1)	0,0031***	0,0009	C(7,2)	0,0009	0,0009	C(7,3)	0,0022***	0,0008	C(7,4)	0,0011	0,0011	C(7,5)	0,0000	0,0009	C(7,6)	0,0000	0,0010
C(8,1)	0,0035***	0,0004	C(8,2)	0,0010	0,0006	C(8,3)	0,0009	0,0006	C(8,4)	-0,0003	0,0009	C(8,5)	0,0000	0,0023	C(8,6)	0,0000	0,0005
C(9,1)	0,0019**	0,0008	C(9,2)	0,0020***	0,0007	C(9,3)	0,0004	0,0009	C(9,4)	0,0013	0,0010	C(9,5)	0,0000	0,0016	C(9,6)	0,0000	0,0013
C(10,1)	0,0050***	0,0007	C(10,2)	0,0013	0,0010	C(10,3)	0,0021**	0,0009	C(10,4)	-0,0004	0,0014	C(10,5)	0,0000	0,0037	C(10,6)	0,0000	0,0007
C(11,1)	0,0050***	0,0007	C(11,2)	0,0026***	0,0008	C(11,3)	-0,0001	0,0006	C(11,4)	0,0001	0,0008	C(11,5)	0,0000	0,0010	C(11,6)	0,0000	0,0005
C(12,1)	0,0022***	0,0006	C(12,2)	0,0014***	0,0005	C(12,3)	0,0011*	0,0006	C(12,4)	0,0010	0,0007	C(12,5)	0,0000	0,0010	C(12,6)	0,0000	0,0007
A(1,1)	0,0909***	0,0315	A(2,1)	0,4511***	0,0502	A(3,1)	0,0680*	0,0392	A(4,1)	0,0023	0,0579	A(5,1)	-0,2032***	0,0503	A(6,1)	-0,2453***	0,0397
A(1,2)	-0,1587***	0,0221	A(2,2)	0,1954***	0,0433	A(3,2)	-0,0136	0,0287	A(4,2)	-0,2448***	0,0502	A(5,2)	0,0550	0,0448	A(6,2)	0,1505***	0,0319
A(1,3)	0,0579**	0,0230	A(2,3)	0,3165***	0,0431	A(3,3)	0,0167	0,0306	A(4,3)	-0,2455***	0,0513	A(5,3)	-0,0897**	0,0415	A(6,3)	0,0827***	0,0294
A(1,4)	0,1765***	0,0244	A(2,4)	-0,2773***	0,0347	A(3,4)	0,1027	0,0314	A(4,4)	0,3095***	0,0549	A(5,4)	0,1161***	0,0400	A(6,4)	-0,0687**	0,0277
A(1,5)	0,0862***	0,0281	A(2,5)	0,2256***	0,0372	A(3,5)	-0,0608	0,0332	A(4,5)	-0,0082	0,0562	A(5,5)	-0,1351***	0,0455	A(6,5)	0,1361***	0,0308
A(1,6)	0,2737***	0,0377	A(2,6)	0,1303**	0,0556	A(3,6)	-0,0142	0,0438	A(4,6)	0,1954**	0,0789	A(5,6)	0,0675	0,0515	A(6,6)	0,2910***	0,0389
A(1,7)	-0,0363	0,0299	A(2,7)	0,4465***	0,0403	A(3,7)	-0,1012***	0,0319	A(4,7)	0,0248	0,0539	A(5,7)	0,0758	0,0490	A(6,7)	0,1724***	0,0303
A(1,8)	0,0947***	0,0197	A(2,8)	0,0096	0,0288	A(3,8)	0,0449*	0,0247	A(4,8)	0,1342***	0,0405	A(5,8)	-0,1287***	0,0281	A(6,8)	0,1192***	0,0213
A(1,9)	-0,1415***	0,0259	A(2,9)	0,0918**	0,0438	A(3,9)	-0,0246	0,0296	A(4,9)	0,0801	0,0597	A(5,9)	-0,0331	0,0443	A(6,9)	0,0778***	0,0298
A(1,10)	-0,0422	0,0288	A(2,10)	0,1698***	0,0378	A(3,10)	0,0411	0,0331	A(4,10)	0,1255**	0,0511	A(5,10)	0,1417***	0,0416	A(6,10)	-0,0322	0,0313
A(1,11)	-0,0318	0,0290	A(2,11)	0,2501***	0,0359	A(3,11)	-0,0315	0,0318	A(4,11)	-0,0081	0,0486	A(5,11)	0,0973**	0,0458	A(6,11)	0,1063***	0,0293
A(1,12)	-0,0959***	0,0233	A(2,12)	0,3319***	0,0396	A(3,12)	-0,1224***	0,0297	A(4,12)	0,1364***	0,0490	A(5,12)	0,2052***	0,0374	A(6,12)	0,0140	0,0247
B(1,1)	0,9136***	0,0259	B(2,1)	-0,2667***	0,0556	B(3,1)	0,08474**	0,0363	B(4,1)	0,0397	0,0700	B(5,1)	0,0008	0,0474	B(6,1)	0,2474***	0,0429
B(1,2)	0,0716***	0,0256	B(2,2)	0,6260***	0,0491	B(3,2)	0,0533**	0,0278	B(4,2)	0,3544***	0,0713	B(5,2)	0,0252	0,0358	B(6,2)	0,0075	0,0309
B(1,3)	0,0508***	0,0187	B(2,3)	0,0544	0,0410	B(3,3)	0,7634***	0,0250	B(4,3)	0,1215*	0,0665	B(5,3)	-0,3015***	0,0389	B(6,3)	-0,2170***	0,0286

B(1,4)	0,1712***	0,0262	B(2,4)	0,3638***	0,0364	B(3,4)	-0,0155	0,0339	B(4,4)	-0,0730	0,0812	B(5,4)	0,0437	0,0480	B(6,4)	-0,1018*	0,0536
B(1,5)	0,0199	0,0255	B(2,5)	-0,0372	0,0329	B(3,5)	0,3496***	0,0278	B(4,5)	-0,1373**	0,0568	B(5,5)	0,6452***	0,0443	B(6,5)	0,0155	0,0534
B(1,6)	0,1732***	0,0291	B(2,6)	0,1418**	0,0594	B(3,6)	0,3589***	0,0465	B(4,6)	-0,2481**	0,0999	B(5,6)	-0,2723***	0,0655	B(6,6)	0,6587***	0,0636
B(1,7)	0,2393***	0,0265	B(2,7)	0,2815***	0,0374	B(3,7)	0,0909***	0,0294	B(4,7)	-0,5616***	0,0633	B(5,7)	-0,2793***	0,0473	B(6,7)	-0,1350**	0,0534
B(1,8)	0,1047***	0,0134	B(2,8)	0,0548*	0,0303	B(3,8)	0,2098***	0,0183	B(4,8)	-0,2122***	0,0504	B(5,8)	0,0566*	0,0312	B(6,8)	0,0726**	0,0348
B(1,9)	0,1066***	0,0286	B(2,9)	-0,1052**	0,0461	B(3,9)	0,2760***	0,0314	B(4,9)	-0,5970***	0,0747	B(5,9)	0,5229***	0,0567	B(6,9)	0,1170**	0,0494
B(1,10)	0,1616***	0,0283	B(2,10)	0,3482***	0,0369	B(3,10)	0,3254***	0,0282	B(4,10)	-0,4711***	0,0650	B(5,10)	-0,1624***	0,0415	B(6,10)	0,1217**	0,0549
B(1,11)	0,0410*	0,0230	B(2,11)	0,0131	0,0321	B(3,11)	0,2562***	0,0251	B(4,11)	-0,2218***	0,0613	B(5,11)	-0,2535***	0,0456	B(6,11)	0,0303	0,0477
B(1,12)	0,1863***	0,0213	B(2,12)	-0,0114	0,0408	B(3,12)	-0,0237	0,0244	B(4,12)	-0,3976***	0,0701	B(5,12)	0,0716*	0,0372	B(6,12)	0,1741***	0,0447

	Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error
	ITALY=7			SINGAPORE=8			NEW_ZEALAND=9			SWEDEN=10			UK=11			USA=12	
C(7,1)	0,0031***	0,0009	C(8,1)	0,0035***	0,0004	C(9,1)	0,0019**	0,0008	C(10,1)	0,0050***	0,0007	C(11,1)	0,0050***	0,0007	C(12,1)	0,0022***	0,0006
C(7,2)	0,0009	0,0009	C(8,2)	0,0010	0,0006	C(9,2)	0,0020***	0,0007	C(10,2)	0,0013	0,0010	C(11,2)	0,0026***	0,0008	C(12,2)	0,0014***	0,0005
C(7,3)	0,0022***	0,0008	C(8,3)	0,0009	0,0006	C(9,3)	0,0004	0,0009	C(10,3)	0,0021**	0,0009	C(11,3)	-0,0001	0,0006	C(12,3)	0,0011*	0,0006
C(7,4)	0,0011	0,0011	C(8,4)	-0,0003	0,0009	C(9,4)	0,0013	0,0010	C(10,4)	-0,0004	0,0014	C(11,4)	0,0001	0,0008	C(12,4)	0,0010	0,0007
C(7,5)	0,0000	0,0009	C(8,5)	0,0000	0,0023	C(9,5)	0,0000	0,0016	C(10,5)	0,0000	0,0037	C(11,5)	0,0000	0,0010	C(12,5)	0,0000	0,0010
C(7,6)	0,0000	0,0010	C(8,6)	0,0000	0,0005	C(9,6)	0,0000	0,0013	C(10,6)	0,0000	0,0007	C(11,6)	0,0000	0,0005	C(12,6)	0,0000	0,0007
C(7,7)	0,0000	0,0006	C(8,7)	0,0000	0,0004	C(9,7)	0,0000	0,0010	C(10,7)	0,0000	0,0006	C(11,7)	0,0000	0,0005	C(12,7)	0,0000	0,0006
C(8,7)	0,0000	0,0004	C(8,8)	0,0000	0,0003	C(9,8)	0,0000	0,0010	C(10,8)	0,0000	0,0004	C(11,8)	0,0000	0,0004	C(12,8)	0,0000	0,0006
C(9,7)	0,0000	0,0010	C(9,8)	0,0000	0,0010	C(9,9)	0,0000	0,0007	C(10,9)	0,0000	0,0004	C(11,9)	0,0000	0,0005	C(12,9)	0,0000	0,0005
C(10,7)	0,0000	0,0006	C(10,8)	0,0000	0,0004	C(10,9)	0,0000	0,0004	C(10,10)	0,0000	0,0004	C(11,10)	0,0000	0,0003	C(12,10)	0,0000	0,0004
C(11,7)	0,0000	0,0005	C(11,8)	0,0000	0,0004	C(11,9)	0,0000	0,0005	C(11,10)	0,0000	0,0003	C(11,11)	0,0000	0,0003	C(12,11)	0,0000	0,0004
C(12,7)	0,0000	0,0006	C(12,8)	0,0000	0,0006	C(12,9)	0,0000	0,0005	C(12,10)	0,0000	0,0004	C(12,11)	0,0000	0,0004	C(12,12)	0,0000	0,0004
A(7,1)	0,2541***	0,0361	A(8,1)	0,4864***	0,0622	A(9,1)	-0,2533***	0,0464	A(10,1)	-0,2204***	0,0511	A(11,1)	0,2033***	0,0689	A(12,1)	-0,2481	0,0510
A(7,2)	0,0829***	0,0284	A(8,2)	-0,0657	0,0534	A(9,2)	-0,2058***	0,0412	A(10,2)	-0,1826***	0,0434	A(11,2)	0,1080*	0,0556	A(12,2)	-0,0745	0,0382
A(7,3)	0,0718**	0,0336	A(8,3)	0,3569***	0,0526	A(9,3)	-0,0710*	0,0401	A(10,3)	-0,0770*	0,0402	A(11,3)	-0,4251***	0,0493	A(12,3)	-0,0481	0,0338
A(7,4)	-0,2704***	0,0350	A(8,4)	-0,1962***	0,0463	A(9,4)	0,0549	0,0349	A(10,4)	0,1976***	0,0485	A(11,4)	0,0562	0,0505	A(12,4)	-0,2798	0,0358
A(7,5)	-0,0046	0,0303	A(8,5)	0,1446***	0,0392	A(9,5)	-0,4246***	0,0405	A(10,5)	-0,1774***	0,0441	A(11,5)	0,3657***	0,0566	A(12,5)	-0,3224	0,0433

