Impact on Liquidity of the stock market due to COVID-19 and BREXIT

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Abstract

In my thesis, I study the impact on liquidity of the capital markets due to COVID-19 and BREXIT. In my first empirical chapter, taking a sample of the indices of the USA, UK, China, Brazil, Germany, and Spain, I study how the pandemic has impacted the liquidity of the capital markets of the mentioned countries. COVID-19 has been declared as a pandemic by the World Health Organisation (WHO) on March 11, 2020. I study a 60-day pre and post period of March 11, 2020 to capture the liquidity effects. For a short-term analysis, I use the relative spread and for the long-term analysis, I use the price impact ratios of Amihud (2002) and Florackis et al. (2011). I report that in the short-term, the pandemic has decreased the liquidity of the capital markets. In the long run, there has been a liquidity effect only in China. In order to further analyse what caused the deterioration, I decompose the effective spread and discover that the information asymmetry has played a role in the liquidity effect of the capital markets. However, the information asymmetry effect cannot be found on the capital markets of China.

For the second empirical chapter, I study the impact of the pandemic, COVID-19, on the liquidity of the European Tourism Industry by analysing forty-nine companies from the FTSE ALL Share Index, EURONEXT 100, and IBEX 35 indices. As the WHO declared COVID-19 as a pandemic on March 11, 2020, hence, I develop a 60 days pre and post period around March 11, 2020, to capture the short-term and long-term effects of COVID-19 on the European Tourism Industry. For a short-term measure, I use the relative spread and for the long-term measure, I use the price impact ratios of Amihud (2002) and Florackis et al. (2011). I report that both in the short and long terms, the liquidity of the European Tourism Industry has decreased.

For the third empirical chapter, I study twenty-four events from the BREXIT referendum until the transition period to capture how BREXIT has impacted the liquidity of the FTSE 100 index. I study a period of 10 days pre and post around each of the twenty-four events. Thus, I develop an event-study methodology and compute the quoted, relative, and effective spreads for each of the events. I discover that during the period, there exhibits positive and significant spreads which tend to decrease as the referendum is absorbed and again tend to rise near the transition period.

My research supports the information cost/liquidity hypothesis. Whenever noise or events occur, one part of the market participants become aware of superior information than that of the other segment of traders. Hence information asymmetry appears in the financial markets. Thus the market participants, also known as specialists, who do not have access to the superior information require premium for accommodating information and taking positions against informed investors/traders. The specialists, then in turn, increase the bid-ask spread as a liquidity premium. As a result, the market also signals a fall in the price impact ratios. Overall, the liquidity of the financial markets decreases.

My research shows that COVID-19 and BREXIT have created information asymmetry in the financial markets. I report that these two events have significant effect on the liquidity of the capital markets. My research can hence be used as a guide to determine portfolio organizing in times of the pandemic or political events and also to stabilise the long-term effects of the noises. Moreover, it can provide advice on the policy framework in times of the market events.

Preface

The third chapter of this thesis has been published as:

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Dedication

I would like to dedicate this thesis to my special friend, Md Emran Kabir, for constantly supporting me.

Declaration

I hereby declare that this thesis is the original work of the author. I declare that the research output explained here has not been submitted to any other university or by any other author as part of degree.

Chapter One: Introduction

A major concern in the world of finance revolves around the term liquidity. Liquidity is the single concept which has been recognised as the driving factor for determining expected returns, trading volume, and the portfolio selection of investors. As mentioned by Brennan (2012), liquidity is defined as how quickly the investors can buy and sell large quantity of assets at low cost and without having a significant impact on price. A prominent importance of liquidity is that there is less risk, as there is always a presence on the other side of the market. On the other hand, a liquid market creates a platform where the highest price any buyer is prepared to pay and the lowest price any seller is happy to accept will move closer together. In other words, the bid-offer spread will tighten. The risk an asset suffers due to the liquidity constraint is referred to as the liquidity risk.

Given the importance of liquidity, and as mentioned by Tiwari et al. (2022), the liquidity of the capital markets acts as a major underlying factor for economic growth and financial stability. When extreme market conditions approach, markets signal shocks and liquidity risk evolves, leading to either a negative return or a wipe out of the whole investment.

The liquidity and its risk have been studied by numerous theoretical and empirical researchers. Some of the theoretical studies are based on the concept that a decline in the market triggers illiquidity. A concept known as spiral effect has further been explained by the model of Brunnermeier and Pedersen (2009) which states that during crisis periods, as the market tends to fall, the value of the investor's asset also declines, which in turn leads to an increase in the margin calls. As a result, the investor can be forced to sell-off part or whole of his/her portfolio which in turn creates additional downward pressure on the market. Thus, the dealers face further constraint from providing market liquidity. This theory is documented by the authors with the background that there is a linkage between the asset's market liquidity, i.e., the ease of changing hands of an asset, with the trader's liquidity, i.e., the ease of obtaining the funds. In terms of tightened market conditions, market participants hesitate to take positions which further leads to low market liquidity and high volatility. A paper by Rosch and Kaserer (2014) further examines the theoretical spiral effect of liquidity with their research stating that during the crisis period, there exists a funding crisis which in turn leads to liquidity commonality and liquidity dry ups. Moreover, during tightened market conditions, there exists a positive relation between market risk and liquidity risk, and credit risk and liquidity risk. Arguably, a model by Anshuman and Viswanathan (2005) provides evidence that as the value of the leveraged investor's assets declines, there rises a situation during which they are required to enhance collateral for the asset. The investors then tend to default more and thus the sell-off assets of increases. On the other hand, due to the tightened repo market, the dealers, and brokers face difficulty in obtaining funds to buy the assets from the market. Thus, illiquidity prevails in the markets leading to financial contagion.

The capital markets face liquidity crunches whenever there are any events or crisis. These crises, along with the market behaviour and anomalies, lead to a fall in liquidity of the capital markets. The following sections summarize how the liquidity of the capital markets have impacted during the events:

1.1 Liquidity and Crisis

A crisis period acts as a catalyst for a declining market and increasing illiquidity. Numerous research has been conducted to determine how capital markets have reacted during the periods of different crisis. A paper by Chordia et al. (2001) study a sample of NYSE stocks from 1992 to 1998. They use bid-ask spreads and highlight that in declining markets, there is a rise in illiquidity and volatility. The paper also states that during the rising markets, the bid-ask spread improves marginally. A more integrated paper has been published by Liu (2006) which analyses the major economic and financial events namely the 1972-1974 recession, the 1987 crash, the Asian financial crisis in 1997, the 1998 Russian default, the collapse of the Long-Term Capital Management (LTCM) hedge fund in 1998, the early 2000 burst of the high-tech bubble and the terrorist attacks on September 11, 2001. He has applied different liquidity measures on the US stock market and reports that market liquidity is significantly impacted by the events. Lesmond (2005) uses the bid-ask spreads and other liquidity measures and reports in his paper that the measures deteriorate during the Asian and Russian crisis. He studies 23 emerging markets over the period of 1993-2000. Yeyati et al. (2008) study a period of April 1994-June 2004 and use three measures of liquidity namely, trading volume, the Amihud (2002) ratio, and the bid-ask spreads over seven emerging markets: Argentina, Brazil, Indonesia, South Korea, Mexico, Russia and Thailand, and report that during turmoil conditions, markets continue the trading with a higher cost of transactions. The Amihud (2002) ratio rises, and the bid-ask spread have increased. Therefore, the liquidity of the capital market decreases. Hameed et al. (2007) use bid-ask spread for measuring liquidity and find out that during a bearish market, the bid-ask spread rises by 2.8 (6.2) basis points. Their sample was on the NYSE stocks for a period of January 1988 to December 2003. Naes et al. (2011) use relative spread, the Lesmond, Ogden, and Trzcinka (1999) measure, the Amihud (2002) illiquidity ratio, and the Roll (1984) implicit spread estimator as liquidity measures and study a sample which includes the NYSE stocks over a period of 1947 through 2008 and the Oslo Stock Exchange stocks from 1980 to 2008. Their findings state that as the economy goes downwards, the liquidity of capital markets deteriorates rapidly.

