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# Investigating the impact of Covid-19 pandemic on stock markets: Evidence from global equity indices

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ABSTRACT

*This paper aims to examine the impact of Covid-19 pandemic on stock markets. This paper also analyses the stock market cointegration of selected global equity indices that performed better and have a quick speed of recovery during the pandemic. This paper also questions how increasing uncertainty and volatility deters investors' perception of the diversification of equity investments. The dataset for the selected 12 global equity indices has been used from Thompson Reuters's EIKON database in a given period of time between 2010 and 2021. This paper employs Vector Error Correction Models to assess the relationship among the selected global equity indices. Findings demonstrate that (i) there is an adverse impact of Covid-19 on the Global Equity markets, (ii) there is a clear sign of cointegration in global equity indices, (ii) investors can benefit from investing in particular equity indices that have exhibited quick speed of recovery from the pandemic records lows. The findings finally provide a strong foundation for constructing a resilient equity portfolio in a highly uncertain market environment.*



## Introduction

Executing an informed decision in the process of making an investment in the stock market is a determining factor to the success of an investment. It is indeed of interest to investors, both retail and institutional investors including policy makers to understand the stock market mechanisms and expected future performance of the market. This includes both short run and long run dynamics. In order to ensure the success of an informed investment practice and effective policy employment, it is critical to understand the relationship of global stock indices. The utter mission of an investor is to maximize the returns from an investment vis-à-vis mitigation of risks associated with that investment. Therefore, it is of utmost importance for an investor to understand how stock indices perform in the global financial markets if strategies such as portfolio diversification are to be capitalized on (Faque, 2021).

There are several factors that affect the movement of stock markets in various countries. National specific dynamics such as Interest rate, exchange rate fluctuations, economic productivity, economic policies including political environment and many more (Dincer et al., 2018; Dincer et al., 2018b). All these factors aside, technical analysis is a widely used technique on top of other fundamental factors to increase the probability of positive outcome from an investment. The question of stock index interaction on a global level has undoubtedly stirred a debate from financial markets enthusiast and academics of all walks. Do stock market Cointegrate? Do they have a long run association with each other? Does increasing volatility and uncertainty reduce the window for diversification among global equity indices? These are among other questions that this study aims to respond to.

Across the years, financial markets in particular stock markets have evolved through ups and down from the great depression of 1929 to the recent Covid-19 Pandemic that has caused political and economic unrest. The Great depression lasted for 10 years, an economic downturn that started with the crash of the stock market. At this point it is important to acknowledge the significant role of stock

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markets in the economy. Studies have documented different crises including the 1997 Asian crisis, the 2001 dot com bubble, the 2008 housing bubble, and the European debt crisis. There are direct links of economic performance to the performance of stock markets and how stock market crises can cause social unrest, unemployment and political upheaval (Antonios, 2010; Ake, 2010; Verma, et al., 2021; Junior et al., 2021; Dincer et al., 2019; Hacioglu & Dincer, 2013, 2013b; Hacioglu & Dincer 2017).

To most investors however, their interest has dwelled upon the performance of stock markets during the crisis and post the crisis. With increasing globalization, spillover effects in many disciplines, including finance, are distinct. Economic ties, bilateral trade agreements including trade blocks and cross-border investments have intensified economic dependency on each other. In turn, shock waves emanating from one country are no longer considered local threats, with Corona Virus an explicit example. In such globalized dynamics, we could see how financial markets as well are tied to each other and to what extent they can impact one another despite varying fundamentals.

In our study we deploy various stock indices from across the globe and try to understand how these indexes perform in a globalized financial market arena.

Increasing cross-border capital movement has been necessitated by advancing technology, cross-border capital movement, liberalization and deregulation of markets including activities in financial centers and institutionalization of financial markets. With all these necessary conditions enriching the dynamics in the international financial markets, it is ideal to study how assets, such as equities in our study, present a background and guidance to successful investment practices in the global market arena.

The study aims to examine the performance of these equity indices during the COVID-19 pandemic using a Vector Error Correction Model. This study also questions how increasing uncertainty and volatility deters investors benefitting from equity diversification on the international market, and how equity indices performed during the COVID-19 pandemic? Equity indices of Brazil (BOVESPA), Canada (TSX), Germany (DAX), Hongkong (HANGSENG), Mexico (MXX), Japan (NIKKEI225), Qatar (QSE), South Africa (JTOP40), Turkey (BIST100), United Kingdom (FTSE100), Unites States (SnP500) and United Arab Emirates (UAEDFMG) have been selected in our study based on their speed of recovery during the pandemic. The dataset for the selected 12 global equity indices has been used from Thompson Reuters's EIKON database in a given period of time between 2010 and 2021.

This paper organizes as follows; Following the introduction, a literature review with theoretical and empirical studies have been completed. Data and methodology has been explained under research and methodology part. Quantitative analysis and empirical findings have been presented and discussed under analysis and findings part. Finally, this paper concludes with concluding remarks, policy implications and recommendations for the future studies.

## Literature Review

### Theoretical background

The literature that we intend to examine in this topic primarily comprises of two subsections and these are, the theoretical and empirical aspects. In order to establish a good grounding, we will look at the theoretical aspect of the topic and then later examine the empirical aspect of the matter. International portfolio construction has become an important aspect to all the investors with respect to increasing liberalization and increasing international capital flows. It is therefore the job of an investor to have a comprehensive aspect of the movement of international assets in order to adjust and construct a sound-proof cross-border investment portfolio.

To start with, portfolio diversification constitutes a crucial aspect in a resilient international asset portfolio construction. Markowitz, in his modern portfolio model, established the phenomena of diversification that serves as foundation in this paradigm (1952). He suggests that holding constant the variance of a portfolio will in turn maximize the expected returns. On the other hand, holding the expected returns constant will also hold the variance of the portfolio constant. Emphasis on efficient and inefficient portfolios was one of the main aspects in the founding documents of this theory. Markowitz (1999) proposes that efficient frontier represents a "combination of efficient mean-variance". He suggests that all these aspects including variance, covariance & variance should be estimated using a combination of statistical analysis.

#### Modern Portfolio Theory (MPT)

The modern portfolio theory further suggests that increasing the number of securities on a designated portfolio minimizes the risk associated with the portfolio. This means that an investor is able to bypass the risks associated with individual securities, (Biswas, 2015; Grubel, 1968). Basically, when constructing an investment portfolio, or investing in stock markets there is a trade-off in risk and returns. The former comprises of two components, and these are systematic and unsystematic risk.

Systematic risk is also referred to as non-diversifiable risk and unsystematic risk is that which affects particularly one asset in a portfolio and is completely diversifiable. (Caves et. al. 1971, Penrose et. al., 2009, Gorecki ,1975 & Teece, 1982) suggest that the prevailing theory of diversification is primarily pillared on productive factors in the aspect of firms. Moreover, a failure in these market aspects poses diversification as a desirable choice. This same concept is a hundred percent applicable in equity investment platforms.

**Efficient Market Hypothesis (EMH)**

Efficient Market hypothesis (EMH) – under financial theory, the concept of EMH has a considerable weight in constructing a resilient portfolio. According to Markiel (2003) the efficient market hypothesis is defined as securities in the market reflecting all the information that is available in the market. This applies to both at a firm level on stocks and a weighted index at a national level. All the news in the market, all the previous prices of the stock indices are embedded in the current price of the stock or the index in general. Theoretically, fundamental analysis that is analysis of the available financial information and technical analysis, analysis that uses past prices of an index with the aim of predicting the future prices of an assets are not feasible under EMH. In other words, there is no room for arbitrage, or profiting from discrepancies in the market. Early studies of Bachelier (1900) and Kendall (1953) described the movement of the markets to follow the Brownian motion or following a random walk. In that way, no analysis can assist in predicting the future prices of a random walk abiding asset prices.

At this juncture the studies on cointegration question the basis of efficient market hypothesis as far as asset price predictability is concerned. Dimpfl (2014) further pondered upon the concept of cointegration relationship, emphasizing that if cointegration holds, then efficient market hypothesis is in turn violated. This, however, has steered debate among financial enthusiasts who argue that people are blinded or misunderstand the efficient market hypothesis. Malkiel (2011) suggested that during the 2008 financial crises conservative EMH followers were by far most restrictive in their interpretation of the hypothesis. Suggesting that EMH does not mean prices are surely in appropriate levels at a point in time. In fact, they are always wrong, however no one knows whether they are overpriced or not. In a nutshell, EMH does not refute the idea that environmental and other factors can have great impact on the required returns. Moreover, EMH in its basic sense supports the fact that arbitrage is hardly achieved for assets that do not carry a substantial amount of risk with them.

**Volatility**

Apparent in the literature is the concept of volatility's impact on asset prices. To be precise, increasing volatility increases correlation among asset prices, in this case the equity indices. Dey (2005) touches upon the determinant of determinants of index returns/Prices, which are volatility and turnover. The former is our main concern in this aspect. It is highly evident in both the 2008 crisis and also during the Covid-19 pandemic that we intent to examine later in the study. Correlation, or long run relationships, however, do not usually hold during the time of recovery in most cases. The reason for this could be the fact that countries grow at different rates, but when there are shock waves in the market, it is easy to impact all the markets as investors flee to safety at the same period of time. During the times of crisis, volatility spillovers happen quickly especially in this information age, accordingly prices adjust causing high fluctuation in related markets (Ozbekler, 2017).

## Empirical Studies

**Financial Markets and Globalization**

Financial markets have undergone a tremendous transformation in the past half a century due to major market trends experienced in this period. Today's financial market playground has molded into a different shape with respect to financial crises, changing national policies, firm ambitions and investor attitude towards the market. Slowly, just like many other disciplines, the financial market has been moving towards globalization. In this regard, thanks to globalization, entities are no longer limited to domestic markets when it comes to raising funds(capital), concurrently investors are not confined to the domestic markets in search of spreading risks and maximize returns on investment. In other words, investors are able to diversify their portfolios on an international level. This is a process known as internationalization of financial markets. Today we are witnessing the financial markets move towards integration and becoming "borderless", forming an international financial market. It is a market that has taken decades to take shape into the current state and it is still in the process (Fabozzi, 2015).

Contemporary literature has discussed factors that provided conducive environment for the internationalization of financial markets. It is these factors and other developing factors that are continuing to shape and transform the international financial market arena today. These include the following: (1) the technological advancement used to observe financial market prices (Hacioglu, 2019; Hacioglu 2019b), searching for investment opportunities, and executing orders; (2) liberalization and deregulation of markets including activities taking place in financial centers; (3) growing institutionalization of financial market (Chou et al,1994; Saunders & Cornett, 2012; Helleiner, 1995).

Entities going international and seeking equity capital became a trend in the early 1980s when multinational corporation embarked on a journey seeking funds by listing in foreign stock markets. For instance, Daimler-Benz listed on the New York Stock Exchange despite the differences in accounting principles of USA and Germany. It is suggested that the motion was driven by one of the following two reasons, either the local capital markets were too small for their vision or just to attract rather a bigger investor base. Other European firms followed Daimler-Benz footsteps to list outside of domestic markets. As of 1998, European companies amounting to 133 were listen on NYSE with an astounding market capitalization of $2639.1billion.