A(7,6)	-0,1393***	0,0492	A(8,6)	0,1102	0,0780	A(9,6)	-0,5452***	0,0537	A(10,6)	-0,5253***	0,0574	A(11,6)	0,4384***	0,0622	A(12,6)	-0,6433	0,0562
A(7,7)	0,3024***	0,0290	A(8,7)	0,0193	0,0375	A(9,7)	-0,3314***	0,0433	A(10,7)	-0,0859*	0,0472	A(11,7)	0,0307	0,0601	A(12,7)	-0,4161	0,0463
A(7,8)	-0,0284	0,0269	A(8,8)	0,0532	0,0358	A(9,8)	-0,3724***	0,0297	A(10,8)	-0,1799***	0,0355	A(11,8)	0,2926***	0,0441	A(12,8)	-0,3336	0,0336
A(7,9)	0,0934***	0,0333	A(8,9)	-0,2272***	0,0559	A(9,9)	0,0486	0,0370	A(10,9)	-0,0731	0,0468	A(11,9)	0,1033*	0,0595	A(12,9)	-0,2325	0,0455
A(7,10)	0,0109	0,0318	A(8,10)	0,1312***	0,0351	A(9,10)	-0,4958***	0,0363	A(10,10)	0,0199	0,0442	A(11,10)	0,1743***	0,0594	A(12,10)	-0,1853	0,0419
A(7,11)	-0,0373	0,0278	A(8,11)	0,0251	0,0359	A(9,11)	-0,3878***	0,0400	A(10,11)	-0,1776***	0,0348	A(11,11)	0,4188***	0,0566	A(12,11)	-0,2400	0,0448
A(7,12)	0,2123***	0,0311	A(8,12)	-0,2117***	0,0419	A(9,12)	-0,2123***	0,0354	A(10,12)	0,0626*	0,0376	A(11,12)	-0,1776***	0,0488	A(12,12)	0,1288	0,0348
B(7,1)	0,4413***	0,0642	B(8,1)	-0,5807***	0,0756	B(9,1)	-0,2121***	0,0495	B(10,1)	-0,2106***	0,0742	B(11,1)	0,0287	0,0774	B(12,1)	-0,1340	0,0450
B(7,2)	0,3357***	0,0537	B(8,2)	-0,4680***	0,0647	B(9,2)	-0,0275	0,0402	B(10,2)	-0,1061*	0,0547	B(11,2)	-0,2643***	0,0646	B(12,2)	0,1889	0,0411
B(7,3)	-0,0187	0,0537	B(8,3)	0,2902***	0,0499	B(9,3)	-0,1061***	0,0386	B(10,3)	-0,3114***	0,0517	B(11,3)	0,2420***	0,0717	B(12,3)	0,3612	0,0297
B(7,4)	-0,2394***	0,0472	B(8,4)	0,3031***	0,0904	B(9,4)	-0,2868***	0,0380	B(10,4)	-0,5544***	0,0809	B(11,4)	0,4561***	0,0822	B(12,4)	0,0408	0,0406
B(7,5)	0,5689***	0,0551	B(8,5)	-0,4627***	0,0842	B(9,5)	-0,2141***	0,0428	B(10,5)	-0,6958***	0,0765	B(11,5)	-0,1372	0,0945	B(12,5)	0,2061	0,0496
B(7,6)	-0,0662	0,0667	B(8,6)	-0,2923***	0,1045	B(9,6)	0,0138	0,0564	B(10,6)	-0,7465***	0,0845	B(11,6)	0,1355	0,0929	B(12,6)	0,3744	0,0594
B(7,7)	0,7623***	0,0537	B(8,7)	0,2058**	0,0842	B(9,7)	-0,0035	0,0490	B(10,7)	-0,3786***	0,0789	B(11,7)	-0,2621***	0,0809	B(12,7)	0,1809	0,0425
B(7,8)	0,0881**	0,0420	B(8,8)	0,5442***	0,0609	B(9,8)	-0,1485***	0,0300	B(10,8)	-0,2646***	0,0459	B(11,8)	-0,1980***	0,0632	B(12,8)	0,2173	0,0242
B(7,9)	-0,2297***	0,0500	B(8,9)	-0,2310***	0,0813	B(9,9)	0,4117***	0,0436	B(10,9)	0,0708	0,0619	B(11,9)	0,1815**	0,0906	B(12,9)	-0,0935	0,0407
B(7,10)	0,3771***	0,0562	B(8,10)	-0,3034***	0,0805	B(9,10)	-0,2730***	0,0408	B(10,10)	0,3132***	0,0820	B(11,10)	-0,4392***	0,1055	B(12,10)	0,0053	0,0499
B(7,11)	0,4436***	0,0526	B(8,11)	-0,2330***	0,0775	B(9,11)	-0,2045***	0,0368	B(10,11)	-0,2717***	0,0750	B(11,11)	0,4691***	0,0831	B(12,11)	0,1478	0,0409
B(7,12)	0,1356**	0,0627	B(8,12)	-0,1852***	0,0709	B(9,12)	-0,3757***	0,0301	B(10,12)	-0,1520***	0,0576	B(11,12)	-0,0973	0,0808	B(12,12)	0,7100	0,0373

The Table reports MVGARCH BEKK estimation results for daily stock returns over the period 1st July 2019 to 30th June 2020. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The GARCH model is described in section 3.2.3.

The off-diagonal matrices of A and B capture cross-market effects of volatility spillovers. The USA exhibits high unidirectional linkages in the transmission of shocks to all the markets except South Korea which is more significantly affected by other emerging markets. The USA exports as high as 33% (Russia) of its volatility. This result is not surprising as the S&P 500 is the major transmitter of volatility worldwide (Ling and Gurjeet, 2010). Over the last two decades there has been substantial financial integration driven by increased capital flows and technological advancements, with the USA being central to both (Li and Giles, 2014). As a result, during the COVID-19 pandemic, the volatility transmission has been significant as investors from the USA withdraw their investments from different markets. The fact that no bidirectional volatility is noted with regards to the USA shows that it was the source of the financial contagion that affected the stock markets during the early stages of the pandemic. The GARCH effects, however, are not as significant. Only 7 countries show significant (1% and 5% levels) off-diagonal matrices in relation to the cross-market effects of volatility spillovers. Russia, India, and China, notably, are among the countries with no significance volatility persistence.

The contagion test, when analysing correlations, is seen in the significant increase of stock price co-movement (Naoui and Liouane, 2010). Figure 25,26 and 27 highlight the conditional correlation between emerging market stocks. Though volatility increases are visible during the initial period of the pandemic, the volatility does not seem to persist after the initial shock. It should be noted though, that even pre-crisis correlation is high among the emerging market countries. The shock of the pandemic only serves to increase the correlation, though as in the case of Figure 25 and 26, for a brief period, there is a negative correlation as each market investors in each market reacted at different degrees to the news and the prospective effect of the pandemic on each country. The increased correlation is proof of financial contagion being prominent during the pandemic.

Figure 25 Conditional correlation between the Brazil Stock market returns and South Africa stock market returns, estimated by DCC

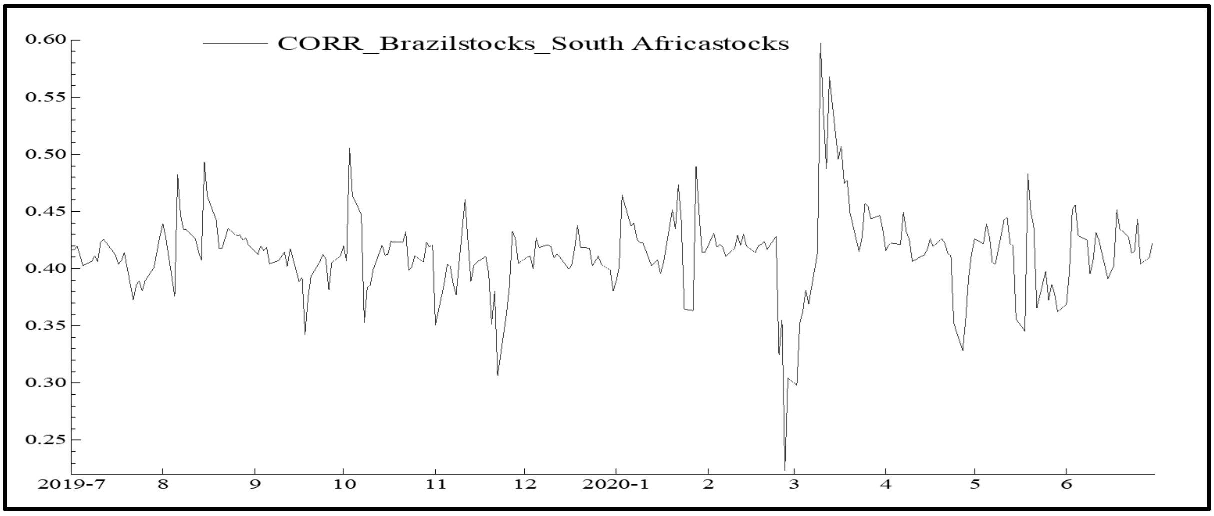


Figure 26 Conditional correlation between the Russia Stock market returns and the China stock market returns, estimated by DCC