1.2 Liquidity and News

The liquidity of the capital markets depends on different types of news as well. News, such as disclosures, mergers, additions, deletions, earnings announcement, can lead to a buy or sell-pressure in the market causing a subsequent effect on liquidity. A paper by Schoenfeld (2017) states that when a new firm joins the S&P 500, there is a subsequent increase in the voluntary disclosure as the level of ownership of index funds increases. As a result, stock liquidity, as measured by bid-ask spread and the Amihud (2002) ratio, also improves. Lakhal (2008) in his paper discovers that when news (good or bad) is released, effective spread decreases. His paper also points out that during the period of quarterly earnings announcement, market liquidity is improved as indicated by a decrease in bid-ask spread. Shyu et al. (2020) in their paper study the shares listed at the Shanghai Stock Exchange from June 1, 2007 to December 31, 2008 and report that during the earnings announcement period of the firms, media exaggerates the dispersions in earnings. This is turn leads to a fall in the liquidity of the firms. This can be due to the fact that in terms of earnings announcements, firms that are more volatile with fundamentals often obtain help of the media during times of earnings announcements. The individual journalists may focus on only part of the earnings and may interpret the news to investors in such a way that the investors are more concerned with the future cashflows of the firms rather than the level of the performance. This creates an information gap leading to information asymmetry in the market. Thus, investors find it more costly to process information for the firms. As a result, they increase the bid-ask spread in order to prevent liquidity to the more informed investors. Donders et al. (2000) support the idea and report that on the earnings announcement day and following first two days, there is an increase in the effective spread of the firms leading to a fall in liquidity. News such as stock splits also effect the liquidity of the firms. Tabibian et al. (2020) have a sample of 214 stock splits announced and executed in 2004-2018 in Bursa Malaysia and find out that there is a subsequent increase in liquidity of the firms during the stock splits announcement period. They use the turnover ratio and relative spread to measure liquidity. A paper by Huang et al. (2015) also state that stock splits announcement improves stock liquidity. Li et al. (2013) study the NYSE over a period of 2000 to 2009 and discover that the stock splits announcement improves the liquidity of the stocks. They use the average of the change in volume and change in turnover as proxies for the deviations in liquidity.

Liquidity is impacted due to additions and deletions of the index. Gregoriou (2011) studies the revisions of the CAC40 index during the period of 1997 to 2001 and states that the additions to the index improve the liquidity of the stocks and deletions decrease the liquidity of the assets. He applies the daily quoted spread, relative spread, and effective spread as measures of liquidity. Hedge and McDermott (2003) study the S&P 500 index for a period of 1993 to 1998 and report that the liquidity of the added stocks have improved. They apply the quoted and relative spreads as measures of liquidity.

Liquidity is also impacted by other various news release such as mergers. Massa and Xu (2013) use the US M&A database and study the mergers for a period of 1987 and 2007. They proxy the liquidity of the acquirer firms by trading volume, turnover, the Amihud (2002) ratio and the bid-ask spread. They discover that the liquidity of the acquirer firms improve after the mergers.

Empirical research and findings point out that the liquidity of a stock or index is affected by crisis or any type of good or bad news or shocks. These shocks can also be caused by external factors such as environmental issues and political instability. In recent time periods, the liquidity of capital markets have been severely shaken by important events in world history. These two events, namely COVID-19 and BREXIT, have created a platform for researching and cultivating their impact on liquidity.

1.3 Liquidity and COVID-19

As reported by Salo (2020), the World Health Organisation (WHO) declared COVID-19 as a pandemic during March 2020. The infections started to arise leading to deaths which in turn compelled the governments of the nations to close border and impose locked-down measure worldwide. These caused the investors to be concerned about the cash flows of the companies leading the environmental contagion to prevail its way to the financial markets. Investors started to fear which led to panic sale creating a downward pressure on returns and liquidity in the markets. The combination of economic restrictions and general fears resulted in a 4.7 percent economic contraction across the OECD in 2020. The financial markets were affected as investors/savers become more risk averse, the yield curve steepened, and businesses faced reduced profitability and a cut-back on capital expenditure. As described by Klebnikov (2020), fears grow and savers seek to reduce exposures to particular markets and sectors, liquidating their investments, leading ultimately to falling valuations across capital markets. Falling share volumes signify reduced liquidity and the risk that securities may be sold only at significantly lower prices. Without buyers, sellers cannot close positions. A clear liquidity risk started to prevail in the markets.

A large number of empirical research has been conducted on liquidity and COVID-19. Tiwari et al. (2022) study the three liquidity measures namely, the Amihud (2002) ratio, spread, and traded value on the G7 countries and report that during the COVID-19 period of December 2019 to July 2020, a negative causal relationship had been preceding between the number of infections and the stock market liquidity. Kunjal (2021) highlights that the liquidity of the Johannesburg Stock Exchange had decreased during the period of March 2020 to June 2020 which was the prominent time of COVID-19. Umar et al. (2022) study the stock market of China, United States, Brazil, India, and Russia for the period of July 2019 to July 2020 and discover that the liquidity of the markets had dried up with the COVID-19 news outbreak. The paper also establishes that the shocks were only for the short term. They use the Amihud (2002) ratio as a measure of liquidity and the Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) model to capture the time-series effect.

Priscilla et al. (2022) use the Amihud (2002) ratio and effective spread in order to capture the liquidity of the stock markets of Indonesia, Thailand, Malaysia, and Singapore during the COVID-19 period of March 2020 until June 2021. Their study shows that the liquidity had decreased due to infections and confirmed deaths but increased during the time of recovery and COVID-19 vaccinations. Uddin et al. (2021) report that COVID-19 had increased volatility in the global stock market and identify monetary policy as an important factor during global pandemic periods. Yaseen and Omet (2021) examine the Jordanian market (Amman Securities Exchange/ASE) by using the daily bid-ask spread before and after the opening of the exchange during the pandemic period of January to December 2020. Their paper highlights that the liquidity of the ASE has fallen even further after the reopening of the exchange. Donnell et al. (2021) investigate Spain, Italy, China, the United Kingdom, and the United States by using a regression model of trading volume, volatility, liquidity risk, gold and crude oil prices, and discover that during the COVID-19 period, the stock prices of the indices had significantly changed.

1.4 Liquidity, COVID-19 and Tourism

The tourism industry is one of the most prominent industries in the world. However, during the environmental crisis such as the pandemic, the imposition of the locked-down measures and trip cancellations caused a negative impact on the profits and cash flows of the companies. Immediately after the outbreak of the COVID-19 pandemic, tourism activity was declared as a vector that could easily spread the virus. Consequently, in 2020 the industry experienced one of the hardest times that abruptly interrupted tourism activity with UNWTO (2021) estimating a 74% decrease (1.5b USD in 2019 to 381m USD in 2020) of international travel. As stated by Kirby (2020), future estimates reveal that expected increase with recovery seems a long way ahead to reach post-pandemic figures. Thus, this vibrant industry had been significantly impacted and presented as a matter of concern which in turn created a platform for the researchers to study the in-depth analysis of the industry.