On the other hand, the move to seek equity capital internationally had an adverse effect on the investors' character and approach towards equity markets (Dincer & Hacioglu, 2013a; Dincer et al., 2016;). An investor's job is to try all means possible to minimize the risk associated with their investment portfolio. At this point it is important to give a distinction in portfolio risk-variation. This type of risk can be separated into two; systematic (non-diversifiable) and unsystematic risk (diversifiable), see Hodvedt & Tedder (1978). Development of financial markets therefore substantially widened the horizon of investors as far as portfolio diversification is concerned. In modern portfolio theory it is hypothesized that an investor is capable of reaping benefits of diversification by investing in more than one stock. This, however, can be on an industrial or national level, in which both can still suffer from systematic risk on a national level. Therefore, international or cross-border diversification can increase the chances of an investor to enjoy benefits from an internationally diversified portfolio**.**

Generally, there are two types of investors described in the literature, these are: retail and institutional investors (this section, regarding investors, is well elaborated in the later section of this literature). Basically, retail investors constitute individuals or household investors that use brokers to participate in financial markets. On the other hand, institutional investors are legal entities trading financial instruments in large quantities. It is argued that the latter is more willing to go seek investment opportunities outside the national borders than the former due to a number of reasons: (1) availability of funds (pool of funds accredited to institutional investors), (2) magnitude of investment, (3) need for diversification. This was credited to the savings and retirement funds that are prominent in mainly developed countries such as the US, UK and Japan. Financial Institutional investors pose power with access to such a pool of funds made available to them ready for mass investments. This trend brought in a new phenomenon well known today as institutionalization of financial markets (Fabozzi, 2015; Saunders & Cornett, 2012; Valdez & Molyneux, 2015; Chou et al, 1994).

There is corroboration in the literature on numerous benefits attributed to cross-border equity listings that has immensely contributed to internationalization and eventually globalization of financial/capital markets at large. Evidence shows that firms are incentivized by the following benefits in cross-border equity listing: (1) Cheap cost of equity capital, (2) increased trade volume of equity after listing, (3) enhancing of corporate marketing efforts through ease of recognition by investors and consumers, (4) increase shareholder base (Karolyi, 1998; Biddle & Saudagaran,1991; Benos & Weisbach, 2004; Chaplinsky & Ramchand, 2000; Dincer et al., 2019; Dincer et al., 2020).

Historically, cross-border listing can take either one of two forms, a standard procedure (direct) listing or through a depository receipt procedure (Karolyi, 1998; Reese & Weisbach, 2002). In the standard procedure firms do need to meet the requirements of the host stock exchange regulations in terms of disclosures, accounting principles including listing fees. Some stock exchanges are loose in regulations in pair wise comparison; for example, terms of disclosure are strict in the US, NYSE than in Japan, but Japan tends to have higher fees of listing than the NYSE. A major cross-border listing was first evident with the Deutche Telecommunication company on the second ever privatization of German state-owned firms in early 1996. By then they claimed to be the only company with the most shares listed abroad distributed across the world, Americas 98million shares, UK 57million shares, rest of Europe 38million shares and the rest of the world with 34million shares (Valdez & Molyneux , 2015).

The second procedure firms can use to list on a foreign stock exchange is through Depository Receipts (DRs). According to (Karolyi, 1998) DRs are contracts that represents equity ownership by domestic investors. They were developed in the United States by JP Morgan in 1927 to serve as a channel for local US investors to own a share of non-US stocks. DRs are created and managed by US depository banks and traded on the NYSE. Throughout the years the depository receipts have experienced a substantial growth and consequently increasing the international trade volumes of cross-border listed stocks on the international arena. Today, depository receipts have spread across the globe in one of the following two forms: Global Depository Receipts (GDR), European DRs and International DRs (IDR). Even though they are referred to as Global Depository Receipts, these instruments are traded on London Stock Exchange and ADRs are traded on the US National Stock Exchange. Since DRs trace their roots back to America, where they were first evident, they are referred to as American Depository Receipts (ADRs) (Domowitz et al. 1998; Pagano et al,2002; Benos & Weisbach, 2004; Karoyli, 2004; Alsayed & McGroarty, 2012; Onyuma et al, 2012; Bancel & Mittoo, 2001).

**Financial Market Volatility & Covid-19 Pandemic**

Increasing globalization has facilitated the proliferation of economies and contributed to integration in trading, economic and financial aspect at large. For the past century, we have experienced more cross-border capital flows than ever before. Moreover, the internet has made globalization much easier and intense than it was before, trading of foreign financial instruments including stocks is now at our fingertips. However, history has not been kind to globalization and in our case the financial globalization of capital markets. Financial markets (Stock markets) have gone through gradual transformation that was necessitated by minor to severe stock market crashes in the history (Hacioglu & Dincer, 2017; Dincer & Hacioglu, 2018; Dincer & Hacioglu, 2015).

The great depression of the 1920's is considered to be one of the largest and longest market crashes in the history of financial markets. The effect spread to different parts of the world causing havoc in various economies. There is undeniable evidence on the relationship between financial markets and economic prosperity in numerous documented studies, (see Miller, 1998; Alfaro et al.,2004; Ndikumana, 2001). In countries that have a functioning and integrated economies, mainly the developed countries, financial crises have severe impact on social-economic aspect. The results are increasing unemployment, instability, and political unrest to some extent.

The year 2020, humanity has faced yet one of the biggest health crises emanating from Covid-19. In December 2019, the first case of Covid-19 was registered in Chinese provide Hubei, and since then it has spread quickly across the world. The virus exposed the ruins of the fragile global health systems in a span of a few months. With regard to the speed of transmission, on March 11,2020 the

WHO organization declared the Covid-19 outbreak a pandemic. At the time this paper was written, 76,250,431 Cases 1,699,230 deaths were recorded in 222 countries (WHO,2020). Following the announcement, panic waves rolled out across the globe causing both real economy and financial markets crashes.

An attempt by different countries to curb the spread of Covid-19 caused massive shockwaves in Global Supply Chain (GSC). Travel restrictions, social distancing, and lockdown measures adopted by many countries had a disastrous impact on many economies including major countries. Production slowed down, human labor movement declined, and lockdowns meant reduced physical shopping causing supply and demand shockwaves. The disruption of the ecosystem had a huge impact on both global economic and financial dimension (Harjoto et al. 2020; Hacioglu & Aksoy, 2021; Aksoy & Hacioglu, 2021).

According to IMF revised October 2020 outlook report, world economic growth was estimated at -4.4% by 2020 year end. However, it is projected to rise to 5.2 by 2021year end with the glimpse of hope on Covid-19 vaccine progress (IMF, 2020). The downward world growth projections were followed of course by reduction in country specific growth rate as well, mainly the arguably largest world economies. According to IMF, 2020 economic performance report the projected growth for 2020 in United States and Canada were -4.3% & -7.1% respectively, the Euro area countries expected growth was as follows: Germany, -6.0%, France -9.8%, Italy -10.6%, Spain -12.8% and -9.8% for United Kingdom while Russia was expected to grow at -4.1%. Japan -5.3, China 1.9%, India -10.3% and ASEAN-5 countries by -3.4%. Brazil was expected at -5.8% and Mexico -9.0%. Saudi Arabia expected -5.4% growth while Nigeria and South Africa's growth was projected at -8.0% & -1.2% respectively (IMF, 2020).

Looking at these figures it would suffice to say that they indeed portray how severe the pandemic impact to the real economy and its consequent impact on world financial markets. Stimulus packages were by different countries and to some extent they helped to keep stock markets just afloat enough while other markets showed positive gains in a short period of time (Harjoto et al. 2020). Furthermore, in another study by (Phan & Narayan, 2020) suggested that travel ban, lockdown and stimulus packages helped to contain stock markets during the pandemic. Interestingly the recovery in the real economy is expected to take a U-turn rather than a V-shaped according to (Baldwin & Weder, 2020). Financial Markets, in this case stock markets seem to take the latter shape and by the end of 2020 most stock markets were back to the old 2019 high and even more, (see MSCI graph).

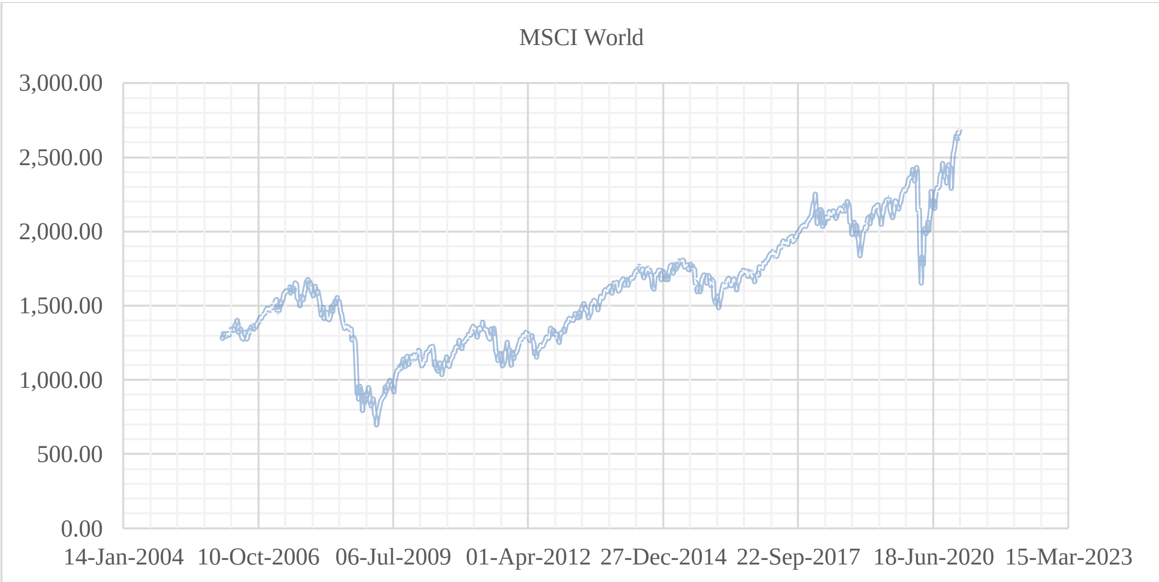


**Figure 1:** MSCI Global Index Movement; *Source:* Thompson Reuters, 2021

Covid-19 pandemic and consequently its impact in various disciplines has intrigued both academics and non-academics alike. Early documented literature depicts the negligence towards the immediate response to the biggest threat for humanity as a tragedy. According to (Morales & O'Callaghan, 2020) the world awoke to the pandemic after Italy registered its first cases of Covid-19. A state of emergency due to the increased number of cases and deaths in Italy spiraled fears and severe clashes in the Euro zone stock markets with the Italian stock market (FTSE MIB) as an epicenter. The fatal impact further spread across the world due to uncoordinated response to the pandemic leading to a huge stock market drop in early February,2021. According to a study that used a text base approach by (Baker et al, 2020), no infectious disease previously has affected the stock market like the Covid-19 pandemic including the Spanish flu back in 1918. Volatility index rose to all-time highs in early 2020, just 13 points lower as compared to the 2008-09 Global Financial Crisis (Yahoo finance).