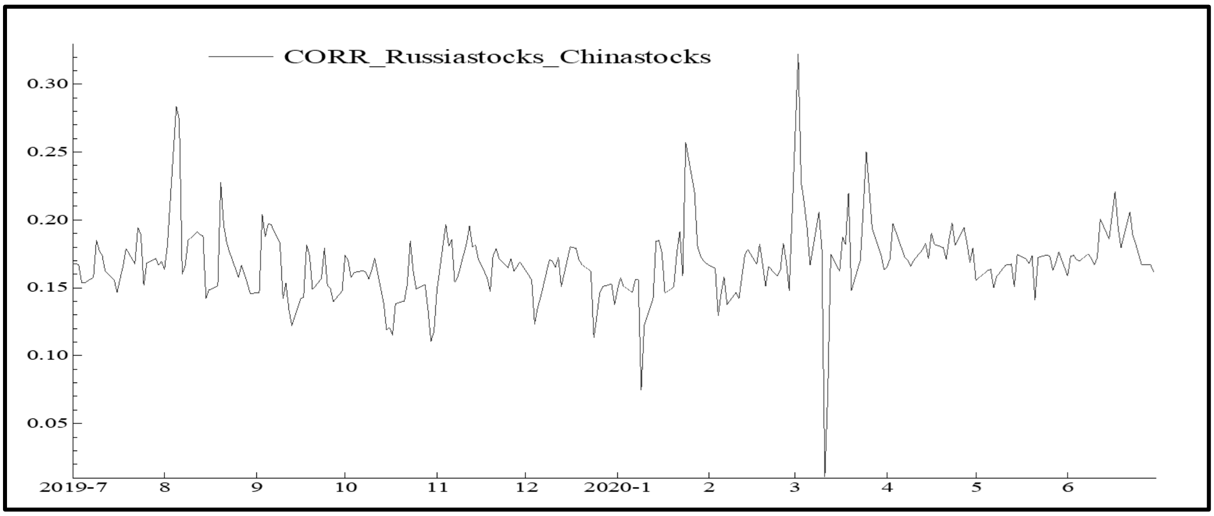
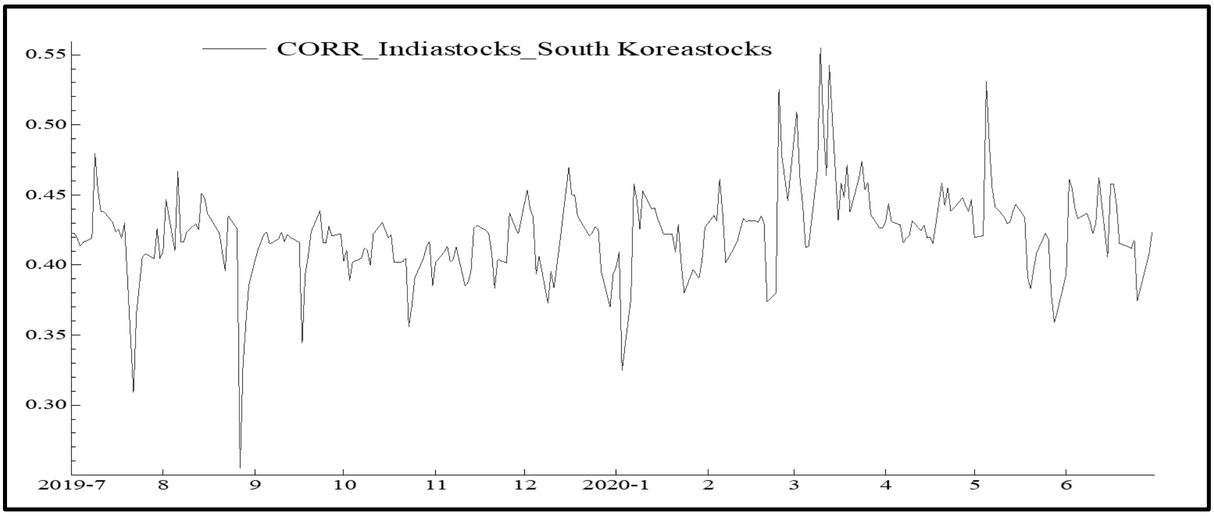


Figure 27 Conditional correlation between the India Stock market returns and the South Korea stock market returns, estimated by DCC



The dynamic conditional correlation graphs in Figure 28,29 and 30 represent the correlations between developed and emerging market returns. Similar to the effects of the global financial crisis on correlation between the USA and emerging market countries (Naoui and Liouane, 2010), we find strong evidence of correlation between the US and the BRICS nations during the COVID-19 pandemic. The research by Zhang, Li and Yu (2013) found that, in comparison to India and China, Russia and Brazil's stock markets had stronger correlations with developed countries. In comparison to Figure 28, Figure 29 and 30 show this to be true as correlations between Russia and Brazil with the USA are much more prominent than the correlation between the USA and India. With Brazil and Russia, we see a sharp negative correlation with the US market in mi-March. Negative correlation during periods of uncertainty signify the presence of "flight to quality" rather than contagion (Baur and Lucey, 2009). This would therefore highlight that at the onset of the pandemic investors retreated significantly from these emerging markets.

Figure 28 Conditional correlation between the India Stock market returns and the USA stock market returns, estimated by DCC

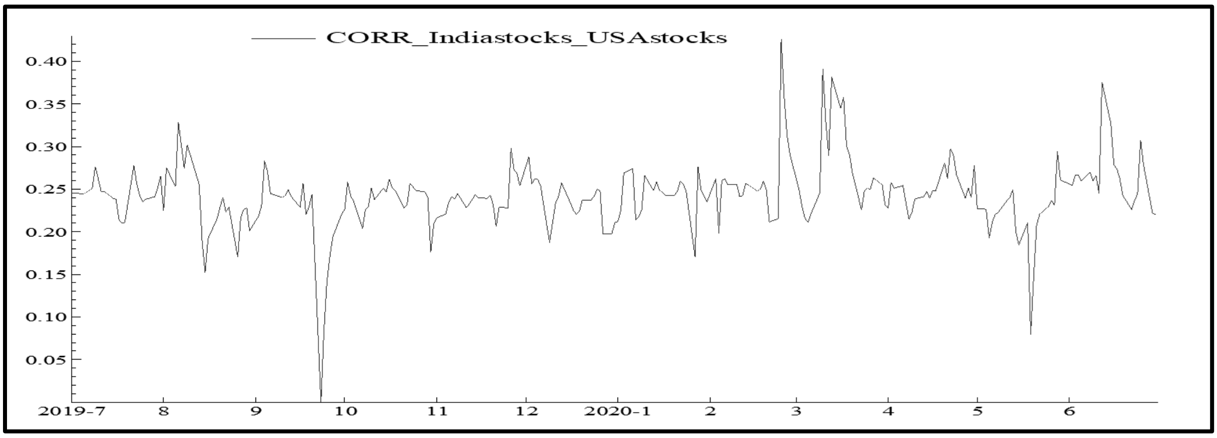


Figure 29 Conditional correlation between the Russia Stock market returns and the USA stock market returns, estimated by DCC

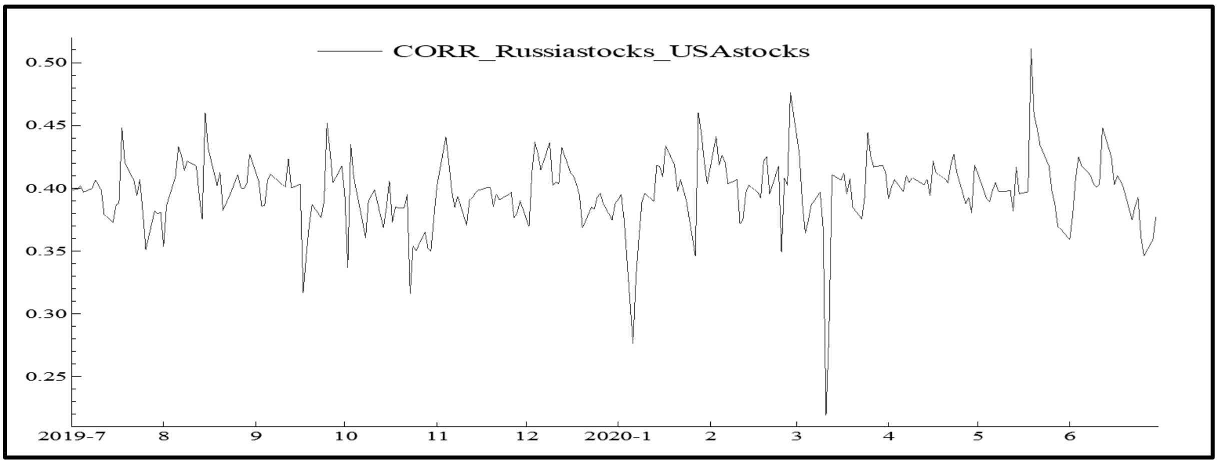


Figure 30 Conditional correlation between the Brazil Stock market returns and the USA stock market returns, estimated by DCC

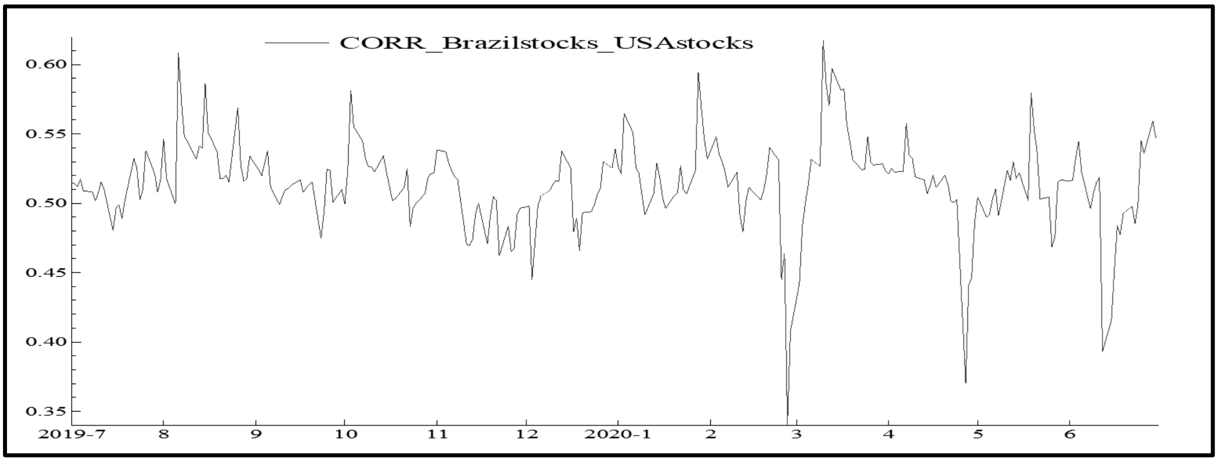
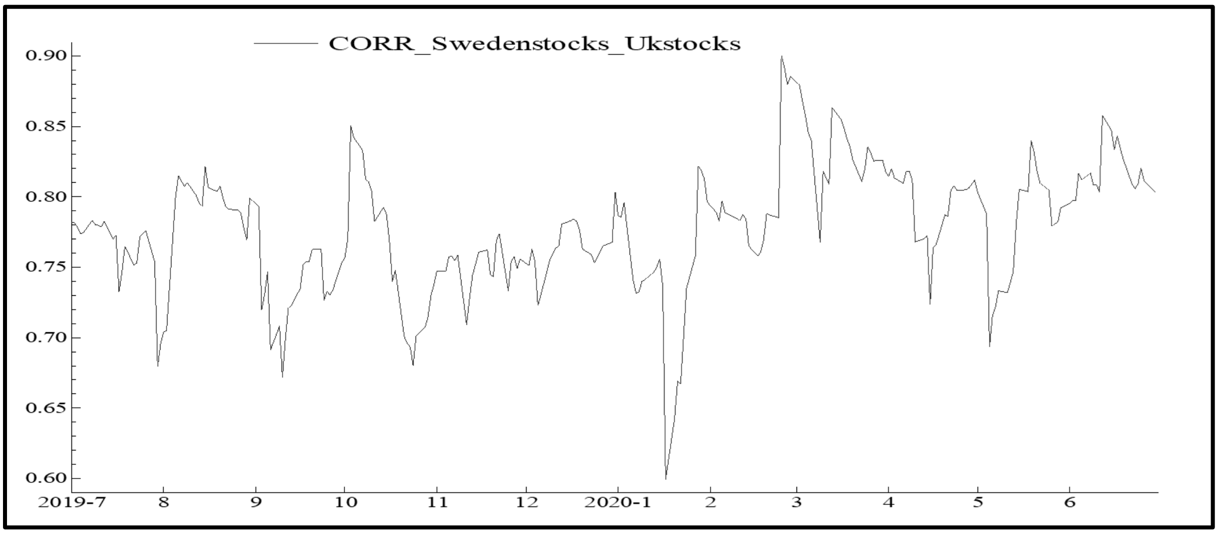


Figure 31, 32 and 33 represent conditional correlations between developed markets. Cappiello (2006) finds that financial turmoil results in a dramatic increase in conditional equity correlation among developed markets. This is proved to be true, with a strong correlation witnessed within the 1st and 4th month of 2020. It must, however, be noted that the significant correlation in towards the end of January with the correlations linked to the UK also include the effects of the BREXIT deadline which at the time had been pushed to January 31st 2020[59]. The correlations noted prove the effects of financial contagion during the COVID-19 pandemic on stock markets in developed countries.