Ugur and Akbiyik (2020) study the reactions of the tourists from TripAdvisor during the period of December 2019 and March 2020 and report that as the number of cases rises, the cancellations and delaying of the trips started to increase. They use a data mining technique in order to segregate the comments. Fotiadis et el. (2020) use the Long Short Term Memory Neural Network and the Generalized Additive Model in order to determine the international tourism demand during the COVID-19 pandemic. Their paper highlights that the range of the drop in the tourist arrival would prevail between 30.8% and 76.3% until June 2021. Wu et al. (2021) study the tourism industry of China during the COVID-19 period and report that the virus had caused short-term negative impact on the industry. They use the event study method for the analysis and implement a regression analysis of government response index, confirmed cases, market capitalization, and price-to-book ratio. They analyse the abnormal returns on the 69 stocks of different tourist sectors being listed on the Shanghai Composite Index and Shenzhen Composite Index. A similar study by Liew (2020) also reports that the returns of the Chinese tourism stocks had plunged by 20% as a response of three consecutive days post pandemic fears. Sikiru and Salisu (2021) further extend the study of the pandemic on the tourism industry by employing a hedging strategy. They provide evidence that by including gold with the portfolio of tourism industry stocks can act as a way to reduce the negative effect of the stocks. Undoubtedly, the effects on the tourism industry urge key policymakers to reconsider their strategies with new actions as part of the recovery and restarting period planning (Skare, Soriano, and Porada-Rochon (2021); Akron et al. (2020)). Vulnerability is the key component of the industry in relation to financial crises, natural disaster, political instability, and health related issues (Duro et al (2021), Gregoriou and Liasidou (2019)). However, the tourism industry has proven resilient when dealing with previous crises (Zopiatis et al (2019), Gregoriou and Liasidou (2019)), given that it can recover as soon as tourism arrival numbers increase (Sharma, Thomas and Paul (2021) and Brouder (2020)). According to Zhang et al. (2021:12) ‘business decisions are contingent on demand forecasts, which are useful for strategic and operational planning such as budgeting, sales, marketing, and resource allocation'. Recovery deals with rebuilding the tourism industry in the sense of providing a more holistic approach of development can be spread in more geographical areas as a gradual process (Sharma, Thomas and Paul (2021) and Navarro-Drazich and Lorenzo (2021)).

1.5 Liquidity, political instability, and BREXIT

Liquidity of the capital markets have been disrupted due to various political instabilities as well. A paper by Dash et al. (2019) uses wavelet coherence and wavelet phase angle tests to determine the stock liquidity of the G7 countries during the aftermath of the 2007-2008 global financial crisis. Their research states that the liquidity of the stock market decreased in terms of economic crisis and a positive relationship exists between policy uncertainty and illiquidity. Asteriou and Siriopoulos (2003) examine the capital market development and economic growth of Greece in times of political instability by constructing an index which replicated the behaviour of the market in times of different political violence. Their research, which is based on time-series analysis, indicates that as socio-political conditions increase, the development of the stock market and economic growth tends to fall. Mbanyele (2023) highlights that the high risky, small and competitive Brazilian firms face illiquidity due to economic policy uncertainty during the period of 2002 to 2015. He uses relative spread as a measure of liquidity and a two-step GMM dynamic method to encapsulate the endogenous variables.

Kwabi et al. (2023) examine 42 countries from 2001 to 2019 and discover that elections disrupted the market size and liquidity of the stock markets, and the factors also fuelled transaction costs. They use turnover ratio, calculated as the value of total shares trades scaled by GDP, to encapsulate the liquidity. Vianez at al. (2020) study the S&P 500 and NASDAQ 100 and highlight that economic policy uncertainty impacts the liquidity only in the periods of expansion and monetary policy uncertainty affects the liquidity only in the periods of recession. Their papers uses the Amihud (2002) illiquidity measure to capture the liquidity. Chen and

Chiang (2020) study the China Stock Market and report that during economic policy uncertainty, as volatility increases, stock return decreases.

The recent world political announcement of BREXIT has further deteriorated the liquidity of the capital markets. Recently, the UK leaving the EU (Brexit) has caused significant effects on the financial market worldwide, especially for the UK market. Arshad et al. (2020) study how the London Stock Exchange (LSE) has changed due to the Brexit vote reaction. They report that short-term volatility exists during the Brexit vote period which reduced the efficiency of the LSE. From a theoretical perspective, Wielechowski and Czech (2016) suggest an increase in economic uncertainty for the UK market post referendum. Furthermore, they forecast that Britain's exit from the EU would negatively impact on the GDP growth rate between 2016 and 2020. Cox and Griffith (2018) report that the Brexit referendum increased information asymmetry among market participants, which caused a transitory decline in stock market liquidity. Kong et al. (2018) discover that the Brexit referendum generated fatter tails on liquidity measures' distributions. This indicates that low levels of liquidity occurred more frequently during the Brexit referendum. Kadiric and Korus (2019) study the UK and European bond markets and state that the news of the BREXIT referendum had increased the credit spreads of the bonds both in the UK and EU. Their study also highlight that the spread is greater in the UK than that of the Eurozone and the credit default risk is higher for the post-referendum period in the UK and the EU.

1.6 Contributions of my research

The liquidity of the capital markets has been studied widely during phases of world events. Previous research has been conducted extensively on the financial crisis (see among others, Liu (2006), Lesmond (2005)) and the news related effects (such as Lakhal (2008) and Tabibian et al. (2020)). I study the impact on the liquidity of the capital markets due to the two most recent world events, namely COVID-19 and BREXIT.

The contributions of my thesis to the literature can be divided into many ways. First, I am the first to comprehensively examine the impact of the COVID-19 pandemic on liquidity in the USA, Europe and Emerging capital markets using short-term bid-ask spread measures as well as the long-term price impact illiquidity ratios of Amihud (2002) and Florackis et al. (2011). Previous studies on liquidity and COVID-19 have focused on either the long-term measures (Umar et al. (2022), Priscilla et al. (2022), Just and Echaust, (2020)) or on short-term measures (Yaseen and Omet (2021), Mdaghri et al. (2020)). Second, Tiwari et al. (2019) in their study used both the long-term price impact ratio (Amihud (2002)) and the short-term spread as a proxy for liquidity. However, they have used the wavelet methodology to study the causal relationship between infections and liquidity. I use both the short-term spread and long-term price impact ratios to examine how COVID-19 has impacted liquidity using event-study methodology. Third, following Zhang and Gregoriou (2020), I am the first to investigate the impact on liquidity of COVID by decomposing the bid-ask spread into adverse selection, inventory holding and order processing cost components using the Huang and Stoll (1997) model.

As a fourth contribution, I study the liquidity impact on the tourism industry due to the pandemic COVID 19. The tourism industry is the earnings source for a major part of the world and the closing down of the borders have severely impacted the companies. Studies have been undertaken by analysing the number of infections, market capitalisation, and price-to-book ratio (Wu et al. (2021), returns (Liew (2020) and hedging strategy (Sikiru and Salisu (2021)). Studies have also been published using the data mining point of view (Fotiadis et al. (2020) and economic point of view (Carter et al. 2021). However, I am the first to compute the liquidity effect on the tourism industry by using the short-term (spread) and long-term (price-impact ratios) measures. Also, I am the first to capture the impact of COVID-19 on the liquidity of the European tourism industry.