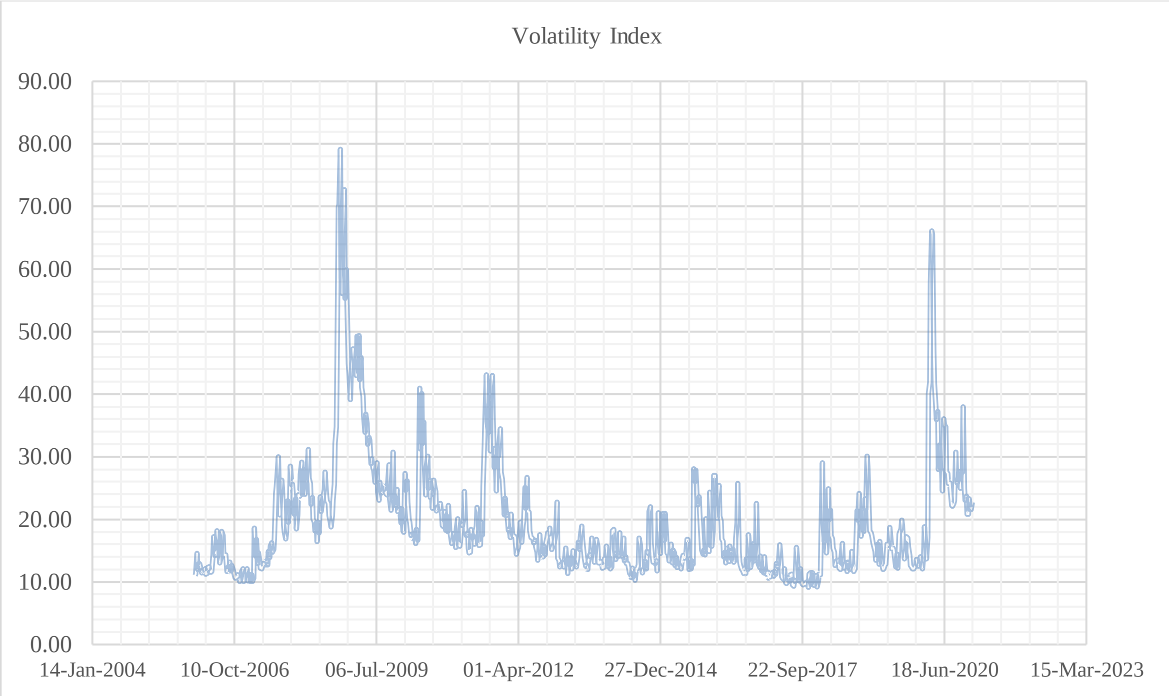


**Figure 2:** World Financial Markets Volatility Index; *Source:* Thompson Reuters, 2021

Various studies have documented the spillover effects in stock markets during the high volatility periods, see (Hwang 2014; Qiao & Yan, 2020; Corbet et al.2020; Baek,2020). These studies show that investors activated defensive positions in highly uncertain environment and in turn a chain reaction of events was ignited. In a study by Gunay (2020), a model proposed depicts the breaks in stock index time series data that captures the impact of Covid-19. The findings show that the risk factor that started by end January in the Shanghai stock market had an adverse impact on other Stock markets, namely the United States, Italy, Spain, Ukrane and Turkey. In another study by Onali (2020), the results indicated an increase in negative stock returns and increase in Volatility index due to the increased number of deaths in France and Italy. In retrospect we can observe sound evidence pointing in the direction of strong market correlation during high volatile periods as a spillover effect. In other words, will the post pandemic markets be more integrated due to increased global risk and will diversions from long run relationship be scrutinized? In further studies by Senol & Zeren (2020) with regard to the Covid-19 stock market crash, the data exhibit a long run relationship in stock market performance under cointegration tests which we intend to examine in this study.

**Stock Market Cointegration**

The concept of Cointegration in financial markets has stirred a debate among financial market enthusiast and academicians alike. With advancing technology and enhanced forecasting techniques, the twenty-first century has experienced transformation in the ability to predict financial market prices. According to Jochum et al, (1999), cointegration in stock market indices implies a long run relationship among them(markets). Evidently, if market prices are stochastic or follow a random walk, how can they have impact on each other? This implies that there is little to no room in international portfolio diversification for investors. On the other hand, Dimpfl (2014) argues that long run association in stock market stand against fundamental of financial asset pricing models and Efficient Market Hypothesis (EMH). EMH argues that returns and future prices of an asset are unpredictable and that markets are efficient in the sense that they reflect all the information available. Furthermore, Dwyer & Wallace, (1992) argue that asset prices cointegration has nothing to do with EMH and it does not serve as a necessity for EMH to hold. Rather, if market efficiency is defined as absence of arbitrage, there should not be any association between cointegration and EMH. In the very end this dispute has created two different school of thoughts, those who support cointegration as a means of finding out whether market prices are for sure predictable and on the other hand those against cointegration, as a contradicting aspect to financial markets principles. Nevertheless, are financial markets really cointegrated?

Contemporary literature presents mixed results as far as cointegration is concerned. Supporting argument for cointegration is presented in a study of three major European equity markets by Kasibhatla (2006). These include France, Germany and the United Kingdom. Literature argues that these are not only giant markets but also fall under an integrated market, so it comes not as a surprise that they have an impact on each other. Further groundbreaking studies by Chou et al., (1994) on major stock markets of United Kingdom, Germany, United States, France, Canada and Japan exhibit a long run relationship to some extent. Interestingly theses are independent economies and that market prices follow a random walk, but how come they are cointegrated? One major explanation is globalization and cross-movement of investment funds among the major economies due to liberalization and deregulation in economic policies, Saunders & Cornett (2012). Another explanation as to why equity markets of different countries are cointegrated presented in a study of ASEAN-5 countries by Majid et al. (2009). They argue that increased bilateral trade agreements among ASEAN-5 countries serves as a fertile ground for corresponding equity markets to exhibit long run relationship characteristics.

Further studies in Asian eight equity markets including Japan, Taiwan, Singapore, Hongkong, Korea, Shanghai and Bombay exhibit long run relationship among them (Rizwanullah et al, 2020). It is comprehensible for the long run relationship of equities in these countries. The heavy linked relationship, intensive & increasing investments and bilateral trade relationship among them is undeniable. However, looking at a study by Ansari (2009) where equities of countries including Australia, Canada, France, Germany, Hong Kong, Japan, Singapore, United Kingdom and the United States are examined the results emanating from the study suggest an increased number of cointegrating vectors, showing a significant long run relationship among these markets. Now, previously presented studies are mainly from same regions or sharing common markets such as Europe, Eastern Europe and Asia separately. It is understandable as they share common markets and economic zones. However, above listed markets sharing a long run relationship can rather be explained by the power of increasing globalization. Complementary studies include the BRICs, a group of major emerging markets that share no physical borders but rather merely common goal in developing their markets to play a big role in the international arena. Tripathy (2015) analyzed the BRICs and found a shared long run equilibrium among these countries.

As globalization intensifies markets are getting more integrated. Studies have shown that during the time of crises, market movement of different countries are highly correlated. Assidenou (2011) explains the behavior of Asian equity markets during the crisis of 2008. At the time, they exhibited intensified cointegration among them. Babecky et al., (2013) supports the idea and further indicated that post 1997 Asian Crisis, markets became more integrated than ever before. The Study of 1997 Asian Crisis conducted by Koutmos (1997) indicated how stocks of the pacific basin behaved similarly during high volatile periods.

Contradicting findings to Long-run relationship among equity markets has also been well documented in the literature. Jeyanthi (2012) performed a study on BRIC countries' equity markets that showed no sign of long run relationship among them before and after the 2008 Crisis. These findings contradict with the findings by Tripathy (2015) in the same timeframe. The former, suggests an opportunity of portfolio diversification across BRIC countries. Absence of Long run relationship suggests that even with the factor of Globalization introduced to the equation, these markets are completely independent of each other. Further evidence is cemented by Singh, & Kaur (2016), a study in the period of 2004-2013 range, same as the studies above. Interesting they support the notion of no co-integrating vectors among the BRIC countries. Even though short run variations do not provide signification diversification opportunities, eventually the long-term horizon does give that opportunity. Keeping the assumption that markets follow a stochastic (random) walk model, Dimpfl (2014) emphasizes that equity markets in the international financial markets cannot be integrated if Eangle & Granger (1987) principles are to hold. Earlier studies by Yuce & Simga-Mugan (2000) also refute the notion of cointegration with different set of countries in eastern Europe and a contrasting timeframe. Further studies disagreeing with the presence of long run relationships are presented by (Fapetu & Aluko, 2017; Yang et al., 2003). Unfortunately, most of the studies are focused on European, Asian and American equity markets, and less on African markets. Nevertheless, a contributing study by Agyei-Ampomah, (2011) implies that African equity markets are still separated from the global financial markets despite increased structural adjustments. Volatilities in these markets are rather country specific and entirely diversifiable across the continent of Africa. We intend to contribute and enrich the literature on African equity markets later in this study.

Mixed results on existence of cointegration can be found in other studies conducted by (Wong et al. 2004; Syriopoulos, 2007; Singh & Singh,2016). The data sets exhibit partially the existence of cointegrating vectors among the countries studied.

## Research and Methodology

### Data

This study aims at examining the relationship among global equity indices (cointegration) and how they are impacted by the Covid-19. Using selected equity markets from various regional markets. Stock markets were selected as per size in terms of Market capitalization and the influence in the region. Each equity index represents the main equity index of the selected country. Moreover, for the employed methodology to work, all these markets have to exhibit non-stationarity character at their levels. Our study therefore includes 12 equity indices from across the globe, used as proxies for global equity indices in our analysis. These include, the Standard & Poors (SnP500), German DAX, Canadian TSX, United Kingdom FTSE100, Brazil's Bovespa, Hong Kong Hangseng, the Mexico MXX, Qatar's QSE, United Arab Emirates' UAEDFMG, South Africa's JTOP40, Turkey's BIST100 and the Japanese.

Time Series data analysis has been used to examine the relationship among global equity indices and implications of the novel Covid-19 pandemic on the global equity markets. In order to simplify our analysis, and since we use US(SnP500) as our base equity index, all the data was downloaded in United States dollars from Thompson Reuters, except for Japan, that was downloaded from Investing.com in Japanese Yen. The prices were then converted to US dollars using the St. Louis federal reserve daily exchange rate. The source of our data is presented in table 1 respectively.

Based on the literature, countries chosen are listed as; Brazil, Canada, Germany, Hong Kong, Japan, Mexico, Qatar, South Africa, Turkey, United States, United Kingdom and United Arab Emirates.