Figure 31 Conditional correlation between the Sweden Stock market returns and the UK stock market returns, estimated by DCC



[59] Brexit in January 2020 won't lift fog over UK markets, investors say | Reuters [Accessed: 12.12.20]

Figure 32 Conditional correlation between the Italy Stock market returns and the New Zealand stock market returns, estimated by DCC

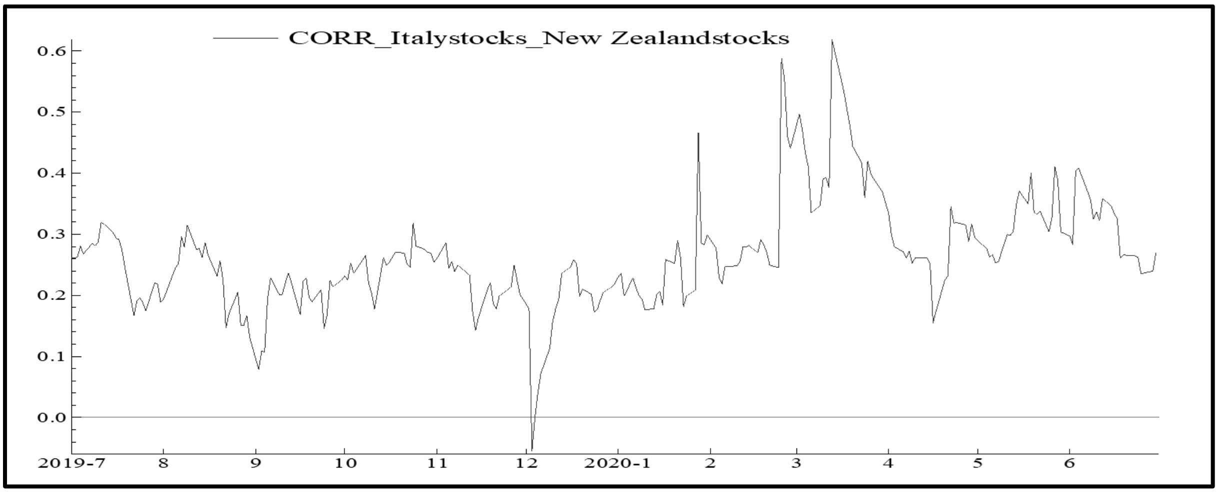


Figure 33 Conditional correlation between the UK Stock market returns and the USA stock market returns, estimated by DCC

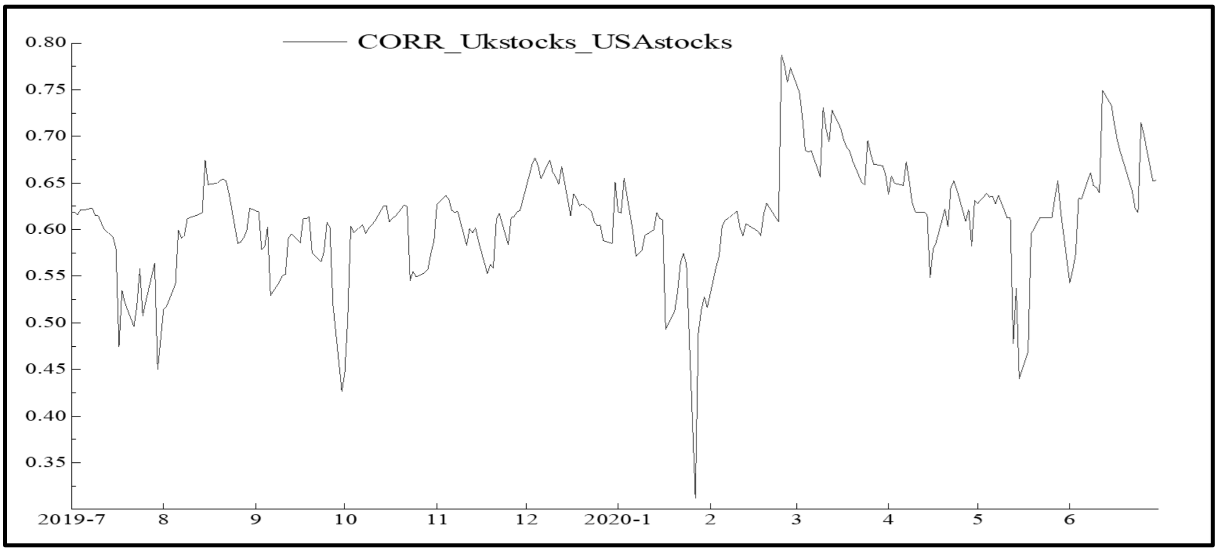


Table 24 highlights the BEKK estimations for the bond yields of the sample countries. The diagonal parameters are significant for Russia, South Africa, Italy, Singapore, Sweden, and the USA. The own spillover effects range from 51% (Russia) to -6% (South Africa). For these countries, the current volatility of the bond yields is highly dependent on its own volatility in the preceding period. The diagonal B matrices are statistically significant, therefore highlighting the presence of conditional variances and indicating that GARCH effects are significant.

The off-diagonal matrices capture strong cross-market effects of volatility spillovers. All the countries' bond yields have a least 8 A and B matrices with statistically significant coefficients. This indicates that the linkages are significantly bidirectional when it comes to the transmission of shocks. This finding supports existing evidence of the integration of bond markets and that no single country is at the “centre” of financial linkages (Gilmore, Lucey and Boscia, 2010; Ciner, 2007). It can, therefore, be concluded that though spillover effects are evident, with no single direction of volatility being ascertained, that the hypothesis of the presence of financial contagion in bond markets during this period can be rejected.

Table 23 BEKK Estimations (Bond Yields)

$$\boldsymbol{H_t} = \boldsymbol{C} + \boldsymbol{A}'\,(\boldsymbol{\varepsilon_{t-1}}\boldsymbol{\varepsilon}'_{\boldsymbol{t-1}})\,\boldsymbol{A} + \mathrm{B}'\boldsymbol{H_{t-1}}\mathrm{B}$$

	Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error
	BRAZIL=1			RUSSIA=2			INDIA=3			CHINA=4			SOUTH_AFRICA=5			SOUTH_KOREA=6	
C(1,1)	0,0026***	0,0005	C(2,1)	-0,0010*	0,0006	C(3,1)	0,0013**	0,0007	C(4,1)	-0,0009**	0,0005	C(5,1)	-0,0005	0,0004	C(6,1)	-0,0136***	0,0021
C(2,1)	-0,0010*	0,0006	C(2,2)	0,0032***	0,0004	C(3,2)	-0,0009	0,0006	C(4,2)	0,0003	0,0004	C(5,2)	-0,0001	0,0004	C(6,2)	0,0022	0,0025
C(3,1)	0,0013**	0,0007	C(3,2)	-0,0009	0,0006	C(3,3)	0,0012**	0,0005	C(4,3)	-0,0006	0,0009	C(5,3)	0,0005	0,0005	C(6,3)	-0,0082**	0,0035
C(4,1)	-0,0009**	0,0005	C(4,2)	0,0003	0,0004	C(4,3)	-0,0006	0,0009	C(4,4)	-0,0008	0,0006	C(5,4)	0,0001	0,0007	C(6,4)	0,0014	0,0101
C(5,1)	-0,0005	0,0004	C(5,2)	-0,0001	0,0004	C(5,3)	0,0005	0,0005	C(5,4)	0,0001	0,0007	C(5,5)	0,0000	0,0005	C(6,5)	0,0000	0,0109
C(6,1)	-0,0136***	0,0021	C(6,2)	0,0022	0,0025	C(6,3)	-0,0082**	0,0035	C(6,4)	0,0014	0,0101	C(6,5)	0,0000	0,0109	C(6,6)	0,0000	0,0060
C(7,1)	0,0055*	0,0030	C(7,2)	-0,0009	0,0021	C(7,3)	-0,0113	0,0080	C(7,4)	0,0085	0,0111	C(7,5)	0,0000	0,0157	C(7,6)	0,0000	0,0095
C(8,1)	-0,0030***	0,0012	C(8,2)	-0,0027***	0,0011	C(8,3)	-0,00093102	0,0013	C(8,4)	0,0006	0,0020	C(8,5)	0,0000	0,0022	C(8,6)	0,0000	0,0018
C(9,1)	-0,0020	0,0017	C(9,2)	-0,0010	0,0017	C(9,3)	0,0018	0,0034	C(9,4)	0,0028*	0,0016	C(9,5)	0,0000	0,0026	C(9,6)	0,0000	0,0025
C(10,1)	0,0151	0,0323	C(10,2)	0,0701***	0,0271	C(10,3)	-0,058**	0,0298	C(10,4)	0,0147	0,0567	C(10,5)	0,0000	0,0670	C(10,6)	0,0000	0,0437
C(11,1)	-0,0140**	0,0071	C(11,2)	-0,0379***	0,0042	C(11,3)	-0,0005	0,0070	C(11,4)	0,0018	0,0069	C(11,5)	0,0000	0,0045	C(11,6)	0,0000	0,0084
C(12,1)	-0,0042	0,0026	C(12,2)	-0,0126***	0,0015	C(12,3)	-0,0010	0,0033	C(12,4)	0,0028	0,0022	C(12,5)	0,0000	0,0026	C(12,6)	0,0000	0,0032
A(1,1)	0,0443	0,0391	A(2,1)	0,0116	0,0512	A(3,1)	0,2590***	0,0664	A(4,1)	-0,1639**	0,0646	A(5,1)	-0,0851**	0,0429	A(6,1)	0,2016***	0,0268
A(1,2)	0,3514***	0,0347	A(2,2)	0,1893***	0,0382	A(3,2)	0,1288**	0,0528	A(4,2)	0,0229	0,0497	A(5,2)	-0,2593***	0,0608	A(6,2)	0,1150***	0,0239
A(1,3)	0,1143***	0,0193	A(2,3)	-0,0820***	0,0265	A(3,3)	0,0059	0,0361	A(4,3)	0,1669***	0,0364	A(5,3)	-0,0433	0,0276	A(6,3)	-0,0365**	0,0162
A(1,4)	-0,0530***	0,0191	A(2,4)	-0,1013***	0,0290	A(3,4)	0,1568***	0,0359	A(4,4)	-0,0582	0,0402	A(5,4)	-0,0594**	0,0252	A(6,4)	-0,0035	0,0153
A(1,5)	0,0999***	0,0229	A(2,5)	-0,1096***	0,0404	A(3,5)	-0,1482***	0,0477	A(4,5)	0,2536***	0,0454	A(5,5)	-0,0653**	0,0347	A(6,5)	-0,0302*	0,0181
A(1,6)	0,0183	0,0707	A(2,6)	-0,4570***	0,0857	A(3,6)	-0,2430**	0,1135	A(4,6)	0,5887***	0,1382	A(5,6)	-0,1846**	0,0764	A(6,6)	0,0438	0,0498
A(1,7)	0,8077***	0,1267	A(2,7)	0,7855***	0,1654	A(3,7)	-0,7504***	0,2348	A(4,7)	0,3462*	0,2041	A(5,7)	-1,0959***	0,1845	A(6,7)	-0,3550***	0,1019
A(1,8)	-0,4334***	0,0587	A(2,8)	-0,4503***	0,0764	A(3,8)	-0,3787***	0,1128	A(4,8)	0,5956***	0,1142	A(5,8)	0,2423***	0,0740	A(6,8)	-0,4620***	0,0457
A(1,9)	-0,8539***	0,0858	A(2,9)	0,7341***	0,1261	A(3,9)	-0,2570	0,1763	A(4,9)	0,5278***	0,1612	A(5,9)	-0,0609	0,1271	A(6,9)	-0,3087***	0,0735
A(1,10)	-2,392*	1,3971	A(2,10)	5,8762***	2,0719	A(3,10)	14,9263***	2,7155	A(4,10)	12,8265***	2,9149	A(5,10)	-2,5259	1,8005	A(6,10)	-3,0522***	1,0344
A(1,11)	-0,3403*	0,1957	A(2,11)	0,2273	0,2582	A(3,11)	-1,5836***	0,4409	A(4,11)	-2,8328***	0,4445	A(5,11)	0,4091	0,3117	A(6,11)	-0,7555***	0,2053
A(1,12)	-0,5279***	0,0988	A(2,12)	-0,9128***	0,1376	A(3,12)	-0,4459**	0,1792	A(4,12)	-1,0790***	0,1577	A(5,12)	0,4339***	0,1484	A(6,12)	-0,5630***	0,0824
B(1,1)	0,7464***	0,0205	B(2,1)	0,0276	0,0399	B(3,1)	-0,1233	0,0867	B(4,1)	-0,1347**	0,0613	B(5,1)	-0,0644	0,0405	B(6,1)	0,1178***	0,0198
B(1,2)	0,0748***	0,0196	B(2,2)	0,6832***	0,0336	B(3,2)	0,0473	0,0828	B(4,2)	-0,1902***	0,0422	B(5,2)	-0,0414	0,0291	B(6,2)	-0,1107***	0,0195
B(1,3)	-0,0794***	0,0187	B(2,3)	0,2042***	0,0309	B(3,3)	0,1398**	0,0665	B(4,3)	-0,0700	0,0461	B(5,3)	-0,1042***	0,0404	B(6,3)	0,1706***	0,0242