As a fifth contribution to the literature, I am the first to examine the liquidity effect on the FTSE 100 index from the BREXIT referendum until the transition period. Studies have been conducted on other various political instability events (Cox and Griffith (2018), Asteriou and Siriopoulos (2003), Mbanyele (2023), Kwabi et a.l (2023), Vianez at al. (2020) and Vianez at al. (2020)). Their papers have used economic indices (Asteriou and Siriopoulos (2003), and relative spread and GMM dynamic (Mbanyele (2023), turnover ratio (Kwabi et al. (2023), and the Amihud (2002) ratio (Vianez at al. (2020) to measure liquidity. Studies have examined the liquidity effects of the BREXIT referendum using spreads and price-impact ratio (Cox and Griffith (2018)). Using an event-study methodology, I study the twenty-four major events from the BREXIT referendum until the transition period. I use the quoted spread, relative spread, and effective spread in order to encapsulate the liquidity effect. Furthermore, studies have been conducted on the US stock markets during the referendum (Cox and Griffith (2018)). I study the liquidity effect on the FTSE 100 index.

Chapter Two: Literature Review

2.1 COVID-19

Boot et al. (2020) report that during the start of the year 2020, there has been a world-wide spread of a disease with large number of people, particularly in China, Korea, Italy, and Iran, being infected. According to Aljazeera (2020), on December 31, 2019, the World Health Organization (WHO) was alerted by China that a pneumonia has been spreading in the city of Wuhan and on January 05, 2020, Chinese officials suspected it to be the return of the severe acute respiratory syndrome (SARS) virus-an illness that originated in China and killed more than 770 people worldwide in 2002-2003. On January 07, 2020, WHO identified the novel virus and gave it a name of 2019-nCOV and declared it as a member of the coronavirus family which includes SARS and the common cold. The first death occurred in January 11 in China. Due to the current interlink of the world economy, the disease has spread throughout every country increasing the mortality rates in dramatic fashion. As reported by Salo (2020), the WHO declared the COVID-19 as a pandemic during March 2020. The countries around the world start to impose locked down measures which include closing borders as well as the domestic economy by restricting the unnecessary public interaction all of which have drastically impacted the economic activity of the countries. The global lack of proper spending pattern by the customers as well as collapse of major industries like tourism have gradually paved a way for a global recession. The flow of the contagion has spread its way to the financial markets. Difficulty in coping with the functioning of business activities, the profitability structure of world-wide firms and financial institutions were all consequences of the pandemic. As reported by Klebnikov (2020), as panic increases between the mass public, investors begin selling their shares leading to a free fall in the capital markets. With the stock markets plummeted and a shrinking demand side of the market, liquidity risk starts to evolve.

According to the World Economic Forum (2020) and later documented by Akhtaruzzaman et al. (2021), panic sell off of the shares by the market participants had triggered the circuit breakers four times in March 2020. The S&P 500 had experienced a drop of 7% on the previous days which caused the level 1 market wide circuit breakers to trigger on March 9, 12, 16. The drop tripled which caused the circuit breaker to trigger again on March 18. The circuit breaker was once triggered in 1987 when the Dow Jones Index dropped down to 22.6%. COVID-19 has been the only reason for the circuit breaker since the 1987 drop. The Dow Jones Industrial Average Index has experienced a sixth largest drop of approximately -10% on March 12, 2020, and the third largest drop of approximately -14% on March 16, 2020. As reported by the BBC (2020), after the 2008 financial crisis, 2020 was the worst year for the FTSE 100 index. The index dropped by 14.3% over the year. The World Bank (2020) reported that the central banks worldwide targeted the conventional and non-conventional ways to inject liquidity in the financial markets. They implemented policy adjustments such as interest rate cuts, capital requirement adjustment, Emergency Liquidity Assistance (ELA) and using other expanding the collateral facilities for the repo transactions. COVID-19 is regarded as the worst financial crisis with a strong liquidity crunch after the 2008 financial crisis.

2.1.1 Empirical Studies on COVID-19 and Financial Markets

Already many empirical studies have been conducted investigating the influence of Coronavirus pandemic outbreaks on capital markets and the greater economy. The literature to date, roughly falls into three categories:

- Research examining the micro-effects of the pandemic shock employing various liquidity related metrics;
- Research analysing how the pandemic shocks precipitated changes between markets and asset classes;
- Researchers appraising the overall effect of the pandemic upon financial institutions.

Investigating the micro-effects of the pandemic in a study involving 320 listed firms operating in six MENA countries from February to May 2020, Mdaghri, et al. (2020) report that bid-ask spreads widened while the liquidity of shares fell as measured by the depth and tightness of markets. Building upon the classic work of Demsetz (1968) in which the bid-ask spread is framed as a form of transaction costs, Wang et al. (2020), examining the effects of the pandemic, use relative rather than absolute spreads on several indices. In the research of Gormsen and Koijen (2020) dividend futures on the aggregate share market were used to directly compute a lower bound on growth expectations across maturities. Using dividend futures, the expected return in excess of risk-free bonds increased because of the pandemic, as markets responded quickly to negative expectations of growth. Zhang et al. (2020) state that the pandemic led to an increase in the volatility of share markets though ironically, some domestic policies may have amplified such phenomena.

Looking at earlier events, researchers Huang and Heian (2010) and Douch et al. (2018) had examined the effect of secular shocks upon trading volume. In this vein, Baker et al. (2020) comparing the 2019 pandemic with previous pandemics, discover that impact upon share markets was much smaller than that under COVID-19, as would be expected given that the ownership of securities per capita was historically lower. According to Baker et al. (2020), policy actions and regulations play a greater role in explaining the fall in share prices rather than the virus itself although such polices would not have been enacted without the pandemic. Barro et al. (2020) compared the effects of Coronavirus and Spanish Flu and found as mortality climbs, real returns on securities, especially on short-term government bills fell. Looking at the role of expectations, Papadamou et al. (2020) using panel data analysis, report that internet searching for topics related to COVID-19 were associated with panic behaviour increasing risk-aversion and volatility in the share market. From this sampling of research, it can be observed that, according to various liquidity related metrics, bid-ask spread, market depth, returns and volatility, the shock of the 2019 pandemic affected global capital markets in diverse manners.

The pandemic also led to changes between markets and asset classes as well as deviations between securities within an asset class. Like the 2008 financial crisis when we saw previously low correlated asset classes now moving in tandem under stress conditions, reducing the scope for diversification, similar phenomena were observed in response to the pandemic (Gao and Mei (2019)). As was observed in response to the 2008 shocks, asset classes which may have had low linear correlation proved to have high degrees of non-linear correlation, reducing scope for diversification and risk mitigation. Similarly, during the pandemic, it was found that secular shocks like Covid precipitated changes to the correlation structure between asset classes (Kinateder, Campbell and Choudhury 2021).

According to research by Bouri et al. (2021) during the COVID pandemic, returns across different securities becoming more "connected". Similarly, in research by Ali et al. (2022), using the wavelet-based Granger causality approach, it was established that the oil and share indices have less co-movement on a smaller scale but greater movement on a larger scale across all periods. In addition, the same researchers found significant bidirectional causality from oil to stock markets. In addition to correlation structures, "volatility spill-over effects" were also observed in security markets, where greater risk in one market leads to higher risks in other markets (Shahzad et al. (2021)). Naturally, adjusted for non-diversifiable risk all securities should earn the same returns and thus it is intuitive that a pandemic induced change in one asset class should lead to changes for others. So called, volatility "spill-over" is a form of transmission of risk across sectors and prevalent during crisis, the aftermath of shocks. Following spill-over effects, Akhtaruzzaman et al. (2021) study the stocks of China and G7 countries during and after the COVID-19 period. Their paper, using various statistical theoretical tests, stated that there has been a significant increase in the dynamic conditional correlations (DCCs) among the financial and nonfinancial firms of the countries being studied. The value of the DCCs is higher given that the financial firms acted as a financial contagion during the pandemic period. The paper also highlighted that China and Japan were the two important countries that take part in the spill-over effects. According to Laborda and Olmo (2021) the effects of the pandemic were first felt in the banking and insurance, energy, technology and biotechnology sectors before rippling-out causing secondary shocks across the rest of the economy. For purposes of contrast, during the 2007-2009 financial crisis, matters began with disturbances to the banking sector while the energy sector was first to be affected by the COVID pandemic, as consumption of petroleum particularly in the transport sector decreased. Health Care and Pharmaceuticals sectors, as is well known, benefited from the pandemic seeing upward adjustments to the quantity and quality of returns. Firms selling personal protection equipment and disinfectants saw sales climb sharply in 2020-21. Most notably, the world's largest retailer, Amazon, gained handsomely from the pandemic for well-known reason (John Harris, 2021). Though no general inferences or "theory" of how shocks are transmitted between markets or sectors, or asset classes has been formalised, clearly in a modern economy, the combination of specialisation and network effects, implies no sector or market is isolated.