**Table 1:** Representation of Variables and Data Sources

| Variable(s) | Representation | Data Frequency | Data source | Data Points |
|---|---|---|---|---|
| **Brazil** | BOVESPA | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **Canada** | TSX | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **Germany** | DAX | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **Hong Kong** | HANGSENG | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **Japan** | NIKKEI225 | Daily | Investing.com | 01/04/2010-02/19/2021 |
| **Mexico** | MXX | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **Qatar** | QSE | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **South Africa** | JTOP40 | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **Turkey** | BIST100 | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **United States** | SNP500 | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **United Kingdom** | FTSE100 | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |
| **United Arab Emirates** | DFMG | Daily | Thompson Reuters | 01/04/2010-02/19/2021 |

**Source:** Authors, 2021

Prevalent in the literature is the classification of data into subsamples inspired by the research of Babecky, et al. (2013). This research has employed a similar approach and divided the data into two different periods. The first analysis focuses on the whole data samples as represented in the data table without acknowledging the exogeneous shock of Covid-19 in Model I. In the next phase Model II of our studies, it employs Covid-19 as and exogeneous sudden shock to the time series using the statistical binary variable, a dummy variable. This variable separates the data into two sections, by taking the value of "one" indicating the existence of an exogenous shock and on the other hand the value of "zero" for the normal period in the time series.

**Method and Analysis**

In this study, Vector Error Correction Model (VECM) is deployed to determine the relationship among global equity indices (cointegrations) including their speed of adjustments in the designated sub-sample periods. Using dummy variable, the study employs covid-19 as an exogeneous dummy variable to understand how they equity markets perform during high volatile periods, designated by covid-19. The study also intends to understand better the theory of strengthening cointegration of global equity markets using recent data and the recent covid pandemic. Using the VECM framework the relationship between variables that are being observed was determined and at the same time the estimates on both the long run and the short run relationship was established. According to Rahmaddi & Ichihashi (2012), the information on the long run relationship among the variables will be provided by the cointegration analysis while the short run relationship among the variables will be provided by granger causality test. In this case, the short run dynamics provided by the VECM in the Error correction term section is employed. Eview-10 analysis software was used to analyze data herein generation a regression model of the variable. After the data analysis the results were presented in form of equations, graphs and tables.

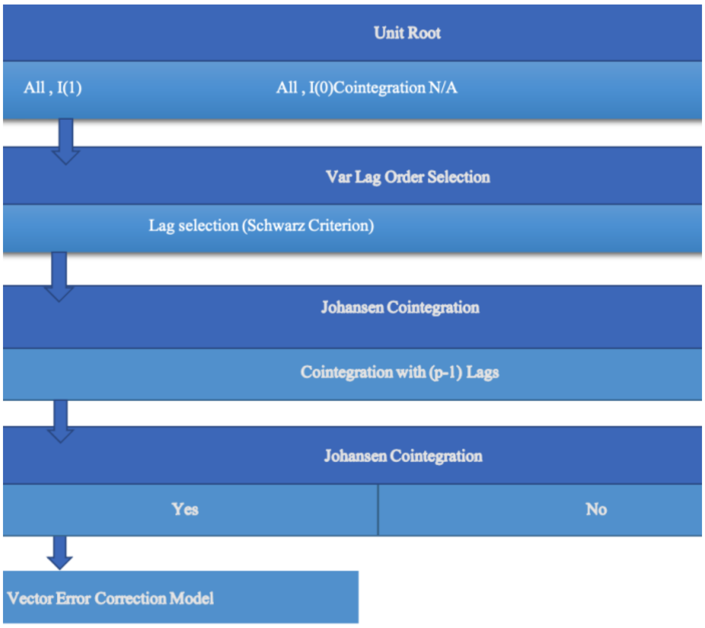


**Figure 3:** Flowchart for the empirical analysis; *Source:* Author, 2021

**Stationarity Test**

Analysis using time series have shortcomings as far as stationarity is concerned. This means that the series lacks independence in observations across time. Thus, these deficiencies lead to unintended and spurious regression outcomes. Before proceeding to Johansen cointegration and VECM, in that order, we need to make sure that the series is not stationary at level but rather at first difference. This is also referred to as integral of order 1 or I(1). According to Engel and Granger (1987), the order of integration is determined by the number of time that a series is difference before achieving stationarity. In our case we will employ Augmented dickey fuller test (ADF) to verify stationarity of our series, (Khan, 2011).

A standard Augmented Dickey Fuller test is performed using the equation:

Test for Unit Root (none)

$$\Delta y_t = \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi i \, y_{t-1} + \mu_t$$

Test for Unit Root (with constant)

$$\Delta y_t = \beta_0 + \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi i \, y_{t-1} + \mu_t$$

Test for Unit Root with Constant and Deterministic trend

$$\Delta y_t = \beta_0 + \beta_1 t + \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi i \, y_{t-1} + \mu_t$$

Where,

$y_t$ is represent the value variable at time period $t$, $\beta_0$ represents a constant term, $\beta_1 t$ represent the deterministic trend and,

$\mu_t$ is the white noise term.

The null hypothesis examined is as follows.

$$H_0 : \varphi^* = 0 \rightarrow Series\ has\ a\ Unit\ Root;\ H_1 : \varphi^* = 0 \rightarrow Series\ has\ no\ Unit\ Root$$

**Var Lag Order Selection**

The number of lags to be used through the proceeding steps of Johansen cointegration and Vector error correction model was determined by Vector error autoregression lag order selection. With reference to literature, we use Schwarz Information Criteria (SIC). It was chosen over Akaike Information Criteria (AIC) because it proved to be consistent, AIC lag order changes with increase in specified number of lags determined, while SIC was constant even if the specified number of lags is changed.

**Johansen Cointegration Test**

To explore the presence of cointegration among our variables, global equity markets, Johansen (1988) cointegration test will be employed. Cointegration test aims at exploring the long run relationship among designated non-stationary variables by looking at their forms of co-movement. The presence of cointegration suggest that markets are becoming less efficient and that the window of diversification is closing as globalization intensifies. (Assidenou, 2011; Rizwanullah et al, 2020).

Below is the procedure of Johansen Cointegration test in order of necessity;

VAR of order *p:*

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t$$

Where,

$y_t$ represents a $k$*1 vector of endogenous variables that are non-stationary I(1), $x_t$ represents a d*1 vector of exogenous and deterministic variables and $\varepsilon_t$ represents a k*1 vector of white noise innovation.

We can expand this AR as specified below:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma\, i \Delta y_{t-1} + \beta x_t + \varepsilon_t$$

Where,

$$\Pi = \sum_{i=1}^{p} A_i - \mathrm{I}$$

And

$$\Pi_i = -\sum_{j=i+1}^{p} A_j$$

In this representation, as suggested by granger, assuming that there is a coefficient matrix of Π with a diminished ranking of $< k$ , then we have $r * k$ matrices with $\varphi$ & $\beta$ having the ranking of $r$ on a condition that $\Pi = \varphi\beta'$ is I(0). Where $r$ represent cointegrating ranking relations, while $\beta$ is the cointegrating vector. All the information associated with the long run relationship decays in matrix Π where $\varphi$ elements represent adjustment parameters in a VECM model (also known as Speed of adjustment parameters). In this model we are trying to estimate in our matrix represented by Π from an unrestricted VAR model, that, can we reject the restrictions suggested in the reduced ranking of the matrix represented by Π.

As prevalent in the literature, the study deploys the third Johansen Cointegration Test specification, which states that the data its natural levels of $y_t$ comprises of linear trends, however their cointegrations comprises of intercepts only. This specification is presented as follows:

$$H_1(r){:}\, \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_1 \gamma_0$$

Where,

$\alpha_1$ represents deterministic terms outside the cointegration relations, $\gamma_0$ represents deterministic terms but within the cointegration relations and, $\alpha(\beta' y_{t-1} + \rho_0)$ represents the cointegrating equation.

There are mainly two t-statistics that assist in determining the number of cointegrating vectors as suggested by Johansen & Juselius, (1990). These are trace test and maximum eigenvalue t-statistics. This study adopts and focuses on both trace test and maximum eigen values to determine the cointegration ranking orders in the world equity indices within and across the designated time periods, (Rizwanullah, et al.,2020).

We can express formulation of trace and maximum eigen values as shown below,

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \lambda_i)$$

and

$$\lambda_{max}(r, r+1) = -T\, ln(1 - \lambda_{r+1})$$

Where,

T represents the sample size, $r$ represents the number of cointegrating vectors and $\lambda_i$ represents a value estimate of $i^{th}$ ordered eigenvalue, Rationally, the bigger the value of $\lambda_i$ is, the bigger the value of $ln(1 - \lambda_i)$ with a negative sign, hence the bigger the statistic test statistic value.

Johansen Cointegration Hypothesis Testing:

**Trace test**

$$H_0 = 0 \rightarrow There\ is\ atmost\ r\ cointegrating\ vectors;\ H_1 = 1 \rightarrow There\ is\ more\ than\ r\ cointegrating\ vectors$$

**Max Eigen Values:**

$$\mathbf{H_0} = There\ is\ r\ cointegrating\ vectors;\ H_1 = There\ are\ r+1\ cointegrating\ vectors$$

**Vector Error Correction Model (VECM)**

Vector error correction model is used to estimate the short and long-term dynamics, the relationship among variables over a period of time. VECM also provide the error correction terms, for the short run, these values are also referred to as speed of adjustments. In this case what are the short-term dynamics of a variable, how is a designated variable adjusting in the short-term moving towards the long run equilibrium.

Error term specification:

$$\varepsilon_t = y_t - \beta_{xt}$$

Where,

$\varepsilon_t$ Is the error term in a regression of $y_t$ on $x_t$, $\beta$ is the cointegration Coefficient.

A generic Error Correction Model (ECM) is specified as follows:

$$\Delta y_t = \alpha \varepsilon_{t-1} + \gamma \Delta x_t + \mu_t$$

Where,

$\mu_t$ represents an independent and identically distributed term that has zero mean and $\delta$ Variance; the first difference of $y_t$ is explained by previous values of $\alpha \varepsilon_{t-1}$ and $\Delta x_t$.

**Table 1:** Methodology Models

| **Model** | **Variables** |
|---|---|
| **Model I** | Equity indices |
| **Model II** | Equity Indices + Covid Dummy |