B(1,4)	0,0785***	0,0182	B(2,4)	-0,0744***	0,0268	B(3,4)	0,4039***	0,0469	B(4,4)	0,6997***	0,0296	B(5,4)	-0,0633**	0,0272	B(6,4)	-0,0440**	0,0194
B(1,5)	0,1133***	0,0219	B(2,5)	0,0236	0,0341	B(3,5)	0,3513***	0,0608	B(4,5)	-0,2405***	0,0420	B(5,5)	0,7373***	0,0216	B(6,5)	0,0063	0,0189
B(1,6)	-0,2014***	0,0502	B(2,6)	0,4336***	0,0632	B(3,6)	-0,2784	0,2116	B(4,6)	0,3283***	0,1184	B(5,6)	0,0871	0,0686	B(6,6)	0,5295***	0,0460
B(1,7)	-0,434***	0,1039	B(2,7)	-0,2329	0,1433	B(3,7)	-0,0649	0,3622	B(4,7)	-0,2327	0,2220	B(5,7)	0,0661	0,1237	B(6,7)	-0,2522**	0,1047
B(1,8)	0,2019***	0,0588	B(2,8)	0,2821***	0,0698	B(3,8)	0,8952***	0,1138	B(4,8)	-0,3421***	0,0981	B(5,8)	-0,3446***	0,0633	B(6,8)	-0,0009	0,0504
B(1,9)	0,2564***	0,0711	B(2,9)	-0,1599	0,1297	B(3,9)	-0,7354***	0,2384	B(4,9)	-0,6883***	0,1600	B(5,9)	0,5134***	0,0856	B(6,9)	0,2370***	0,0731
B(1,10)	-2,0030	1,2741	B(2,10)	4,9297**	1,9313	B(3,10)	3,5890	4,1157	B(4,10)	-37,2133***	2,7395	B(5,10)	-8,7371***	2,0115	B(6,10)	-1,9494	1,5208
B(1,11)	0,8451***	0,2143	B(2,11)	-0,6347	0,5007	B(3,11)	-4,0426***	0,6767	B(4,11)	2,9010***	0,4823	B(5,11)	1,7441***	0,2702	B(6,11)	-1,0428***	0,1989
B(1,12)	-0,3079***	0,0732	B(2,12)	0,4541***	0,1576	B(3,12)	-0,2739	0,2517	B(4,12)	1,1855***	0,1945	B(5,12)	0,5716***	0,1135	B(6,12)	-0,3687***	0,0813

	Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error		Coefficient	Std Error
	ITALY=7			SINGAPORE=8			NEW_ZEALAND=9			SWEDEN=10			UK=11			USA=12	
C(7,1)	0,0055*	0,0030	C(8,1)	-0,0030***	0,0012	C(9,1)	-0,0020	0,0017	C(10,1)	0,0151	0,0323	C(11,1)	-0,0140**	0,0071	C(12,1)	-0,0042	0,0026
C(7,2)	-0,0009	0,0021	C(8,2)	-0,0027***	0,0011	C(9,2)	-0,0010	0,0017	C(10,2)	0,0701***	0,0271	C(11,2)	-0,0379***	0,0042	C(12,2)	-0,0126***	0,0015
C(7,3)	-0,0113	0,0080	C(8,3)	-0,00093102	0,0013	C(9,3)	0,0018	0,0034	C(10,3)	-0,058**	0,0298	C(11,3)	-0,0005	0,0070	C(12,3)	-0,0010	0,0033
C(7,4)	0,0085	0,0111	C(8,4)	0,0006	0,0020	C(9,4)	0,0028*	0,0016	C(10,4)	0,0147	0,0567	C(11,4)	0,0018	0,0069	C(12,4)	0,0028	0,0022
C(7,5)	0,0000	0,0157	C(8,5)	0,0000	0,0022	C(9,5)	0,0000	0,0026	C(10,5)	0,0000	0,0670	C(11,5)	0,0000	0,0045	C(12,5)	0,0000	0,0026
C(7,6)	0,0000	0,0095	C(8,6)	0,0000	0,0018	C(9,6)	0,0000	0,0025	C(10,6)	0,0000	0,0437	C(11,6)	0,0000	0,0084	C(12,6)	0,0000	0,0032
C(7,7)	0,0000	0,0028	C(8,7)	0,0000	0,0012	C(9,7)	0,0000	0,0025	C(10,7)	0,0000	0,0312	C(11,7)	0,0000	0,0047	C(12,7)	0,0000	0,0021
C(8,7)	0,0000	0,0012	C(8,8)	0,0000	0,0010	C(9,8)	0,0000	0,0026	C(10,8)	0,0000	0,0422	C(11,8)	0,0000	0,0041	C(12,8)	0,0000	0,0018
C(9,7)	0,0000	0,0025	C(9,8)	0,0000	0,0026	C(9,9)	0,0000	0,0021	C(10,9)	0,0000	0,0391	C(11,9)	0,0000	0,0066	C(12,9)	0,0000	0,0022
C(10,7)	0,0000	0,0312	C(10,8)	0,0000	0,0422	C(10,9)	0,0000	0,0391	C(10,10)	0,0000	0,0204	C(11,10)	0,0000	0,0032	C(12,10)	0,0000	0,0019
C(11,7)	0,0000	0,0047	C(11,8)	0,0000	0,0041	C(11,9)	0,0000	0,0066	C(11,10)	0,0000	0,0032	C(11,11)	0,0000	0,0050	C(12,11)	0,0000	0,0019
C(12,7)	0,0000	0,0021	C(12,8)	0,0000	0,0018	C(12,9)	0,0000	0,0022	C(12,10)	0,0000	0,0019	C(12,11)	0,0000	0,0019	C(12,12)	0,0000	0,0017
A(7,1)	-0,0444***	0,0102	A(8,1)	0,0453**	0,0208	A(9,1)	-0,0484***	0,0135	A(10,1)	0,0010*	0,0006	A(11,1)	0,0486***	0,0062	A(12,1)	-0,0792***	0,0133
A(7,2)	-0,0038	0,0072	A(8,2)	0,0210	0,0176	A(9,2)	-0,0297***	0,0089	A(10,2)	-0,0004	0,0005	A(11,2)	-0,0047	0,0051	A(12,2)	0,0527***	0,0097
A(7,3)	-0,0091	0,0064	A(8,3)	-0,0150	0,0114	A(9,3)	-0,0074	0,0062	A(10,3)	-0,0012***	0,0004	A(11,3)	-0,0190***	0,0037	A(12,3)	0,0319***	0,0058
A(7,4)	-0,0444***	0,0059	A(8,4)	0,1028***	0,0142	A(9,4)	-0,0336***	0,0077	A(10,4)	0,0002	0,0004	A(11,4)	0,0196***	0,0037	A(12,4)	-0,0318***	0,0071
A(7,5)	0,0249***	0,0070	A(8,5)	0,0030	0,0167	A(9,5)	-0,0145	0,0099	A(10,5)	0,0000	0,0004	A(11,5)	-0,0155***	0,0049	A(12,5)	0,0197**	0,0094
A(7,6)	-0,1166***	0,0172	A(8,6)	0,1780***	0,0410	A(9,6)	0,0101	0,0213	A(10,6)	0,0038***	0,0012	A(11,6)	0,0574***	0,0115	A(12,6)	-0,2262***	0,0212

A(7,7)	0,2188***	0,0353	A(8,7)	-0,3623***	0,0820	A(9,7)	0,0883*	0,0483	A(10,7)	-0,0077***	0,0024	A(11,7)	-0,0342	0,0245	A(12,7)	0,2023***	0,0497
A(7,8)	-0,1402***	0,0176	A(8,8)	0,5141***	0,0384	A(9,8)	0,0134	0,0209	A(10,8)	0,0036***	0,0011	A(11,8)	0,0403***	0,0113	A(12,8)	-0,1308***	0,0231
A(7,9)	-0,1654***	0,0241	A(8,9)	0,1340**	0,0617	A(9,9)	-0,0315	0,0295	A(10,9)	0,0036**	0,0017	A(11,9)	-0,1094***	0,0184	A(12,9)	0,1519***	0,0388
A(7,10)	0,4687	0,3963	A(8,10)	-4,0299***	1,0699	A(9,10)	0,1255	0,5584	A(10,10)	0,3562***	0,0340	A(11,10)	0,2519	0,3367	A(12,10)	-0,2097	0,6045
A(7,11)	-0,3399***	0,0699	A(8,11)	0,0034	0,1767	A(9,11)	0,4114***	0,0810	A(10,11)	0,0260***	0,0046	A(11,11)	-0,0072	0,0472	A(12,11)	0,3759***	0,1134
A(7,12)	-0,2120***	0,0294	A(8,12)	0,1878***	0,0563	A(9,12)	0,2907***	0,0332	A(10,12)	0,0096***	0,0019	A(11,12)	-0,0607***	0,0174	A(12,12)	0,3510***	0,0324
B(7,1)	0,0044	0,0082	B(8,1)	-0,0234	0,0233	B(9,1)	-0,0620***	0,0102	B(10,1)	0,0015***	0,0005	B(11,1)	-0,0252***	0,0090	B(12,1)	0,1494***	0,0115
B(7,2)	0,0042	0,0065	B(8,2)	0,0056	0,0188	B(9,2)	0,0248***	0,0080	B(10,2)	-0,0018***	0,0004	B(11,2)	0,0267***	0,0075	B(12,2)	-0,0107	0,0099
B(7,3)	-0,0102	0,0072	B(8,3)	-0,0800***	0,0154	B(9,3)	-0,0386***	0,0077	B(10,3)	0,0011**	0,0005	B(11,3)	0,0789***	0,0072	B(12,3)	-0,0387***	0,0118
B(7,4)	0,0276***	0,0051	B(8,4)	-0,0694***	0,0116	B(9,4)	0,0534***	0,0083	B(10,4)	0,0049***	0,0004	B(11,4)	0,0023	0,0056	B(12,4)	-0,0230**	0,0093
B(7,5)	0,0142**	0,0059	B(8,5)	-0,0683***	0,0158	B(9,5)	-0,0295***	0,0072	B(10,5)	-0,0006	0,0004	B(11,5)	-0,0003	0,0064	B(12,5)	0,0184**	0,0092
B(7,6)	0,0577***	0,0143	B(8,6)	0,0586*	0,0345	B(9,6)	-0,0051	0,0230	B(10,6)	0,0033***	0,0011	B(11,6)	-0,0035	0,0218	B(12,6)	0,0361*	0,0218
B(7,7)	0,7472***	0,0225	B(8,7)	-0,0313	0,0782	B(9,7)	-0,1496***	0,0388	B(10,7)	0,0026	0,0019	B(11,7)	-0,1066***	0,0327	B(12,7)	0,5186***	0,0398
B(7,8)	0,0814***	0,0134	B(8,8)	0,5210***	0,0353	B(9,8)	0,1028***	0,0191	B(10,8)	-0,0038***	0,0010	B(11,8)	0,0355**	0,0159	B(12,8)	-0,0575**	0,0260
B(7,9)	0,0846***	0,0199	B(8,9)	-0,1563**	0,0617	B(9,9)	0,8716***	0,0235	B(10,9)	0,0062***	0,0017	B(11,9)	0,0550**	0,0224	B(12,9)	-0,0391	0,0371
B(7,10)	-1,3370***	0,3510	B(8,10)	8,6721***	1,2620	B(9,10)	-2,6426***	0,5336	B(10,10)	0,7071***	0,0204	B(11,10)	-0,0073	0,3739	B(12,10)	-0,6820	0,5426
B(7,11)	0,1981**	0,0785	B(8,11)	1,2119***	0,1664	B(9,11)	-0,0852	0,0815	B(10,11)	0,0199***	0,0042	B(11,11)	0,4005***	0,0742	B(12,11)	-0,1176	0,0944
B(7,12)	-0,0998***	0,0271	B(8,12)	0,2142***	0,0611	B(9,12)	0,0687***	0,0259	B(10,12)	0,0073***	0,0016	B(11,12)	-0,0837***	0,0283	B(12,12)	0,7417***	0,0320