Looking finally at sectoral and macro effects of the pandemic has also been a fruitful area of research. Given the aforementioned shocks within and between asset classes, it is not surprising that the pandemic negatively affected the performance of financial institutions. For instance, in Boot et al. (2020) the impact of the pandemic upon the banking industry was investigated. Greater correlation between securities and even asset classes, reduces scope for risk mitigation. Faced with greater risk exposure and reduced liquidity, banks pursue a de-risking strategy. Such pro-cyclic effects were also seen during the 2008 financial crisis and led to the Basel III counter-cyclic capital buffer (Bank of England, 2022). In this spirit, Fernandes (2020) examined how COVID-19 impacts the industries and the economic potential across 30 countries providing insights into how long it would take for the effects of the pandemic shock to dissipate in terms of GDP and sectoral effects.

Comparing traded markets, in a study by Chatjuthamard, et al. (2021) it was shown that an increase in the growth rate of the number of confirmed cases increases market volatility and jumps while reducing return. The intuition here is that while traders generally welcome market volatility as it may present opportunities (Haar and Gregoriou, 2021), systematically profiting from purely non-predictable chaotic events, is not possible. Interestingly, they found that the impact of COVID-19 on market volatility was weaker in emerging markets and countries with greater sovereign risk. In such markets, the impact of the pandemic is amplified presumably because there is less scope for fiscal measures ("automatic stabilisers") and macro policy intervention. This finding mirrors the work of Zaremba et al. (2021) on the impact of lock-downs on financial markets and economic activity according to which it was shown that COVID-19-related restrictions may adversely influence the trading environment of financial markets with the largest effects in emerging markets. In general, it has been shown, as studied by Elnahass et al. (2021) the performance of the financial sector fell sharply, reducing stability through enhanced default risk while the liquidity of banking assets fell.

2.1.2. Empirical Studies on COVID-19 and Tourism Industry

The environmental pandemics and epidemics have always caused a sharp fall in the travel and tourism industry (Abbas (2021), Jonesetal (2015), Avery (2010), Abbas et al. (2021)). Tourists fear of spreading the virus resulted in hence cancelled trips (Mamirkulova et el. (2020), Avery (2017), Meadows et al. (2019), Abbas et al. (2021)). Various theoretical and empirical research have been conducted on the impact of COVID-19 on the tourism industry emphasising both the impact and predicting recovery remedies that can sustain industry's viability. Sharma and

Nicolau (2020) investigate the returns of the airlines, hotels, cruise lines and rental car indices of the Dow Jones using the Karafiath's (1988) market-based model. The result of their study was indicative and suggested that there was a substantial fall in valuation of the mentioned sectors especially in the cruise division. Carter et al. (2021) in their research on stock prices of U.S. travel-related firms (airlines, restaurants, and hotels) conclude that larger firms were more affected, with cash reserves being more important for hotels.

Lee and Chen (2020) report that there are negative effects on the returns of the travel and leisure industry across 65 countries, when compared with the number of deaths rather than confirmed cases. Lin and Falk (2020) examine the performance and the volatility of the travel and leisure industry of three Nordic countries using the Markov switching model. They conclude that high idiosyncratic risk persists during the COVID-19 period. Yang et al. (2020) compute a dynamic stochastic general equilibrium (DSGE) model which estimates the effect of COVID-19 and/or any other pandemics on the tourism industry. Using a multisectoral model, research by Mariolis et al. (2020) investigate the effects of the tourism industry due to COVID-19. The pandemic caused multiplier effects on GDP, employment and trade balance of the Greek economy.

Gil-Alana and Poza (2020) discover that COVID-19 had caused persistence in the data and the shocks have become permanent in the Spanish tourism sector. Bakar and Rosbi (2020) investigate the impact by analysing the demand-supply economics of the tourism industry worldwide. Their study illustrate that the pandemic had triggered panic which had caused a declining demand function leading to a decreasing equilibrium price of the tourism industry. Jaipuria et al. (2021) study the tourism industry and the foreign exchange earnings of India during the COVID-19 period. Their study has used the artificial neutral networks (ANN) and stated that there has been a substantial decrease in the tourists as well as the earnings and that policy makers and managers need to take precautions to prevent such fall in future.

Foo et al. (2020) report that in Malaysia, the pandemic and the 4 phases of Movement Control Order (MCO) by the government had created major losses in the tourism industry. They highlight that the airline and hotel business had suffered from bankruptcy and losses in revenue, salary and position cut. Sio-Chong and So (2020) investigate two cities Macao and Hong Kong and discover that diseases such as the SARS cause negative effects on the tourism industry. Several studies (Qiu et al. (2020), Lew et al. (2020), and Jones and Comfort (2020)) had also been published on social economic and sustainability to estimate the impact of COVID-19 on the tourism industry.

2.2 BREXIT

2.2.1 The BREXIT referendum and the transition period

Mentioned by Shaw et al. (2017), in 1973, the EU started a 'Eurobarometer' which was used to obtain an idea about how the citizens' emotions against the EU. Just prior to the referendum, the results of the barometers showed that 48% of the respondents were concerned about the immigration as one of the alarming criteria in the EU states, except Portugal. The paper also stated that out of 28 member states, the respondents in the UK were the 25^{th} when they were asked about the future growth of the EU. The UK respondents were 23^{rd} for the crisis in the job market, 27^{th} when they were asked about the usage of the public money for private sector investment at the EU level, 28^{th} when they were asked whether a single digital market and single currency should prevail in the EU, 28^{th} when they were asked about the common energy policy among the EU members, and 19^{th} when they were asked if the EU voice should matter in the world. The then government, Conservative political party, faced a sharp criticism from the citizens as well as from the opposition parties which led the Conservative Prime Minister to promise a referendum on Britain's membership of the EU. On the 23rd of June 2016, the British referendum was held with the final result of 51% voting for the UK's withdrawal from

Europe. According to the paper being published by the House of Commons Library on 6th January 2021, the Brexit referendum occurred on June 23, 2016, and January 31, 2020 was the Brexit day. The UK faced a substantial series of major political events which have occurred between the 2016 referendum and the January 2020 Brexit day. There have been numerous revisions of the deals. From the January 31, 2020, the transition period began which ended on December 31, 2020 leading the UK to exit the EU single market and the customs union.