**Source:** Authors, 2021

**Model I**

$$\Delta lnsnp = \alpha_0 + \alpha_1 \Delta lntsx_{t-1} + \alpha_2 \Delta lnukftse_{t-1} + \alpha_3 \Delta lnnikke225_{t-1} + \alpha_4 \Delta lndax_{t-1} + \alpha_5 \Delta lnhangseng_{t-1} + \alpha_6 \Delta lnbist100_{t-1} + \alpha_8 \Delta lnbovespa_{t-1} + \alpha_9 \Delta lnmxx_{t-1} + \alpha_{10} \Delta lnjtop40_{t-1} + \alpha_{11} \Delta lnuaedfmg_{t-1} + \alpha_{12} \Delta lnqse_{t-1} + \alpha_{13} ECT_{t-1} + \mu_{t1}$$

$$\Delta lntsx = \partial_0 + \alpha_1 \Delta lnsnp_{t-1} + \partial_2 \Delta lnukftse_{t-1} + \partial_3 \Delta lnnikke225_{t-1} + \partial_4 \Delta lndax_{t-1} + \partial_5 \Delta lnhangseng_{t-1} + \partial_6 \Delta lnbist100_{t-1} + \partial_8 \Delta lnbovespa_{t-1} + \partial_9 \Delta lnmxx_{t-1} + \partial_{10} \Delta lnjtop40_{t-1} + \partial_{11} \Delta lnuaedfmg_{t-1} + \partial_{12} \Delta lnqse_{t-1} + \partial_{13} ECT_{t-1} + \mu_{t2}$$

$$\Delta lnukftse = \delta_0 + \alpha_1 \Delta lnsnp_{t-1} + \delta_2 \Delta lntsx_{t-1} + \delta_3 \Delta lnnikke225_{t-1} + \delta_4 \Delta lndax_{t-1} + \delta_5 \Delta lnhangseng_{t-1} + \delta_6 \Delta lnbist100_{t-1} + \delta_8 \Delta lnbovespa_{t-1} + \delta_9 \Delta lnmxx_{t-1} + \delta_{10} \Delta lnjtop40_{t-1} + \delta_{11} \Delta lnuaedfmg_{t-1} + \delta_{12} \Delta lnqse_{t-1} + \delta_{13} ECT_{t-1} + \mu_{t3}$$

$$\Delta lnnikkei225 = \beta_0 + \beta_1 \Delta lnsnp_{t-1} + \beta_2 \Delta lntsx_{t-1} + \beta_3 \Delta lnukftse_{t-1} + \beta_4 \Delta lndax_{t-1} + \beta_5 \Delta lnhangseng_{t-1} + \beta_6 \Delta lnbist100_{t-1} + \beta_8 \Delta lnbovespa_{t-1} + \beta_9 \Delta lnmxx_{t-1} + \beta_{10} \Delta lnjtop40_{t-1} + \beta_{11} \Delta lnuaedfmg_{t-1} + \beta_{12} \Delta lnqse_{t-1} + \beta_{13} ECT_{t-1} + \mu_{t4}$$

$$\Delta lndax = \gamma_0 + \gamma_1 \Delta lnsnp_{t-1} + \gamma_2 \Delta lntsx_{t-1} + \gamma_3 \Delta lnukftse_{t-1} + \gamma_4 \Delta lnnikkei225_{t-1} + \gamma_5 \Delta lnhangseng_{t-1} + \gamma_6 \Delta lnbist100_{t-1} + \gamma_8 \Delta lnbovespa_{t-1} + \gamma_9 \Delta lnmxx_{t-1} + \gamma_{10} \Delta lnjtop40_{t-1} + \gamma_{11} \Delta lnuaedfmg_{t-1} + \gamma_{12} \Delta lnqse_{t-1} + \gamma_{13} ECT_{t-1} + \mu_{t5}$$

$$\Delta lnhangseng = \theta_0 + \theta_1 \Delta lnsnp_{t-1} + \theta_2 \Delta lntsx_{t-1} + \theta_3 \Delta lnukftse_{t-1} + \theta_4 \Delta lnnikkei225_{t-1} + \theta_5 \Delta lndax_{t-1} + \theta_6 \Delta lnbist100_{t-1} + \theta_8 \Delta lnbovespa_{t-1} + \theta_9 \Delta lnmxx_{t-1} + \theta_{10} \Delta lnjtop40_{t-1} + \theta_{11} \Delta lnuaedfmg_{t-1} + \theta_{12} \Delta lnqse_{t-1} + \theta_{13} ECT_{t-1} + \mu_{t6}$$

$$\Delta lnbist100 = \vartheta_0 + \vartheta_1 \Delta lnsnp_{t-1} + \vartheta_2 \Delta lntsx_{t-1} + \vartheta_3 \Delta lnukftse_{t-1} + \vartheta_4 \Delta lnnikkei225_{t-1} + \vartheta_5 \Delta lndax_{t-1} + \vartheta_6 \Delta lnhangseng_{t-1} + \vartheta_8 \Delta lnbovespa_{t-1} + \vartheta_9 \Delta lnmxx_{t-1} + \vartheta_{10} \Delta lnjtop40_{t-1} + \vartheta_{11} \Delta lnuaedfmg_{t-1} + \vartheta_{12} \Delta lnqse_{t-1} + \vartheta_{13} ECT_{t-1} + \mu_{t7}$$

$$\Delta lnbovespa = \sigma_0 + \sigma_1 \Delta lnsnp_{t-1} + \sigma_2 \Delta lntsx_{t-1} + \sigma_3 \Delta lnukftse_{t-1} + \sigma_4 \Delta lnnikkei225_{t-1} + \sigma_5 \Delta lndax_{t-1} + \sigma_6 \Delta lnhangseng_{t-1} + \sigma_8 \Delta lnbist100_{t-1} + \sigma_9 \Delta lnmxx_{t-1} + \sigma_{10} \Delta lnjtop40_{t-1} + \sigma_{11} \Delta lnuaedfmg_{t-1} + \sigma_{12} \Delta lnqse_{t-1} + \sigma_{13} ECT_{t-1} + \mu_{t8}$$

$$\Delta lnmxx = \varphi_0 + \varphi_1 \Delta lnsnp_{t-1} + \varphi_2 \Delta lntsx_{t-1} + \varphi_3 \Delta lnukftse_{t-1} + \varphi_4 \Delta lnnikkei225_{t-1} + \varphi_5 \Delta lndax_{t-1} + \varphi_6 \Delta lnhangseng_{t-1} + \varphi_8 \Delta lnbist100_{t-1} + \varphi_9 \Delta lnbovespa_{t-1} + \varphi_{10} \Delta lnjtop40_{t-1} + \varphi_{11} \Delta lnuaedfmg_{t-1} + \varphi_{12} \Delta lnqse_{t-1} + \varphi_{13} ECT_{t-1} + \mu_{t9}$$

$$\Delta lnjtop40 = \omega_0 + \omega_1 \Delta lnsnp_{t-1} + \omega_2 \Delta lntsx_{t-1} + \omega_3 \Delta lnukftse_{t-1} + \omega_4 \Delta lnnikkei225_{t-1} + \omega_5 \Delta lndax_{t-1} + \omega_6 \Delta lnhangseng_{t-1} + \omega_8 \Delta lnbist100_{t-1} + \omega_9 \Delta lnbovespa_{t-1} + \omega_{10} \Delta lnmxx_{t-1} + \omega_{11} \Delta lnuaedfmg_{t-1} + \omega_{12} \Delta lnqse_{t-1} + \omega_{13} ECT_{t-1} + \mu_{t10}$$

$$\Delta lnuaedfmg = \omega_0 + \omega_1 \Delta lnsnp_{t-1} + \omega_2 \Delta lntsx_{t-1} + \omega_3 \Delta lnukftse_{t-1} + \omega_4 \Delta lnnikkei225_{t-1} + \omega_5 \Delta lndax_{t-1} + \omega_6 \Delta lnhangseng_{t-1} + \omega_8 \Delta lnbist100_{t-1} + \omega_9 \Delta lnbovespa_{t-1} + \omega_{10} \Delta lnmxx_{t-1} + \omega_{11} \Delta lnjtop40_{t-1} + \omega_{12} \Delta lnqse_{t-1} + \omega_{13} ECT_{t-1} + \mu_{t11}$$

$$\Delta lnqse = \emptyset_0 + \emptyset_1 \Delta lnsnp_{t-1} + \emptyset_2 \Delta lntsx_{t-1} + \emptyset_3 \Delta lnukftse_{t-1} + \emptyset_4 \Delta lnnikkei225_{t-1} + \emptyset_5 \Delta lndax_{t-1} + \emptyset_6 \Delta lnhangseng_{t-1} + \emptyset_8 \Delta lnbist100_{t-1} + \emptyset_9 \Delta lnbovespa_{t-1} + \emptyset_{10} \Delta lnmxx_{t-1} + \emptyset_{11} \Delta lnjtop40_{t-1} + \emptyset_{12} \Delta lnuaedfmg_{t-1} + \emptyset_{13} ECT_{t-1} + \mu_{t12}$$

**Model II:**

$$\Delta lnsnp = \alpha_0 + \alpha_1 \Delta lntsx_{t-1} + \alpha_2 \Delta lnukftse_{t-1} + \alpha_3 \Delta lnnikke225_{t-1} + \alpha_4 \Delta lndax_{t-1} + \alpha_5 \Delta lnhangseng_{t-1} + \alpha_6 \Delta lnbist100_{t-1} + \alpha_8 \Delta lnbovespa_{t-1} + \alpha_9 \Delta lnmxx_{t-1} + \alpha_{10} \Delta lnjtop40_{t-1} + \alpha_{11} \Delta lnuaedfmg_{t-1} + \alpha_{12} \Delta lnqse_{t-1} + \alpha_{13} ECT_{t-1} + COVID + \mu_{t1}$$

$$\Delta lntsx = \partial_0 + \alpha_1 \Delta lnsnp_{t-1} + \partial_2 \Delta lnukftse_{t-1} + \partial_3 \Delta lnnikke225_{t-1} + \partial_4 \Delta lndax_{t-1} + \partial_5 \Delta lnhangseng_{t-1} + \partial_6 \Delta lnbist100_{t-1} + \partial_8 \Delta lnbovespa_{t-1} + \partial_9 \Delta lnmxx_{t-1} + \partial_{10} \Delta lnjtop40_{t-1} + \partial_{11} \Delta lnuaedfmg_{t-1} + \partial_{12} \Delta lnqse_{t-1} + \partial_{13} ECT_{t-1} + COVID + \mu_{t2}$$

$$\Delta lnukftse = \delta_0 + \alpha_1 \Delta lnsnp_{t-1} + \delta_2 \Delta lntsx_{t-1} + \delta_3 \Delta lnnikke225_{t-1} + \delta_4 \Delta lndax_{t-1} + \delta_5 \Delta lnhangseng_{t-1} + \delta_6 \Delta lnbist100_{t-1} + \delta_8 \Delta lnbovespa_{t-1} + \delta_9 \Delta lnmxx_{t-1} + \delta_{10} \Delta lnjtop40_{t-1} + \delta_{11} \Delta lnuaedfmg_{t-1} + \delta_{12} \Delta lnqse_{t-1} + \delta_{13} ECT_{t-1} + COVID + \mu_{t3}$$

$$\Delta lnnikkei225 = \beta_0 + \beta_1 \Delta lnsnp_{t-1} + \beta_2 \Delta lntsx_{t-1} + \beta_3 \Delta lnukftse_{t-1} + \beta_4 \Delta lndax_{t-1} + \beta_5 \Delta lnhangseng_{t-1} + \beta_6 \Delta lnbist100_{t-1} + \beta_8 \Delta lnbovespa_{t-1} + \beta_9 \Delta lnmxx_{t-1} + \beta_{10} \Delta lnjtop40_{t-1} + \beta_{11} \Delta lnuaedfmg_{t-1} + \beta_{12} \Delta lnqse_{t-1} + \beta_{13} ECT_{t-1} + COVID + \mu_{t4}$$

$$\Delta lndax = \gamma_0 + \gamma_1 \Delta lnsnp_{t-1} + \gamma_2 \Delta lntsx_{t-1} + \gamma_3 \Delta lnukftse_{t-1} + \gamma_4 \Delta lnnikkei225_{t-1} + \gamma_5 \Delta lnhangseng_{t-1} + \gamma_6 \Delta lnbist100_{t-1} + \gamma_8 \Delta lnbovespa_{t-1} + \gamma_9 \Delta lnmxx_{t-1} + \gamma_{10} \Delta lnjtop40_{t-1} + \gamma_{11} \Delta lnuaedfmg_{t-1} + \gamma_{12} \Delta lnqse_{t-1} + \gamma_{13} ECT_{t-1} + COVID + \mu_{t5}$$