The Table reports MVGARCH BEKK estimation results for daily bond yields over the period 1st July 2019 to 30th June 2020. *, **, and *** indicate that the reported coefficients are statistically significant at 10%, 5% and 1% levels, respectively. The GARCH model is described in section 3.2.3

Figure 34,35 and 36 represent conditional correlations between emerging market countries. These show that the correlations between the countries' bonds increased drastically from February 2020 to around the end of April. The correlation between China and India does appear to be for longer. The start of the increased volatility is during the same period which signalled the start of the pandemic. Siklos (2011) proposed that even though emerging markets were treated as a homogenous group, they exhibit different return patters as they operate in different blocks. However, the increased correlation seen in the BRICS countries, highlights that the COVID-19 pandemic had significant effects on emerging markets regardless of their location.

Figure 34 Conditional correlation between the Brazil bond yields and the South Africa bond yields, estimated by DCC

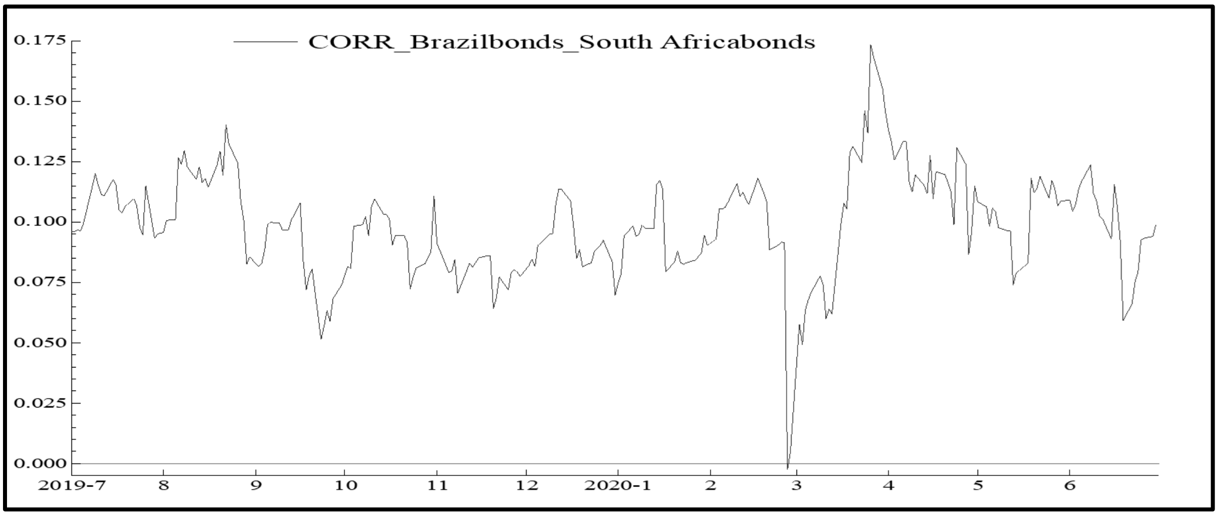


Figure 35 Conditional correlation between the India bond yields and the China bond yields, estimated by DCC

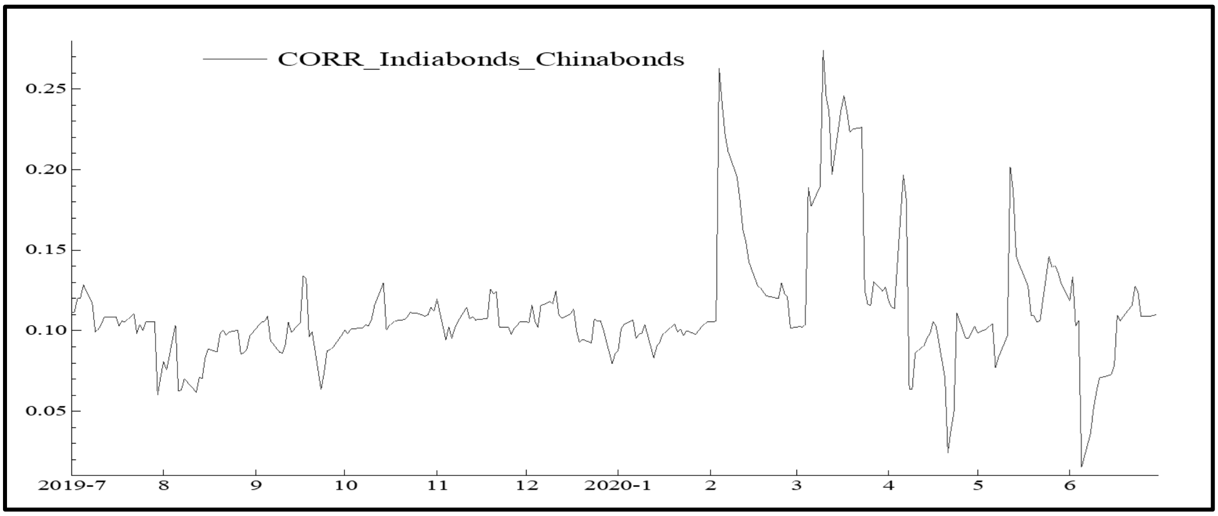
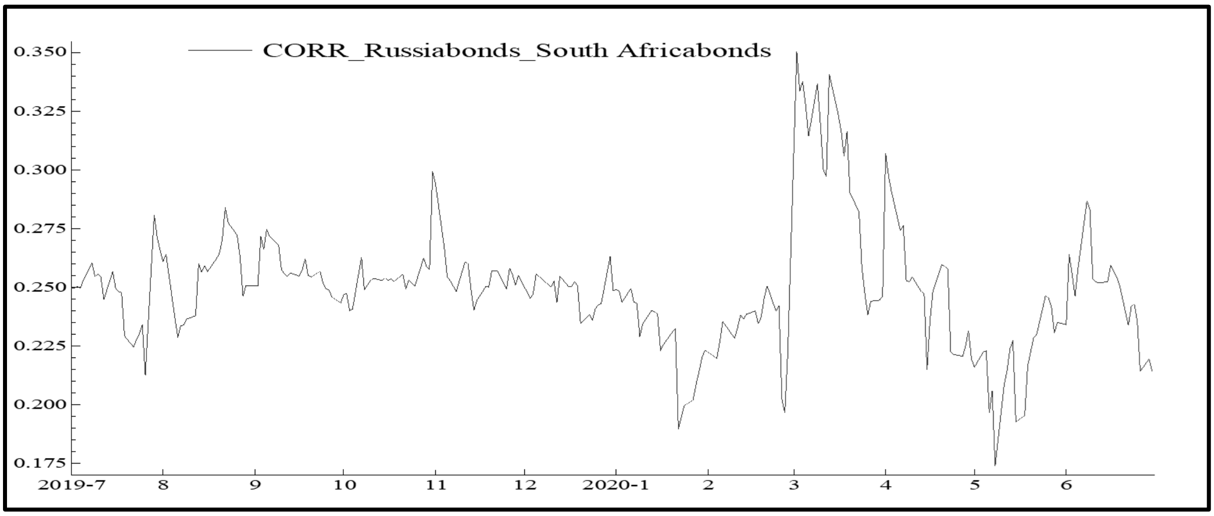


Figure 36 Conditional correlation between the Russia bond yields and the South Africa yields, estimated by DCC



In Figure 37, 38 and 39 we show the conditional correlation between emerging market bond yields and developed markets bond yields. Though the correlations are visible from March 2020, the correlation only goes as high as 27%, in the case of India and New Zealand (Figure 37). This shows that though there was an effect on bond yield volatility as a result of the pandemic, it did not significantly increase between developed and emerging market pairs.

Figure 37 Conditional correlation between the India bond yields and the New Zealand bond yields, estimated by DCC

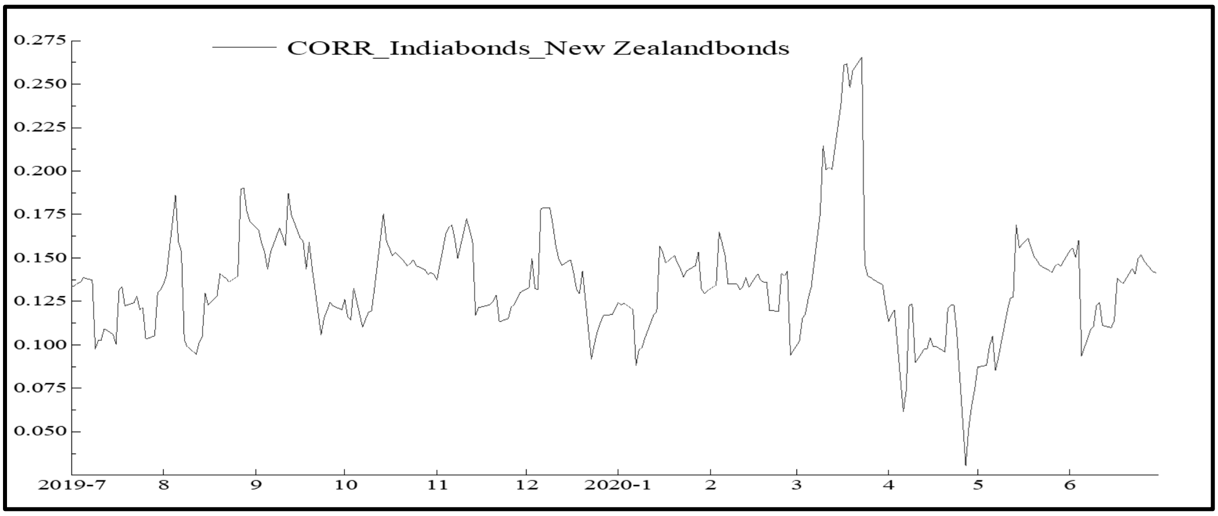


Figure 38 Conditional correlation between the India bond yields and the USA bond yields, estimated by DCC