2.2.2 Empirical studies on BREXIT

The UK leaving the EU during the winning of the referendum on 2016 has established a major base for the researchers to study both the economic and financial impact on the UK and EU economy. Using theoretical models, Van Reenen (2016) states in his paper that higher trade costs with the EU will lead to a long-term loss in trade and investment in the UK. Furthermore, the models predicted that the welfare losses could lead to 1.3 to 2.6% and the incorporate productivity could rise to 6.3 to 9.5 percent. Carreras et al. (2019) study the referendum results and report that cultural grievances resulted in the vote for BREXIT. Samitas et al. (2018) use agent-based modelling method to study the economic impact on the financial stability channel of the UK and the EU due to Brexit. The paper highlighted that even though the results depend on the transition of the UK banks to the EU after Brexit, the research of the agent-based model showed that the financial channel of the EU would suffer more while the channel of the UK was stable to withstand the shock.

A paper by Armour (2017) points out on economic perspective that 'soft' Brexit, where the UK will only be a part of the single market policy, would help the financial services firms to operate in the EU as they were before BREXIT. On the other hand, a 'hard' Brexit, where the UK would leave both the EU as well as the single market platform, would result in the financial services firms finding it costly to export their services to the EU. A paper by Cox and Griffith

(2018) investigates the effect of liquidity due to the Brexit referendum during 2016 using the NYSE daily trade quote. The paper uses quoted, effective, and realized spread with their percentages as a method for measuring liquidity. The paper concludes that information asymmetries increase in the event of political uncertainty, causing the spreads to rise and the liquidity to decrease. Kong et al. (2018) study various liquidity measures to capture the interdependency of the different measures and how they behave in extreme liquidity conditions. They use the time period that covers the BREXIT referendum in order to encapsulate the extreme liquidity impact. Their study shows that during the BREXIT referendum the distribution of the liquidity measures reveals fatter tails indicating low liquidity during the period. Abraham (2016) examined the New Zealand, Australia and Indian Stock Markets to capture the disposition effect, the behavioural bias in financial decisions stating that investors sell off winning stocks and hold on to the loosing ones, during an economic crisis such as BREXIT. The paper concludes that the disposition effect does not hold during BREXIT because the investors develop self-control mechanism and sell off the poor performing stocks when faced with uncertainty in the market atmosphere.

2.3 Liquidity

One of the most interesting research issues in financial markets concerns market liquidity. How liquidity should be defined, what it connotes and how it could be measured have long been an area of inquiry. Although traders have always adjusted the bid-ask spread to compensate for the risks of taking a position, famously it was Demsetz (1968), using New York Share Exchange data, who was one of the first economists to analyse how the behaviour of traders affects the formation of prices. He argued that while a trader willing to wait might trade at the single price envisioned in the Walrasian framework, a trader not wanting to wait could pay a price for immediacy, i.e., liquidity. More recently, refining the definition of liquidity, according to Liu (2006) a security is liquid if large volumes may be traded with little or no price impact.

While according to further research, including Amihud and Mendelson (1986a), Amihud (2002), Hasbrouck (2009) and Le and Gregoriou (2020), liquidity is measured across four different dimensions: trading quantity (how much a security can be traded at a given cost), trading speed (how quickly can a share be traded at a certain cost with given quantity), trading costs (all expenses related to the trade of a given quantity of an asset) and price impact (how easy it is to trade a security of a given quantity with minimum impact on price). However, how these four dimensions may interact and be incorporated into a comprehensive general equilibrium model, awaits specification.

Liquidity becomes a matter of concern in times of recession. Liu (2006) states that risk-averse investors search for more liquid assets during recession. This is in support with Hicks' (1967) who discovers that when holding assets, investors are not only interested in capital gains. They also tend to consider how to use those assets in order to overcome the economic conditions. As a result, they require liquid assets validating the 'liquidity preference'. Naes et al. (2011) study the NYSE and Oslo Stock Exchange and point out a similar result validating a decrease in liquidity of the capital market due to a fall in the economic conditions. Chordia et al. (2005) also suggest out that liquidity is impacted by monetary policy. Liu (2006) also states that firms with high book-to-market ratios are more illiquid. He observes that low performing firms do not generate enough cash flows which make them difficult to sell off in the capital markets. The investors holding them thus require higher liquidity premium.

For years, liquidity has been studied through various aspects. Researchers tried to find out whether liquid markets or liquid stocks are beneficial for firm performance. There are theoretical studies which support that liquid stocks promote as a means of improving firm's performance. As mentioned by Maug (1998), a market which is liquid enables the large shareholders to trade effortlessly. Investors can easily buy and sell large number of shares. As a result, the shareholders do not have to monitor the firms' performances. The paper also stated that liquid markets enhance corporate governance in firms. Holmstrom and Tirole (1993) in their paper report that stock prices include information about the firm; however, the information depends on the how liquid the market is. The liquidity of the market decreases when there are large number of shares under one ownership. Hence, market monitoring to screen managerial performance is not beneficial and there lies a reduction in managerial incentives. Subrahmanyam and Titman (2001) also state in their model that liquid markets make price more informative and improves a firm's performance.

Empirical studies also reveal that liquid markets improve a firm's performance. Fang et al. (2009) stated that when measured by market-to-book ratio, there is an improvement in the firm's performance for liquid stocks. Nguyen et al. (2016) used the Tobin's Q to measure the firm value in the Australian stock market. The Tobin's Q can be divided into three segments such as operating income to price, leverage, and operating income to assets. By analysing the firm's performance, they observe that a liquid market improves firm value. However, they also mentioned that the reason for improvement in the firm's value is due to the increase in the stock price rather than superior operating performance. Cheung et al. (2015) discover that the liquidity of the stocks improve performance and the corporate governance of the Real Estate Investment Trust (REIT) firms. Jawed and Kotha (2018) study the Indian stock market and observe that the liquidity improves the firm's value from an operating performance perspective.

Liquidity has also been extensively studied through the lens of stock returns. Mentioned by Le and Gregoriou (2020), there have been two aspects through which the liquidity and stock returns have been studied. One aspect deals with analysis on whether expected returns take liquidity into consideration. Another dimension is concerned with if expected returns take liquidity risk into account. When stocks are affected due to market liquidity, the expected returns increase. Amihud and Mendelson (1986) mentioned in their paper that investors expect higher returns for stocks with higher spreads. The bid-ask spread is a measure of liquidity and is defined by the difference between the ask (offer) price, the lowest price a seller is willing to accept, and the bid price, the highest price a buyer is willing to pay. The higher the spread, the greater is the cost of the transaction. Hence the investors holding a stock would require compensation for the cost of the transaction and this compensation would be reflected in their expected returns. As a result, expected returns would increase. Following this, Amihud (2002) established a new illiquidity ratio which tests the cross-sectional and time series analysis of the NYSE and confirms that expected return is an increasing function of illiquidity, stating that ex ante returns increase with the decrease in the liquidity of the markets.

To further test this, the relationship between the returns and liquidity and whether liquidity risk should be priced has been studied in many ways by researchers and the results are contradictory. Brennan et al. (1998) study the US markets and measure liquidity with turnover ratio and trading volume. They discover that a negative correlation between liquidity and required asset returns. Narayan and Zheng (2011) study the Chinese Stock Markets in order to find out whether the liquidity risk should be priced or not. Their paper stated that there is a negative relationship between liquidity and returns. Eleswarapu and Reinganum (1993) use the bid-ask spread and report that liquidity and stock returns possess a positive relationship in the month of January. Hasbrouck (2009) further uses a new measure of trading effective cost from daily closing prices and establishes that the effective cost shares a positive relationship with the returns in January. Vo and Batten (2010) study the Vietnam stock market during the financial crisis period and state that there exists a positive relationship between liquidity and stock returns. In support of the stock returns being affected by the liquidity risks, Lustig (2001) finds in a model that investors demand a higher return in times of recessions, which is during the adverse business cycles. He states that during recessions periods, investors are more prone to solvency constraints which paves the path for the liquidity risk and in turn for higher expected returns in order to make up for the risk. Following this, Pastor and Stambaugh (2003) observe that firms with fluctuating aggregate liquidity tends to generate higher returns validating market-wide liquidity to be a crucial factor in asset pricing. Taking this in line and following O'Hara (2003), Liu (2006) has developed a two-factor liquidity-augmented Capital Asset Pricing Model (CAPM) which captures both market and liquidity factors.