$$\Delta lnhangseng = \theta_0 + \theta_1 \Delta lnsnp_{t-1} + \theta_2 \Delta lntsx_{t-1} + \theta_3 \Delta lnukftse_{t-1} + \theta_4 \Delta lnnikkei225_{t-1} + \theta_5 \Delta lndax_{t-1} + \theta_6 \Delta lnbist100_{t-1} + \theta_8 \Delta lnbovespa_{t-1} + \theta_9 \Delta lnmxx_{t-1} + \theta_{10} \Delta lnjtop40_{t-1} + \theta_{11} \Delta lnuaedfmg_{t-1} + \theta_{12} \Delta lnqse_{t-1} + \theta_{13} ECT_{t-1} + COVID + \mu_{t6}$$

$$\Delta lnbist100 = \vartheta_0 + \vartheta_1 \Delta lnsnp_{t-1} + \vartheta_2 \Delta lntsx_{t-1} + \vartheta_3 \Delta lnukftse_{t-1} + \vartheta_4 \Delta lnnikkei225_{t-1} + \vartheta_5 \Delta lndax_{t-1} + \vartheta_6 \Delta lnhangseng_{t-1} + \vartheta_8 \Delta lnbovespa_{t-1} + \vartheta_9 \Delta lnmxx_{t-1} + \vartheta_{10} \Delta lnjtop40_{t-1} + \vartheta_{11} \Delta lnuaedfmg_{t-1} + \vartheta_{12} \Delta lnqse_{t-1} + \vartheta_{13} ECT_{t-1} + COVID + \mu_{t7}$$

$$\Delta lnbovespa = \sigma_0 + \sigma_1 \Delta lnsnp_{t-1} + \sigma_2 \Delta lntsx_{t-1} + \sigma_3 \Delta lnukftse_{t-1} + \sigma_4 \Delta lnnikkei225_{t-1} + \sigma_5 \Delta lndax_{t-1} + \sigma_6 \Delta lnhangseng_{t-1} + \sigma_8 \Delta lnbist100_{t-1} + \sigma_9 \Delta lnmxx_{t-1} + \sigma_{10} \Delta lnjtop40_{t-1} + \sigma_{11} \Delta lnuaedfmg_{t-1} + \sigma_{12} \Delta lnqse_{t-1} + \sigma_{13} ECT_{t-1} + COVID + \mu_{t8}$$

$$\Delta lnmxx = \varphi_0 + \varphi_1 \Delta lnsnp_{t-1} + \varphi_2 \Delta lntsx_{t-1} + \varphi_3 \Delta lnukftse_{t-1} + \varphi_4 \Delta lnnikkei225_{t-1} + \varphi_5 \Delta lndax_{t-1} + \varphi_6 \Delta lnhangseng_{t-1} + \varphi_8 \Delta lnbist100_{t-1} + \varphi_9 \Delta lnbovespa_{t-1} + \varphi_{10} \Delta lnjtop40_{t-1} + \varphi_{11} \Delta lnuaedfmg_{t-1} + \varphi_{12} \Delta lnqse_{t-1} + \varphi_{13} ECT_{t-1} + COVID + \mu_{t9}$$

$$\Delta lnjtop40 = \omega_0 + \omega_1 \Delta lnsnp_{t-1} + \omega_2 \Delta lntsx_{t-1} + \omega_3 \Delta lnukftse_{t-1} + \omega_4 \Delta lnnikkei225_{t-1} + \omega_5 \Delta lndax_{t-1} + \omega_6 \Delta lnhangseng_{t-1} + \omega_8 \Delta lnbist100_{t-1} + \omega_9 \Delta lnbovespa_{t-1} + \omega_{10} \Delta lnmxx_{t-1} + \omega_{11} \Delta lnuaedfmg_{t-1} + \omega_{12} \Delta lnqse_{t-1} + \omega_{13} ECT_{t-1} + COVID + \mu_{t10}$$

$$\Delta lnuaedfmg = \omega_0 + \omega_1 \Delta lnsnp_{t-1} + \omega_2 \Delta lntsx_{t-1} + \omega_3 \Delta lnukftse_{t-1} + \omega_4 \Delta lnnikkei225_{t-1} + \omega_5 \Delta lndax_{t-1} + \omega_6 \Delta lnhangseng_{t-1} + \omega_8 \Delta lnbist100_{t-1} + \omega_9 \Delta lnbovespa_{t-1} + \omega_{10} \Delta lnmxx_{t-1} + \omega_{11} \Delta lnjtop40_{t-1} + \omega_{12} \Delta lnqse_{t-1} + \omega_{13} ECT_{t-1} + COVID + \mu_{t11}$$

$$\Delta lnqse = \emptyset_0 + \emptyset_1 \Delta lnsnp_{t-1} + \emptyset_2 \Delta lntsx_{t-1} + \emptyset_3 \Delta lnukftse_{t-1} + \emptyset_4 \Delta lnnikkei225_{t-1} + \emptyset_5 \Delta lndax_{t-1} + \emptyset_6 \Delta lnhangseng_{t-1} + \emptyset_8 \Delta lnbist100_{t-1} + \emptyset_9 \Delta lnbovespa_{t-1} + \emptyset_{10} \Delta lnmxx_{t-1} + \emptyset_{11} \Delta lnjtop40_{t-1} + \emptyset_{12} \Delta lnuaedfmg_{t-1} + \emptyset_{13} ECT_{t-1} + COVID + \mu_{t12}$$

## Empirical Analysis & Findings

### Descriptive Statistics

Descriptive statistics of the analyzed data is presented in Table 3 Mean & Median was used to analyze the nature or tendency for the distribution of the individual stock market indexes. Standard deviations depict the normality status of the equity indices and to measure the asymmetry of probability distribution, skewness is applied. From 3, BOVESPA has the highest mean value with NIKKEI225 having the least men value. In terms of dispersion, SNP500 has fairly the highest standard deviation with UFTSE having the lowest standard deviation. It is highly evident that the data is not normally distributed as displayed by the skewness. Most of the data is moderately skewed as it falls between -1 and -0.5 or 0.5 and 1, while the rest is less than -1 exhibiting high skewness. Only UAEDFMG is fairly symmetrical as it falls between -0.5 and 0.5.

**Table 3:** Descriptive Statistics

| | **SNP** | **TSX** | **UK** | **NIK** | **DAX** | **HAN** | **BIS** | **BOV** | **MXX** | **JTOP** | **UAE** | **QSE** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 7.506 | 9.3666 | 9.1152 | 4.9945 | 9.2998 | 7.9898 | 5.6147 | 10.086 | 7.8366 | 8.1448 | 6.5406 | 7.842 |
| **Median** | 7.579 | 9.4033 | 9.1366 | 4.9875 | 9.35619 | 7.9967 | 5.6882 | 10.089 | 7.8638 | 8.1833 | 6.5989 | 7.858 |
| **Maximum** | 8.277 | 9.6070 | 9.3742 | 5.6606 | 9.75067 | 8.3526 | 6.2320 | 10.706 | 8.2127 | 8.4354 | 7.3688 | 8.279 |
| **Minimum** | 6.516 | 8.6695 | 8.4924 | 4.3099 | 8.44124 | 7.2590 | 4.8113 | 9.1133 | 6.9944 | 7.3029 | 5.8700 | 7.057 |
| **Std. Dev.** | 0.396 | 0.1466 | 0.1390 | 0.2637 | 0.26269 | 0.1673 | 0.3365 | 0.3311 | 0.2158 | 0.1857 | 0.3822 | 0.200 |
| **Skewness** | -0.177 | -1.864 | -1.207 | -0.0103 | -0.6470 | -0.975 | -0.429 | -0.191 | -1.003 | -1.737 | 0.0409 | -0.649 |
| **Kurtosis** | 2.017 | 7.4999 | 5.2225 | 2.2803 | 2.78713 | 5.0870 | 2.1511 | 2.5919 | 3.9775 | 6.7349 | 1.8735 | 3.933 |
| **Jar. Bera** | 145.2 | 4547.3 | 1434.6 | 68.997 | 229.008 | 1086.8 | 194.05 | 41.764 | 663.78 | 3464.9 | 169.82 | 340.4 |
| **Prob. V.** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Sum** | 23983 | 29926 | 29123 | 15957 | 29713 | 25527 | 17939 | 32226 | 25038 | 26022 | 20897 | 25055 |
| **Sm Sq. Dv.** | 502.1 | 68.737 | 61.731 | 222.12 | 220.404 | 89.430 | 361.78 | 350.21 | 148.81 | 110.18 | 466.76 | 128.5 |
| **Observ.** | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 | 3195 |

**Source:** Author, 2021

Co-movement of 12 equity indices across time starting from January 2007 until February 2021 is displayed by simply plot of standardized equity indices prices in the *y-axis* and time in years on the *x-axis.*

Looking at the following graph, it is apparent that there is a pattern in the movement of equity indices. The co-movement can be seen both in recovery period, as economies recover from the precious market correction, and during the recession as well, through the peaks and the troughs. From the Figure 4 below, we can clearly see three economic downturns, first depicted by the black line, represents during the 2008 Global Financial Crisis.

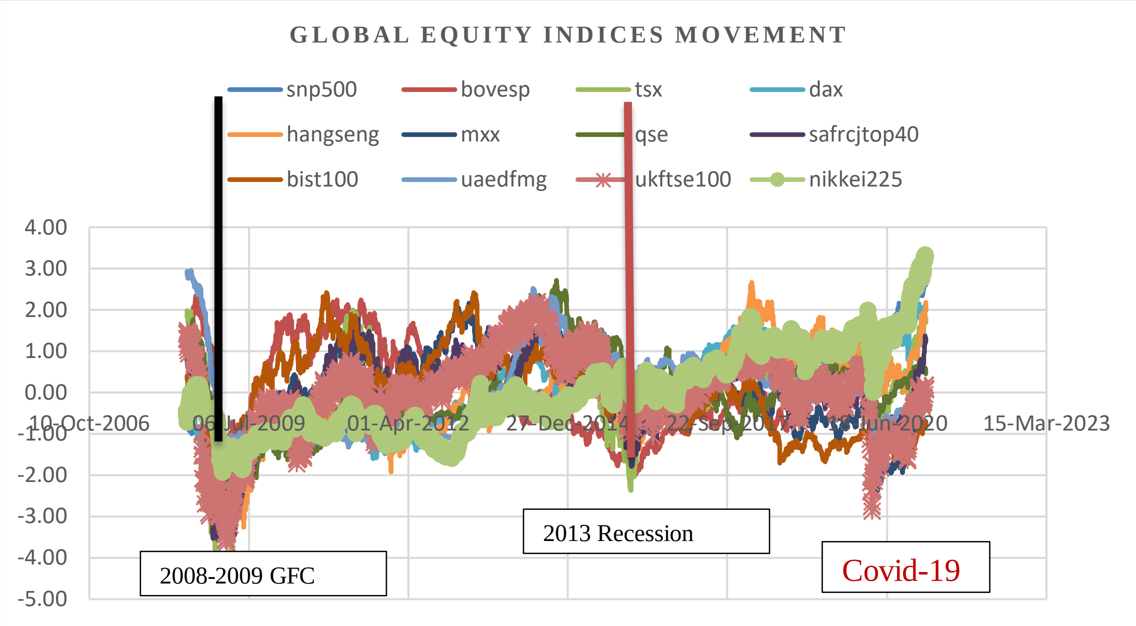


**Figure 4:** Relationship Among Global Equity Indices; Source: Thompson Reuters, 2021

The line in orange depicts a downturn in 2013, a recession instigated by the crisis of 2008-09. Lastly, we can see a sharp drop on 11 March,2020, a drop nearly to the levels of 2008-09 crisis, the recession perpetrated by the novel Corona Virus (Covid-219). As soon as the World Health Organization declared the pandemic, the equity markets experienced a sudden sharp drop. However, after a short period of time the equity indices recovered and regained their pre-pandemic levels and beyond.