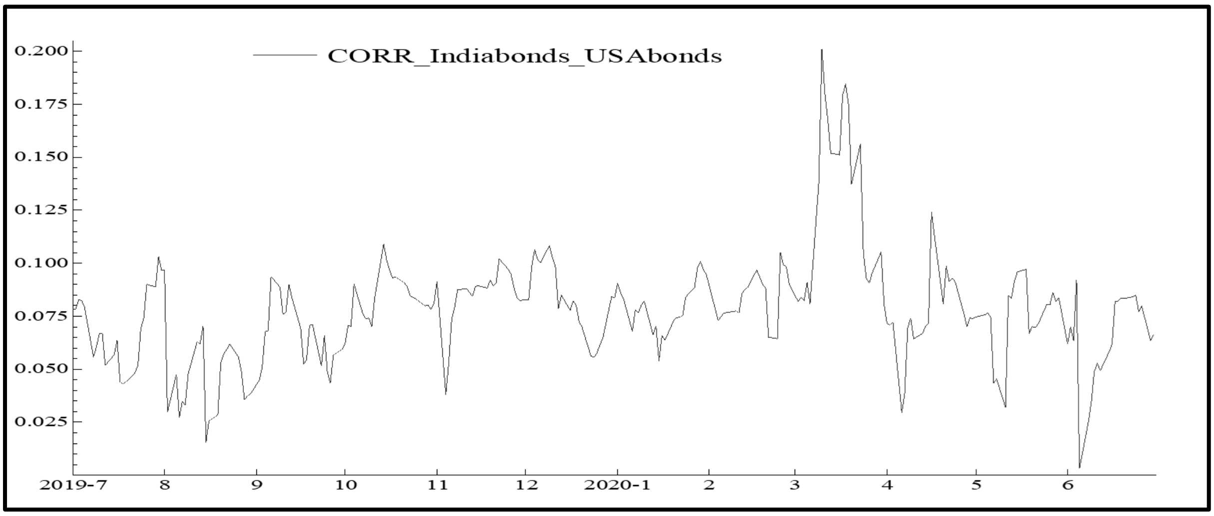
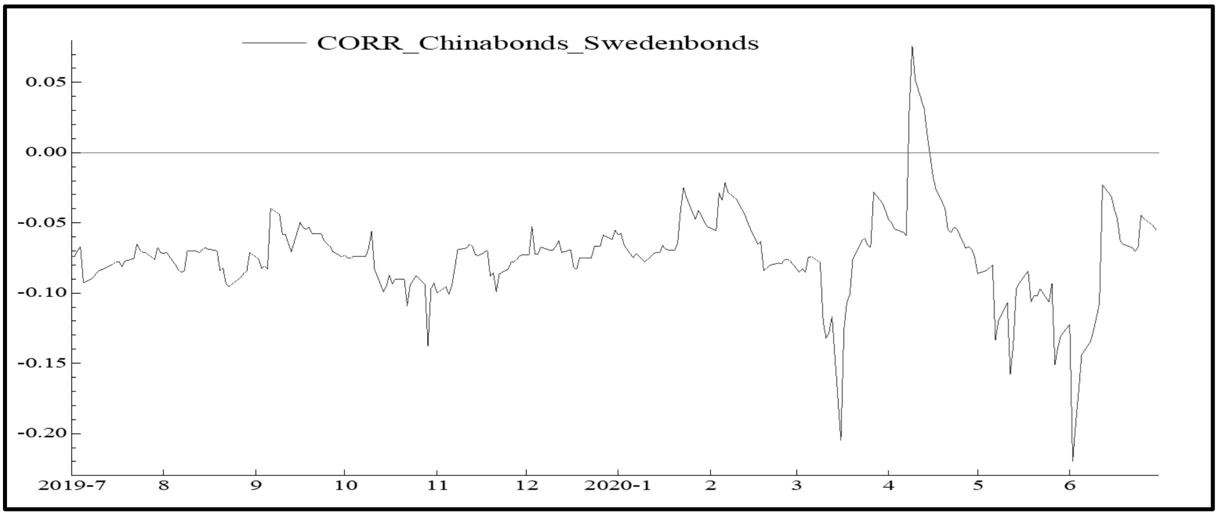


Figure 39 Conditional correlation between the China bond yields and the Sweden bond yields, estimated by DCC



Skintzi and Refenes (2006) propose that with European bond markets, local and regional shocks have an "asymmetric impact" on bond market returns. This is clearly visible from the correlations noted below in Figure 40,41 and 42 which highlights the conditional correlation of developed bond market yields. In the 3 pairs highlighted below, both positive and negative correlations are visible, as a result of the pandemic. For example, in the case of Italy and the UK (Figure 42) there is a 40% drop in correlation between February and March. Considering that the UK was decoupling from the European Union, this could explain the negative directional impact of volatility.

Figure 40 Conditional correlation between the Singapore bond yields and the New Zealand bond yields, estimated by DCC

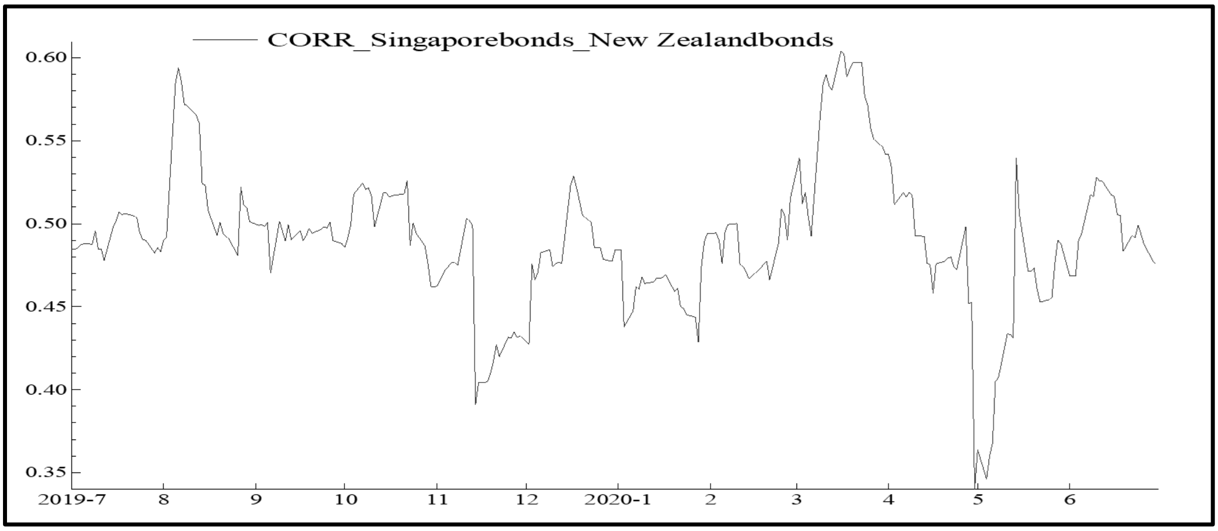


Figure 41 Conditional correlation between the UK bond yields and the USA bond yields, estimated by DCC

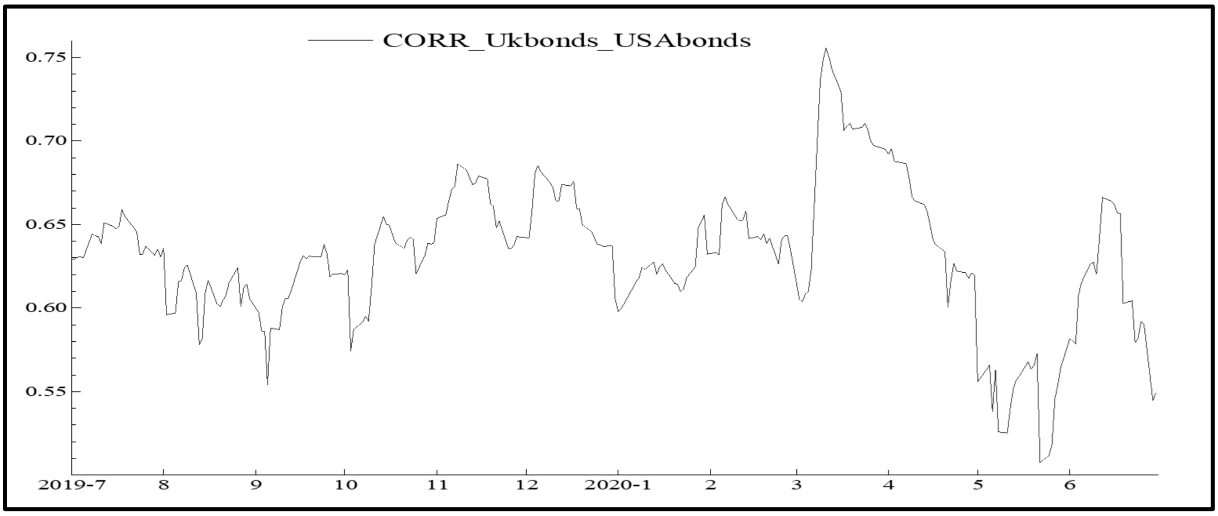
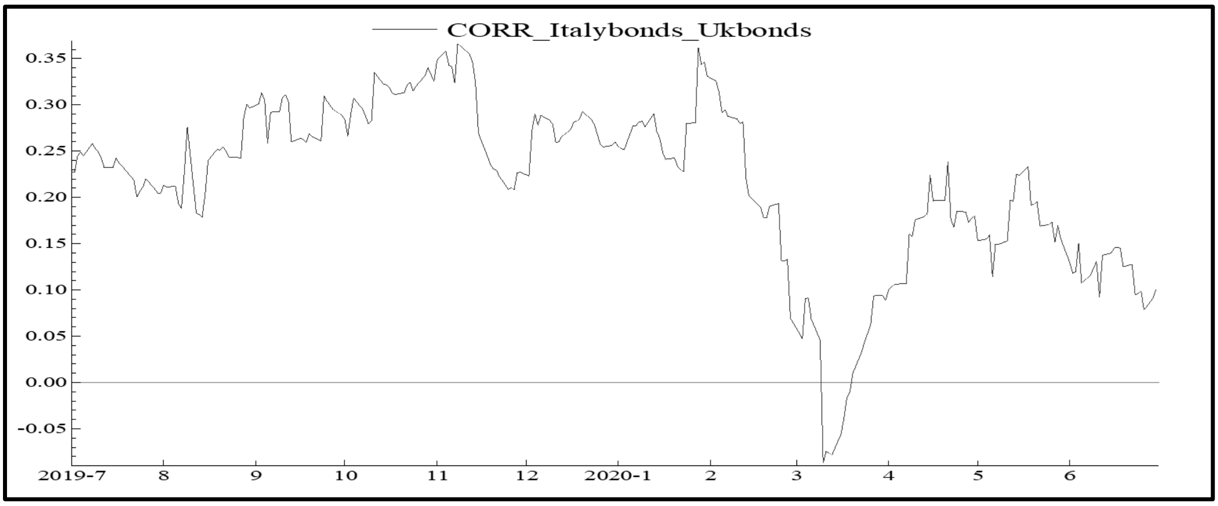


Figure 42 Conditional correlation between the Italy bond yields and the UK bond yields, estimated by DCC



4.4.3. Summary of Results

In investigating the effect of financial contagion during the pandemic, this study employed an MVGARCH BEKK model. This model was used on daily stock and bond yields respectively, for both developed and emerging markets. This model enabled us to determine the direction of the transmission of volatility and therefore ascertain whether financial contagion was present or whether the volatility effects were significantly bidirectional and therefore ruling out a single source of volatility.