Theoretical and empirical research shows that liquidity is priced in stock returns. Acharya and Pedersen (2005) introduced a liquidity-adjusted CAPM which illustrated the evidence of liquidity being priced at cross sectional stock returns. Papers that support this include Korajczyk and Sadka (2008), Hasbrouck (2009) and Ben-Rephael et al. (2015). Li et al. (2011) study the Japan Stock Exchange and report that liquidity and liquidity risk is priced in the stock market of Japan and that liquidity determines stock returns. Contrary to this, Chang et al. (2010) report a negative relationship between liquidity and the stock returns in Japan. Leirvik et al.(2017) study the Norwegian stock market and observe no relationship between returns and stock liquidity. Li and Luo (2019) mention that firms which are financially constrained impose a greater liquidity risk and hence require a higher illiquidity premium. Also, the pricing of these firms involves liquidity during bad economic times. Liu et al. (2020) point out that there exists a positive relationship between liquidity and stock returns in Germany and the UK. China shows a negative relationship, while the USA exhibits a mixed result.

Liquidity has also been studied through various other aspects. Fang et al. (2014) in their paper explained that stock liquidity reduces innovation in the firm, and it increases the chances of hostile takeovers and the existence of institutional shareholders who do not monitor the performance. Bhide (1993) further state that manager stock holding enhances internal monitoring of the firms. However, this creates a platform for information asymmetry among investors and hence reduces liquidity of the firm. Consistent with this agency-problem theory, Jiang et al. (2017) point out that stock liquidity creates a platform for controlling shareholders and insider incentives. As a result, dividend pay-out increases. Brogaard et al. (2017) study whether stock liquidity has any effect on the firm's bankruptcy risk. They report that liquidity improves information efficiency and corporate governance by the block holders. As a result, it reduces the probability of default risk.

Giving the significant importance of liquidity in various aspects of capital markets, there are requirements for measures which can be used to quantify liquidity. Le and Gregoriou (2020) state that liquidity measures have been classified as two aspects: high frequency and low frequency measures. High frequency measures require intraday data and low frequency measures employ the use of daily returns and trading volume data. High frequency measures usually require a large number of data and hence makes its often difficult to apply to emerging markets.

However, each measure has its own advantages and disadvantages. For instance, the spread measures, shown in Corwin and Schultz (2012), and Chung and Zhang (2014), captures the trading cost of the transaction. On the other hand, the Amihud (2002), Florackis et al. (2011), Abdi and Ranaldo (2017), and Karin et al. (2016) measures encapsulate the long-term price impact.

2.3.1 Liquidity Measures: Spreads

As liquidity incorporates different dimensions of a trade, researchers have been trying to decide on measures which can be used to quantify liquidity. There are around 68 different measures that are being suggested by the existing literature to capture liquidity. (Aitken and Winn (1997). Aitken and Forde (2003) have mentioned that in the broader aspect, liquidity measures can be divided into two categories – trade-based and order-based. The trade- based measures uses aspects of trading value, trading volume, the number of trades (frequency), and the turnover ratio. They also mentioned that as these measures exhibit past reactions, they cannot be used as a proxy for trading in the future. As such, traders may face difficulty to make a transaction quickly which can reduce the effect of liquidity. The order book system enables traders to encapsulate the transactions through the order-based measures and they can obtain a sense of the liquidity of the stock.

The core concept of liquidity revolves around transaction costs. In simplest terms, it is the cost of changing hands of a security. These costs can be divided into two categories: explicit costs and implicit costs. Explicit costs are those that are directly involved in trading. Examples include, broker commissions, transaction taxes, stamp duties, and exchange fees. Implicit costs are those which are indirect costs, which can affect the price of the trade. Examples include bid-ask spread, market impact, delay, and unfilled trades. In general, the higher the transaction costs, the lower the liquidity of the security.

Collins and Fabozzi (1991) state that the transaction costs are made up of three components, namely commission, execution, and opportunity costs. The commissions costs are fixed and an investor or a trader can measure it. However, the execution and opportunity costs are variable making it is difficult to assign values to these costs. A trader can reduce the transaction costs by optimizing between the execution and opportunity costs. It is thus necessary to monitor the price of the security over the entire transaction process. Researchers have tried to use different estimates of the transaction costs, such as price, trading volume, firm size, and the number of shares outstanding with a view that these proxies have a negative correlation with the transaction costs (Karpoff and Walking (1998), Bhushan (1994), and Lesmond et al/ (1996)). According to Lesmond et al. (1996), the transaction costs is measured by spread plus commission (S+C) which includes the bid-ask spread plus a commission from a brokerage firm. However, empirical evidence shows that the S+C measure has considerable shortcomings (Lee and Ready (1991), and Peterson and Fialkowski (1994)). As a result, Lesmond et al. (1996), proposed an estimate of zero returns to measure the transaction costs.

Following this and considering the ease of the availability of the data, as mentioned by Marshal et al. (2012) and further documented by Le and Gregoriou (2020), spread, the difference between the ask and bid price, is widely used as the common measure for liquidity. Empirical studies have been conducted for years to calculate spread on high-frequency equity data (Goyenko et al (2009), Hasbrouk (2009), and Corwin and Schultz (2011)).

As mentioned by Le and Gregoriou (2020), the bid-ask spread can be divided into high-frequency and low-frequency forms. Quoted spread, relative spread and effective spread are the three categories of high frequency forms of the spread. The quoted spread is the simplest method for measuring illiquidity. It tends to capture the cost of completing a round trip when the securities are being traded at the quoted prices (Bessembinder and Venkateramam (2010).

The relative spread is the dollar amount of the bid-ask spread over the midpoint of closing bid and ask prices for the trading day (Le and Gregoriou (2020)). As the quoted spread can increase for larger prices, hence the relative spread overcomes this shortfall. However, the relative spread also induces that the liquidity of the large stocks may be less than that of the small securities. The effective spread, measured as twice the absolute value of the difference between the close and the midpoint, holds the trading costs in a more efficient manner (Le and Gregoriou, 2020).

The measures of spread have been widely used in the financial literature to capture liquidity. However, the spreads have their own shortcomings when it comes to information asymmetry in the markets. The financial markets are made up of the informed and uninformed traders (Copeland and Galai (1983) and Glosten and Milgrom (1985)). The uninformed traders, also known as specialists, focus on increasing the capital gain rather than on the value of the security. As a result, they do not intend to do undertake any fundamental research on the securities (Kim and Verrecchia (1994)). As they lack information compared to the informed traders, hence the case of information asymmetry rises in the markets. The specialist traders are thus more likely to suffer from losses. Thus, they increase the bid-ask spread to cover up the losses. Following this, Coller and Yohn (1997) point out that the spreads increase for the firms when management release forecasted earnings prior to the earnings release. There shows an existence of information mismatch among the traders which tend to increase the spreads before the earnings release. Yohn (1998) also suggests similar results. Considering the ineffectiveness of the spreads among the information asymmetry, other measures of liquidity have been widely evolved and used.