**Table 4:** Stationarity Test

| **Test** | **Equity Index** | **At Level** | | | **First Difference** | | | **Conclusion** |
|---|---|---|---|---|---|---|---|---|
| | **Time Series** | **Constant** | **Trend** | **None** | **Constant** | **Trend** | **None** | |
| **Augment. Dickey Fuller (ADF) Test** | **SNP500** | 0.150617 | -5.0892*** | | -65.452*** | -65.47078 | | I(1) |
| | **TSX** | -3.0206** | -3.38073* | -0.05955 | -21.254*** | -21.273*** | -21.25*** | I(1) |
| | **BOVESPA** | -2.301336 | -2.483832 | | -59.233*** | -59.226*** | | I(1) |
| | **MXX** | -2.501903 | -2.534969 | | -52.184*** | -52.806*** | | I(1) |
| | **UKFTSE** | -3.1032** | -3.29945* | -0.23748 | -54.685*** | -54.679*** | -54.69*** | I(1) |
| | **DAX** | -1.408808 | -3.8563** | | -55.350*** | -55.348*** | | I(1) |
| | **CAC40** | -3.1286** | -4.661*** | 0.014953 | -56.565*** | -56.570*** | -56.57*** | I(1) |
| | **JTOP40** | -2.9401** | -3.074388 | -0.00972 | -55.868*** | -55.865*** | -55.89*** | I(1) |
| | **MORROCO** | -3.2823** | -2.844448 | -0.82875 | -48.248*** | -48.289*** | -48.24*** | I(1) |
| | **NIKKEI225** | -0.909711 | -3.7046** | | -57.995*** | -58.006*** | | I(1) |
| | **SINGSGX** | -2.77679* | -3.34319* | 0.03718 | -37.677*** | -37.678*** | -37.6*** | I(1) |
| | **HANGSENG** | -2.190668 | -365469** | | -57.094*** | -57.0928*** | | I(1) |
| | **BIST100** | -1.938534 | -2.384459 | | -52.106*** | -52.0982*** | | I(1) |
| | **QSE** | -2.185736 | -2.928862 | | -51.4918*** | -51.4929*** | | I(1) |
| | **UAEDFMG** | -2.163385 | -2.903990 | | -51.927*** | -51.9558*** | | I(1) |

*Note: ***, ** and * show the rejection of the null hypothesis at 1%, 5% and 10% level of significance respectively.*
**Source:** Author, 2021

### Augmented Dickey Fuller (ADF)

An Augmented Dickey-Fuller (ADF) test (Dickey & Fuller 1979) was employed to test unit roots in our data. Tests at levels was run with three stipulations, that is including only constant, with constant & trend and lastly, none. These stipulations validate the analysis to come up with robust results from the unit roots. ADF test the null hypothesis that there exists unit root in the time series against the alternative hypothesis that the time series is stationary (Phillip & perron 1988). According to (Aysan, A. F. et al, 2021) a time series is stationary if it has constant variance, mean and co-variance across time.

When we look at Table 4, test for unit root by Augmented Dickey Fuller (ADF) suggest that all the equity indices apart from TSX, UKFTSE, CAC40, JTOP40, MORROCCO and SINGSGX, we cannot reject the null hypothesis of unit root at levels at 5% for the former four equity indices and the latter at 10%; it is therefore safe to imply that these time series contain unit root at levels when we consider only constant. However, if constant and trend are brought into the equation, the presence for unit root in time series of TSX, UKFTSE, SINGSGX cannot be reject the null hypothesis at 10%, while SNP500 and CAC40 at 1%, and at 5% for DAX, NIKKEI225 & HANGSENG. Lastly, as depicted in Table 5, when neither constant nor trend is embedded in the equation the null hypothesis of presence of unit root at levels is rejected. Therefore, with these exceptions we can safely consider that all the equity indices in the analysis are stationary at first difference and at the acceptance prob. Value of 1%. In this case, it would suffice to conclude that all the closing prices of the global equity indices are integral of order 1, of in other words, time series of *I(1).*

**Table 5:** Cointegration Mechanism

| **Model I** | | | | | |
|---|---|---|---|---|---|
| | | **Trace test** | | **Maximum Eigen Values** | |
| **Null Hypothesis** | **Alternative Hypothesis** | **Statistics** | **Prob. **** | **Statistic** | **Prob.**** |
| $\boldsymbol{r = 0}$ | $r > 0$ | 789.9617*** | 0 | 204.5493*** | 0 |
| $\boldsymbol{r \leq 1}$ | $r > 1$ | 585.4123*** | 0 | 156.1455*** | 0 |
| $\boldsymbol{r \leq 2}$ | $r > 2$ | 429.2669*** | 0 | 148.0720*** | 0 |
| $\boldsymbol{r \leq 3}$ | $r > 3$ | 281.1948*** | 0 | 94.65972*** | 0 |
| $\boldsymbol{r \leq 4}$ | $r > 4$ | 186.5351*** | 0.0007 | 60.54744*** | 0.0059 |
| $\boldsymbol{r \leq 5}$ | $r > 5$ | 125.9877** | 0.0474 | 42.39017 | 0.1220 |
| $\boldsymbol{r \leq 6}$ | $r > 6$ | 83.5975 | 0.2547 | 32.75254 | 0.2636 |
| $\boldsymbol{r \leq 7}$ | $r > 7$ | 50.84495 | 0.6007 | 22.94188 | 0.5349 |
| $\boldsymbol{r \leq 8}$ | $r > 8$ | 27.90308 | 0.8179 | 16.10360 | 0.6570 |
| $\boldsymbol{r \leq 3}$ | $r > 9$ | 11.79947 | 0.9386 | 9.240307 | 0.8126 |
| $\boldsymbol{r \leq 10}$ | $r > 10$ | 2.559167 | 0.9833 | 2.438844 | 0.9769 |
| $\boldsymbol{r \leq 11}$ | $r > 11$ | 0.120323 | 0.7287 | 0.120323 | 0.7287 |
| **Mode II** | | | | | |
| $\boldsymbol{r = 0}$ | $r > 0$ | 842.2986*** | 0 | 203.9820*** | 0 |
| $\boldsymbol{r \leq 1}$ | $r > 1$ | 639.3166*** | 0 | 171.4233*** | 0 |
| $\boldsymbol{r \leq 2}$ | $r > 2$ | 466.8933*** | 0 | 148.5109*** | 0 |
| $\boldsymbol{r \leq 3}$ | $r > 3$ | 318.3824*** | 0 | 103.0250*** | 0 |
| $\boldsymbol{r \leq 4}$ | $r > 4$ | 215.3574*** | 0 | 75.69908*** | 0.0001 |
| $\boldsymbol{r \leq 5}$ | $r > 5$ | 139.6583*** | 0.0053 | 48.78694** | 0.0261 |
| $\boldsymbol{r \leq 6}$ | $r > 6$ | 90.87136 | 0.1034 | 35.33196 | 0.1556 |
| $\boldsymbol{r \leq 7}$ | $r > 7$ | 55.5394 | 0.3967 | 28.97165 | 0.1722 |
| $\boldsymbol{r \leq 8}$ | $r > 8$ | 26.56774 | 0.8701 | 14.34026 | 0.7985 |
| $\boldsymbol{r \leq 9}$ | $r > 9$ | 12.22748 | 0.9237 | 8.169325 | 0.8930 |
| $\boldsymbol{r \leq 10}$ | $r > 10$ | 4.058155 | 0.8988 | 2.577308 | 0.9708 |
| $\boldsymbol{r \leq 11}$ | $r > 11$ | 1.480848 | 0.2236 | 1.480847 | 0.2236 |

**Note:** *** and ** represents significance at 0.01 and 0.05 level respectively.

**Source:** Author, 2021

**Long-Run Dynamics**

This study focuses on the long run relationship among global equity indices. In order to find out whether indeed there is a long run relationship among the 12 global equity indices we conducted a Johansen cointegration on two designated models (model I and model II). Where, Model I involve all the 12 global equity indices, while the Model II involves all the 12 global equity indices plus COVID-19 as a dummy variable. Results depicted from the analysis of these two models are not far much different from each other, however there is one interesting fact that we can take from this study and one of our main contributions to the literature.

Estimate results from Johansen Cointegration test in Table 5, in Model I, the number of cointegrating vectors is depicted by symbol *r*, under the alternative and null hypothesis. Therefore, in such case if we cannot reject the null hypothesis represented by *r=0*, the conclusion of no cointegrating vectors will be derived from the results. On the other hand, if we can reject the null hypothesis of *r=0*, then we can conclude that there is at least zero cointegrating vectors present. According to model specification I of our analysis, both trace statistics and maximum eigen values rejects the null hypothesis of *r=0* up to $r \leq 4$ cointegrating vector at 0.01. This continues until $r \leq 5$ hypothesized number of cointegrating vectors, where the null hypothesis is rejected at 0.05, and conclude that trace statistics suggest at least 5 cointegrating vectors. However, maximum eigen values rejects the null hypothesis at 0.01 for $= 0$ , $r \leq 4$ cointegrating vectors, suggesting at least 4 cointegrating vectors. According to (Assidenou,2011) who made studies on the pacific stocks cointegration, in either way of the cointegration ranking order, we do have at least 4 cointegrating vectors.

In the model specification II, a model where we induce covid-19 as a dummy variable. A dummy variable is a numerical binary variable that that assumes values of either “one” or “zero”. Accordingly dummy serves as a demarcation indicator to treat different subgroups of data to depict a shift in data arrangements. In this model, Covid-19 dummy variable assumes the value of “one” after 03/11/2020, the date marks the declaration date by the World health organization officially recognizing covid-19 a pandemic. As of the remaining period, from 01/04/2010 to 03/11/2020, the data assumes the value of “zero”. In Model II, where the impact of Covid-19 is factored into the equation, trace test suggests same results to Model I, when we do not consider Covid-19 as an exogeneous shock. However, maximum eigen values on the other hand rejects the null hypothesis of $r = 0$ and $r \leq 4$ at 0.01 level of probability. The null hypothesis of $r \leq 5$ however is rejected at the probability level of 0.05. According to this observation we can safely express that, when Covid-19 pandemic is introduces as a Shock variable to the equation, the global equity markets are more integrated as compared to the case of no Covid-19 inclusion.