With stock returns, 9 out of the 12 countries had statistically significant diagonal values (exception of India, Sweden, and the USA) indicating that the presence of stock returns' own volatility spillovers responded significantly to their own volatility from previous periods. These markets also showed significant GARCH effects, therefore confirming the persistence of volatility. The off-diagonal matrices which captured cross-market effects show that the USA exhibited high unidirectional linkages with the other markets, with the exception of South Korea. This result confirmed previous findings of the USA being a major exporter of volatility (Ling and Gurjeet, 2010) and also the existence of financial contagion.

Table 23 which highlighted bond yield estimations had different results to that of the stock returns. Few countries (6) had significant diagonal parameters. Russia, South Africa, Italy, Singapore, Sweden and the USA's current volatility of bond yields were highly dependent on their own volatility in the preceding periods. The GARCH effects were also found to be present, indicating a persistence of volatility. All the countries' off-diagonal matrices had at least 8 A and B matrices with statistically significant coefficients indicating significant bidirectional linkages. It was therefore concluded that though spillover effects are evident, financial contagion cannot be confirmed in bond market return.

CHAPTER 5 – CONCLUSION

5.1.Introduction

In this paper, I study the effects of the COVID-19 pandemic on capital assets, namely, bond yields and stock returns, through a comparative analysis of the impact on developed (USA, UK, Sweden, Singapore, New Zealand, and Italy) and emerging markets (Brazil, Russia, India, China, South Africa, and South Korea). The research uses daily data for a sample period from 1st July 2019 to 30th June 2020.

The paper answers the questions of how the coronavirus outbreak affected the performance of capital assets as well as what the role of financial contagion was in the evolution of capital asset prices over the sample period. To answer these questions, three models are employed which include an events study, a regression analysis, and to measure contagion, the BEKK GARCH model is used.

5.2.Summary and findings

Aizenman et al., (2016) found consistent negative effects on stock returns as a result of the global crisis. The initial event study attained similar findings. The initial part of the event study looked at three events, namely, the first lockdown in each country, first death and the lockdown announcement using cumulative daily returns. First infection and lockdown were then further analysed using average cumulative abnormal returns (ACAR). The research found that the flight-to-safety phenomenon was more prominent in emerging countries as both the first infection and the lockdown negatively affected stock returns but resulted in a positive effect on bond yields. In developed markets, this phenomenon was not evident in bond markets following the lockdown announcements with investors opting to invest in assets such as gold which were seen as safer assets. The first event, therefore, highlights that COVID-19 did have a significant effect on financial market returns as a result of the announcements regarding infections and lockdowns, with lockdowns having a much more prominent effect.

The second event study provides initial support for contagion. The study analysed the effect of the first lockdown announcement in the Eurozone area, in Italy and the effect of the Fed announcement to slash interest rates on financial markets using ACAR. The second announcement gave us initial support for contagion affecting markets as anticipation of this news began to affect returns days before the announcement was made, supporting a theory of herding behaviour rather than market efficiency. With regards to the first lockdown announcement in Italy, we see the negative relationship between stocks and bonds during the period of turmoil. However, the ACAR results for stocks in both developing and emerging markets following the announcement of the lockdown in Italy were not statistically significant, therefore, ruling out the event as the source of the volatility in the stock markets.

The regression analysis makes use of the Least Squares method and uses the GMM estimation technique as a robustness check. The regression analysis uses similar macroeconomic variables to regress both stock and bond yields for each of the 12 countries sampled. The COVID-19 variable took 3 separate forms, namely, COVID infections per million, COVID deaths per million and a dummy variable recording the day of first infection in a country. The research finds that the dependent variables used had a greater predictability power in bond yields than in stock returns.

The research also found that, when COVID-19 took the form of infections, it did not significantly affect stock returns. however, it did have a significant effect with countries such as the US, Brazil, China and Russia. The coefficients were found to be positive which would mean that increased infections had a positive effect on stock returns. however, this conclusion can be written off considering that the models had significantly low Adjusted R-squared and can conclude that other factors played a more significant role. When this result is coupled with the results attained in the event study, it shows that announcements related to COVID-19 had a more significant effect that the number of infections, regardless of which direction the number of infections were going.

When COVID-19 took the form of deaths, Brazil stands out as being most affected. Oil returns also had a significant predictive power over returns in the Bovespa. Though Brazil is a net exporter, the coefficient is negative. This is as a result of the cost effect outweighing the impact effect as demand had not significantly increased in order for oil returns benefits to accrue in the South American state. With bond yields, the European countries had been affected significantly by COVID related deaths. Increased government interventions in policies, both monetary and non-pharmaceutical, resulted in increased risk premia in the bonds issued by European countries.

With regards to the effect of financial contagion being exhibited during the COVID-19 pandemic, the research had different findings for stock returns and bond yields. Using an MVGARCH BEKK model for the estimations, the research found that cross-market effects in the stock returns showed that the USA exhibited high unidirectional linkages with the other markets, thereby confirming significant effect of financial contagion in stock returns during the pandemic. With bond yields, however, all the countries' off-diagonal matrices had at least 8 A and B matrices with statistically significant coefficients. This ruled out one country as being the source of volatility and supported previous findings of the evidence of integration and co-movements in bond markets (Gilmore, Lucey and Boscia, 2010; Ciner, 2007) and ruled out the effect of financial contagion in bond yields.

5.3. Policy recommendations

As news and announcements have been major drivers of the pandemic, policies to be implemented to safeguard economic interests must be made using facts rather than using herding behaviour as a basis for country specific policy implementation.

5.4. Avenues for future studies

This study contributes to the literature by shedding light on the effects of COVID-19 on capital assets. This is a new branch of literature and as a result, it is continuously changing. This research further provides insight into the effects of financial contagion during the pandemic. To my knowledge, this is the first study that has undertaken to study both the effects of the pandemic on capital assets and measure contagion using the BEKK GARCH model.

The COVID-19 pandemic has shown us the negative effects of globalisation. Financial integration, though positive for economic and technological advancement, has made the effects of the pandemic more profound. As the pandemic is still on going, further research is needed to see if there will be long run effects on market correlation between emerging and developed economies. Further, research is needed to understand the substitutionary effect of gold and cryptocurrency as alternatives to bonds during periods of extreme turmoil.

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APPENDIX

APPENDIX I: Some VAR Test Results for Daily Stock Return Data

Table A 1

Lag structure choice for unit root tests

Lag	1	2	3	4	5	6	7	8
Brazil Stock Return (COVID Infections)								
AIC	-63.28145	-63.27562	-63.38072	-63.75355	-63.75691	-63.78355	-64.59202	-65.49542*
SC	-61.63783*	-60.19385	-58.86078	-57.79545	-56.36066	-54.94913	-54.31943	-53.78468
HQ	-62.62156*	-62.03834	-61.56603	-61.36146	-60.78743	-60.23666	-60.46773	-60.79373
China Stock Return (COVID Infections)								
AIC	-61.42682*	-61.32605	-61.12397	-60.88489	-60.81754	-60.69635	-60.84967	-61.23877
SC	-60.45120*	-59.51418	-58.47585	-57.40052	-56.49692	-55.53949	-54.85656	-54.40941
HQ	-61.03062*	-60.59025	-60.04856	-59.46987	-59.06292	-58.60212	-58.41584	-58.46534
India Stock Return (COVID Infections)								
AIC	-76.18928*	-76.18890	-76.07886	-75.93599	-75.93114	-76.05609	-76.12631	-76.12177
SC	-74.73932*	-73.47021	-72.09144	-70.67986	-69.40629	-68.26251	-67.06401	-65.79075
HQ	-75.60230*	-75.08830	-74.46464	-73.80816	-73.28969	-72.90103	-72.45763	-71.93948
Italy Stock Return (COVID Infections)								
AIC	-75.47002	-75.53863	-75.90632	-76.76569	-76.79937	-76.70494	-77.33708	-77.44316*
SC	-74.01112*	-72.80320	-71.89436	-71.47719	-70.23435	-68.86338	-68.21898	-67.04853
HQ	-74.87958*	-74.43156	-74.28260	-74.62534	-74.14239	-73.53132	-73.64682	-73.23627
New Zealand Stock Return (COVID Infections)								
AIC	-75.30175	-75.89284	-76.41822	-77.08794	-77.20653	-77.80581	-78.31809	-79.48320*
SC	-73.63433*	-72.76643	-71.83282	-71.04355	-69.70315	-68.84344	-67.89672	-67.60285
HQ	-74.63323	-74.63937	-74.57980	-74.66457	-74.19821	-74.21254	-74.13987	-74.72003*
Russia Stock Return (COVID Infections)								
AIC	-68.74201	-69.11560	-69.33550	-69.65228	-70.11516	-70.21773	-70.29525	-70.62491*
SC	-67.27406*	-66.36320	-65.29865	-64.33098	-63.50940	-62.32752	-61.12058	-60.16579
HQ	-68.14808*	-68.00197	-67.70218	-67.49927	-67.44246	-67.02534	-66.58317	-66.39313
South Korea Stock Return (COVID Infections)								
AIC	-83.09060	-83.05927	-83.08608	-83.38394	-83.52830	-83.46508	-83.55391	-84.05155*
SC	-81.70789*	-80.46668	-79.28363	-78.37161	-77.30611	-76.03301	-74.91196	-74.19974
HQ	-82.52986*	-82.00788	-81.54405	-81.35126	-81.00497	-80.45110	-80.04928	-80.05628
Sweden Stock Return (COVID Infections)								
AIC	-75.95038	-75.86049	-75.95395	-75.61268	-76.25219	-76.28917	-76.39119	-76.98221*
SC	-74.48243*	-73.10809	-71.91709	-70.29137	-69.64643	-68.39896	-67.21652	-66.52309
HQ	-75.35645*	-74.74687	-74.32063	-73.45967	-73.57949	-73.09678	-72.67911	-72.75044

APPENDIX II: Some Descriptive Statistics for Control Variables

Table A II

Descriptive statistics for exchange rate

Exchange Rate: Summary Statistics					
	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Brazil	-0.00130	0.01252	0.05999	7.09639	182,64***
China	-0.00012	0.00271	-1.29218	8.91575	453,22***
India	-0.00036	0.00604	-0.45122	6.25895	124,35***
Italy	-0.00004	0.00433	-0.67590	9.90116	537,81***
New Zealand	-0.00017	0.00710	-0.28040	6.80211	160,63***
Russia	0.00074	0.05933	0.05994	14.38928	1410,81***
Singapore	-0.00012	0.00297	-0.06856	5.44927	65,44***
South Africa	-0.00077	0.01066	-0.50451	4.90253	50,44***
South Korea	-0.00014	0.00525	0.38540	6.55541	143,93***
Sweden	-0.00001	0.00683	-1.12123	9.38848	498,52***
UK	-0.00012	0.00683	-0.37310	9.16704	419,66***
USA	0.00012	0.00683	0.37310	9.16706	419,66***

Descriptive statistics for exchange rate quality spread

Quality Spread: Summary Statistics					
	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Brazil	0.00015	0.00002	0.95911	0.15685	41,88***
China	0.00004	0.00001	1.57844	3.27029	27,20***
India	0.00013	0.00001	1.22449	2.38503	91,51***
Italy	0.00000	0.00002	0.64205	-1.12254	4,50
New Zealand	0.00000	0.00001	1.72172	3.93098	32,36***
Russia	0.00014	0.00002	0.92116	0.51719	42,70***
Singapore	0.00000	0.00001	2.83432	9.88833	87,70***
South Africa	0.00020	0.00004	0.95394	-0.19624	9,93***
South Korea	0.00000	0.00001	0.75145	-0.19322	6,16**
Sweden	-0.00004	0.00002	0.77930	-0.60289	6,63**
UK	0.00000	0.00000	0.10483	-0.10692	22,53***
USA	0.00000	0.00001	5.29999	26.94946	306,65***