**Vector Error Correction Model**

The exploration on the long run relationship among global equity indices was established using Vector error Correction Model and the results are presented in table 6. In Model I, we do not consider the presence of Covid-19 in the time series. Five cointegrating Vectors are displayed with corresponding long run relationship among 5 equity indices of SNP500, TSX, UKFTSE, DAX and NIKKEI225, and the rest of the indices. In the first Cointegrating vector, SNP500 indicates a positive relationship with Indexes of HANGSENG, BIST100, BOVESPA, MXX and QSE in the long run, they are all significant at 0.01. Indexes of JTOP40 and UAEDFMG have a negative long run relationship and they are significant at 0.01. The second cointegrating vector shows that TSX is positively related to HANGSENG, BOVESPA, and QSE. All these relationships are significant at 0.01. Cointegrating vector three presents the positive relationship between UKFTSE and MXX, JTOP40 & UAEDMFG. There is However a negative long run relationship between UKFTSE and HANSENG, BIST, BOVESPA & QSE. In cointegration vector four, NIKKEI225 is positively associated with UAEDFMG & JTOP40 and a negative association with HANGSENG, BIST, BOVESPA, MXX & QSE in the long run. The fifth cointegrating vector presents a positive association between DAX and HANGSENG & QSE, while negatively associated with JTOP40 in the long run.

**Table 6:** Normalized Cointegration Coefficients

| **Model I** | | | | | |
|---|---|---|---|---|---|
| **Cointegration Equations** | **CV.1** | **CV.2** | **CV.3** | **CV.4** | **CV.5** |
| **SNP500(-1)** | 1.000000 | - | - | - | - |
| **TSX(-1)** | - | 1.00000 | - | - | - |
| **UKFTSE(-1)** | - | - | 1.000000 | - | - |
| **NIKKEI225(-1)** | - | - | | 1.000000 | - |
| **DAX(-1)** | | - | | - | 1.000000 |
| **HANGSENG(-1)** | -5.57977*** | -0.24443*** | 0.300416*** | 1.868709*** | -2.01267*** |
| | (0.51751) | (0.06998) | (0.07121) | (0.43041) | (0.17907) |
| **BIST100(-1)** | -0.66135*** | - | 0.180978*** | 0.541645*** | - |
| | (0.28335) | | (0.03899) | (0.23566) | |
| **BOVESPA(-1)** | -0.50244*** | -0.23415*** | 0.092567*** | 0.774097*** | - |
| | (0.21251) | (0.02874) | (0.02924) | (0.17674) | |
| **MXX(-1)** | -1.91776*** | - | -0.16707*** | 2.883495*** | - |
| | (0.51614) | | (0.07102) | (0.42928) | |
| **JTOP40(-1)** | 7.050946*** | - | -1.08284*** | -5.8945*** | 1.367371*** |
| | (0.65344) | | (0.08991) | (0.54347) | (0.22610) |
| **UAEDFMG(-1)** | 0.595551*** | - | -0.16245*** | -0.41138*** | - |
| | (0.22816) | | (0.03139) | (0.18976) | |
| **QSE(-1)** | -2.48525*** | -0.33449*** | 0.229241*** | 1.370205*** | -0.582345*** |
| | (0.45071) | (0.06095) | (0.06202) | (0.37485) | (0.15595) |
| | | | | | |
| **C** | 19.00997 | -2.01553 | -4.06618 | -13.422 | 3.931941 |

**Note:** *******represent significance of the co-efficient at 0.01 significance level. Standard errors are in parenthesis.

**Source:** Author, 2021

In Model II, Covid-19 is considered by inducing a dummy variable, and the results are presented below in table 7. Factoring in Covid-19 we proceed with 5 Cointegrating vectors as suggested by both Trace and Maximum Eigen Values. The first cointegrating vector show a positive long run relationship between SNP500 and HANGSENG, BOVESPA, MXX & QSE. JTOP40, however, exhibited a negative association. In the second cointegrating vector TSX is positively associated with BOVESPA, MXX, JTOP40, UAEDFMG & QSE. BIST100, however, portrayed a negative association with TSX.

As of the third cointegrating vector UKFTSE is positively associated with JTOP40 & UAEDFMG. BIST100 and BOVESPA however exhibits a negative relationship in the long run. Cointegrating vector four shows a positive relationship between NIKKEI225 and JTOP40, while BOVESPA and MXX exhibits a negative relationship with NIKKEI225.

Lastly, in cointegrating vector five, DAX shows a positive long run relationship with HANGSENG, MXX and BOVESPA. On the other hand, however, DAX is negatively related with JTOP40. All the results are significant with probability of 0.01.

**Table 7:** Normalized Cointegration Coefficients

| **Model II** | | | | | |
|---|---|---|---|---|---|
| **Cointegration Vector** | **CV.1** | **CV.2** | **CV.3** | **CV.4** | **CV.5** |
| **SNP500(-1)** | 1.000000 | _ | _ | _ | _ |
| **TSX(-1)** | _ | 1.000000 | _ | _ | _ |
| **UKFTSE(-1)** | _ | _ | 1.000000 | _ | _ |
| **NIKKEI225(-1)** | _ | _ | _ | 1.000000 | _ |
| **DAX(-1)** | _ | _ | _ | _ | 1.000000 |
| **HANGSENG(-1)** | -4.94606*** | _ | _ | _ | -1.78327*** |
| | (0.46414) | | | | (0.15556) |
| **BIST100(-1)** | _ | 0.108118*** | 0.089310*** | _ | _ |
| | | (0.02707) | (0.03353) | | |
| **BOVESPA(-1)** | -0.50968*** | -0.24412** | 0.089049*** | 0.791897*** | -0.06731*** |
| | (0.19981) | (0.02077) | (0.02572) | (0.19669) | (0.06697) |
| **MXX(-1)** | -2.58562*** | -0.17607*** | _ | 4.557495*** | -0.68437*** |
| | (0.53983) | (0.05612) | | (0.53142) | (0.18093) |
| **JTOP40(-1)** | 6.525113*** | -0.26634*** | -0.91394*** | -5.12173*** | 1.272851*** |
| | (0.59444) | (0.06179) | (0.07653) | (0.58517) | (0.19923) |
| **UAEDFMG(-1)** | _ | -0.07908*** | -0.09982*** | _ | _ |
| | | (0.02325) | (0.02879) | | |
| **QSE(-1)** | -1.80525*** | -0.09474*** | _ | _ | _ |
| | (0.42165) | (0.04383) | | | |
| **C** | 17.68067 | -2.39549 | -3.7008 | -10.0479 | 3.553953 |

***Note ******represent significance of the co-efficient at 0.01 significance level. Standard errors are in parentheses.*
**Source:** Author, 2021

**Short Run Dynamics**

Presented in Table 8 below are the short run dynamics of our model. The results express the adverse impact of Covid-19 on the Global Equity markets. Equity Markets of TSX, DAX and BIST100 shows that the pandemic had a positive impact on these indexes in the short run and they are significant at 0.01 level. Indices of BOVESPA and UAEDFMG were negatively impacted by the pandemic in the short run, and the results are significant at 0.01 and 0.05 respectively. Equity indices of SNP00, HANGSENG and QSE were positively impacted as well but the results are not significant. On the other hand, equity indices of UKFTSE, NIKKEI225, MXX and JTOP40 were negatively impacted but again the results are not significant.

**Table 8:** Coefficient of Covid-19 in Short-Run Dynamics

| | **SNP** | **TSX** | **FTSE** | **NIKK** | **DAX** | **HANG** | **BIST** | **BOVESPA** | **MXX** | **JTOP40** | **UAE** | **QSE** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COVID** | 8.53E-05 | **.0066 ***** | -0.0027 | -.0022 | **.0060 ***** | .000619 | **.00549 ***** | **-.009 ***** | -.0022 | -.0019 | **-.0031 **** | .0012 |
| | (.0012) | (.0013) | (.0013) | (.00164) | (.0016) | (.00134) | (.00218) | (.00251) | (.00164) | (.00183) | (.00154) | (.00119) |

**Note:** *** and ** represents significance at 0.01 and 0.05 respectively, standard errors are presented in the parentheses.
**Source:** Author, 2021.

## Conclusions

Making an informed decision is at the core of every successful investment option. Increasing uncertainty, volatility in the global financial markets has intrigued academicians and non-academics alike including policy makers, individual and institutional investors. Increasing market globalization has triggered the need to understand the concept of market integration in the short and long run. Moreover, how do markets perform during the period of high volatility and uncertainty? Is the window for diversification closing, and does increasing imminent crises deteriorates utilization of this tool in the global equity markets?

The study uses time series data to examine the relationship among global equity indices and implications of novel COVID-19 pandemic on global equity markets. Twelve equity indices that were used as proxies for global equity indices were employed in the study. Data set used in the study was a daily time series that was collected from Thompson Reuters and Investing.com with dates ranging from 2010 to 2021. Indexes explored in the study comprises indexes of countries including, Brazil, Canada, Germany, Hong Kong, Japan, Mexico, Qatar, South Africa, Turkey, United States, United Kingdom and United Arab Emirates.

In order to examine the long-run relationship and short run dynamics, Vector Error Correction Model is employed to the study. On the other hand, to establish cointegration among the global equity indices, Johansen Cointegration test is applied. Preliminary tests were conducted, and they include, in chronological order, Unit root test, Vector Autoregression for Lag selection, Johansen Cointegration and Vector Error Correction Model.

After running necessary tests, the results shows that there is increasing cointegration among the global equity indices. This confirms the premise and theory that increasing uncertainty and volatility in the markets leads to further cointegration among global equity indices. This is evident in the results after considering COVID-19 as an exogeneous variable to the equation. After the mortgage crisis of 2008, the international market experience further integration in general. At this stance, post COVID-19 we should expect escalating cointegration. In that regard, room for diversification among global equity indices is narrowing down.

Taking a closer look at the short run dynamics, the outcomes are mixed. Some indexes exhibit a positive impact by the COVID-19 pandemic. The reason for this is that most of these indices have recovered from their historical low at the start of the pandemic. At the time of the study these indices are trading above pre pandemic levels. On the other hand, some indices exhibit a negative impact by COVID-19. In that regard, such equity indices are still trading lower than their pre-pandemic levels.

Future studies are required to study the impact of COVID-19 pandemic as a crisis in the long-term horizon. Additionally, investors can put into consideration the dynamics in the global equity markets in order to make a sound and an informed decision in a high volatile market environment. Last but not the least suggestion, is the need to study the link between the quick developing crypto industry and the stock markets.

Even though equity markets were hit by the pandemic. Some of them managed to recover very much faster than others. It is therefore of importance for investors to note the indices that have quick speed of recovery and adjustment while making an investment decision in the global equity markets.

Portfolio managers are also advised to put into consideration the dynamics in the market as discussed above, especially during high volatile periods of the market. The findings provide a strong foundation for constructing resilient equity portfolio in a highly uncertain market environment. To academicians, this literature adds upon the chuck of literature available and serves as source of reference for future studies to be conducted.

Future studies are required to study the impact of COVID-19 pandemic as a crisis in the long-term horizon. Additionally, investors can put into consideration the dynamics in the global equity markets to make a sound and an informed decision in a high volatile market environment. Last but not the least suggestion, is the need to study the link between the quick developing crypto industry and the stock markets.

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