2.3.2 Liquidity Measures: Price Impact Ratios

The most common price impact measure of liquidity used by the literature is the Amihud (2002) ratio. The Amihud (2002) ratio, widely known as the Amihud (2002) ILLIQ ratio, is calculated by dividing the absolute stock returns by dollar volume, averaged over the trading period. The ratio, hereafter as RtoV, is defined as :

$$RtoV = \frac{1}{Di} \sum_{d=1}^{Di} \frac{|Ri,d|}{Vi,d} \tag{2.1}$$

Where, $|R_{i,d}|$ and $V_{i,d}$ represent the absolute return and monetary volume of the stock i on day d respectively and D_i is the number of trading days for the stock i.

The significance of the ratio lies in the fact that the data, returns and trading volume, needed to calculate the ratio, are widely available. Second, the researchers can construct a long time series with the ratio enabling them to study the long-term effects on liquidity. The ILLIQ ratio model shows a positive relationship with the measure to the expected return during the 1964-1997 time period on the NYSE. Lou and Shu (2017) mention that the ratio has been used by over hundred papers published until 2013. They also state that as the ratio uses returns to volume, hence the price impact can be easily captured depending on the trading volume effect.

Consistent with this, Acharya and Pedersen (2005) state that the trading volume component encapsulates the pricing effect which automatically incorporates the ratio into transaction costs.

Despite its wide use and reliability, the Amihud (2002) ILLIQ ratio has some significant drawbacks. Pointed by Florackis et al. (2011), the denominator of the Amihud (2002) ratio, the dollar amount of the trading volume is related to the market capitalisation. Hence the ratio cannot be used to compare across different market values. Cochrane (2005a) also mentioned this similar point stating the characteristics of the Amihud (2002) ratio causes the ratio to be higher for the firms with small capitalization indicating that the small capitalisation firms will have less liquidity. Datar et al. (1998) further stated that trading frequency effects time-series and cross-sectional variations and the Amihud (2002) ratio does not consider trading frequency which is a fundamental aspect of liquidity.

Considering these, Florackis et al. (2011) proposed another price impact ratio, the RtoTR, ratio which measures illiquidity by dividing the absolute returns by the turnover ratio, rather than by the dollar amount of volume as in the case of the Amihud (2002) ratio. Data are also readily available for the turnover ratio which makes it straightforward to compute the RtoTR ratio as well. Brown et al. (2009) state that the turnover does not have the feature for the size, and thus using the turnover ratio Florackis et al (2011) confirms that the RtoTR is free from size biasedness. The ratio also captures the trading frequency pattern of the stocks. Amihud and Mendelson (1986) mentioned in their model that the trader or investor do consider the holding period and holding costs. As a result, they would require a higher liquidity premium for less liquid stocks. Brown et al. (2009) state that the stock with higher turnover ratio supplicates higher return and thus tend to have higher liquidity. The RtoTR ratio supports these arguments by considering both the trading frequency and trading costs through cross-sectional variability.

The RtoTR ratio is defined as :

$$RtoTR = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d\ |}{TRi,d} \qquad (2.2)$$

Where, $TR_{i,d}$ represents the turnover ratio of stock i at day d. The remainder of the variables are defined in the Amihud ratio shown in equation (2.1).

2.4 Spread Decomposition

The information asymmetry in the market arises due to the existence of informed traders who possess superior information which create costs for specialists to process information into their trades. Gregoriou et al. (2005) study the UK stock market and report that during earnings forecast, information disadvantage exists in the market which increases the bid-ask spread. Chung et al. (1995) state that financial analysts follow those stocks which have more information asymmetry and market-makers thus follow the financial analysts in order to compensate for the adverse selection problem and hence determine the bid-ask spread accordingly.

As a result, bid-ask spread rises to compensate those specialists to meet the requirements of the market (Demsetz (1968) and Tinic (1972). Gregoriou and Rhodes (2017) state that these market making costs can be classified as order processing and inventory holding costs. The order processing costs can be defined as the administrative and other costs that result while maintaining and transacting the orders. Inventory costs, mentioned by Amihud and Mendelson (1986), are the costs that refer to the holding period of the security.

Following this, studies including but not limited to Huang and Stoll (1997), Lin et al (1995), and Madhavan et al (1997), further divide the inventory costs into non-information and information components which arise a new component of adverse selection costs of trading from the information part. This adverse selection costs of trading is the cost which the market specialist has to incur in order to make transactions with the informed trader. As spread is decomposed, this adverse selection component thus paves a path for revealing the impact of information asymmetry on liquidity.

The Huang and Stoll (1997) spread decomposition model states that the bid-ask spread is a mixture of the fundamental value of the price and the inventory holding. The inventory holding is then further divided between order processing and inventory costs. The inventory costs are further decomposed into the change in information captured by the last trade (information costs) and the change in the inventory holding costs. The model further suggests that the order processing holds approximately 88.6% of the spread. A more in-depth decomposition of the spread suggests that the cost of adverse selection is low. When the spread is decomposed by buying and selling pressure, the order processing costs still holds the largest amount. Moreover, the information asymmetry costs account for 10% on average. The Huang and Stoll (1997) three-way decomposition model is represented by the following equation:

$$E(Q_{t-1}|Q_{t-2})=(1-2\pi)Q_{t-2} \tag{2.3}$$

$$\triangle \text{ Mid-Point} = (\alpha+\beta)\frac{St-1}{2}Q_{t-1}\alpha\frac{St-2}{2}Q_{t-2}\,(1-2\pi)+\varepsilon_t \tag{2.4}$$

The model is used to decompose the effective spread, (Effective spread = 2 (transaction price - mid price). The trader indicator is defined as Q, Q=1 if a transaction is initiated by the buyer, Q= - 1 if it is initiated by the seller and Q=0 if the transaction occurs at the midpoint. π is defined as the probability of a trade flow reversal. Mid represents the midpoint of the bid-ask spread. The coefficients α and β, represented as proportions, captures the adverse selection and inventory holding cost . The order processing component is equal to 1-(α+β). $\frac{St-1}{2}$ is the half-spread at time t-1. The public information component is captured by εt.

Another model, regarded as the Probability of Information-based Trade (PIN) and presented by Easley et al (1997a,b), stated that the market makers follow the prices and tend to measure whether the executed price is buy or sell relative to the quoted price. They then consider the prices based on the information embedded. The following equation represents the model:

$$\text{PIN} = \frac{\alpha u}{\alpha u + \varepsilon_S + \varepsilon_B} \tag{2.5}$$

In this equation, α is defined as the private information and μ is defined as the arrival rate of informed trading. The product of these (αu) represents the expected number of informed trades. The denominator is defined as the total trading activity which includes the trade of the informed traders, $\alpha\mu$, and the arrival rate of un-informed buy orders ε_S and sell orders ε_B.

Madhavan, Richarson and Roomans (1997) presented the MRR model which states that when new information arrives, the effect can be seen as a change in prices through the process of trading. The model also states that information asymmetry hampers this transition process, and this increases the inventory holding costs. The model is represented by the following equation:

$$\Delta p_t = \alpha + (\phi + \theta)Q_t - (\phi + \rho\theta)Q_{t-1} + u_t \tag{2.6}$$

Where, Δ is defined as the first difference operator and p_t as the security price at time t. Assuming a fixed order size, Q_t indicates the trade initiation indicator. $Q_t = +1$ when the trade is initiated by the buyer , $Q_t = -1$ when the trade is initiated by the seller and $Q_t = 0$ when a trade occurs between the bid-ask spread. The drift in prices is represented by the constant α ; and the price discreteness is represented by the random error term of u_t. The transaction cost component is the ϕ which is the direct cost per share of the market-maker to supply liquidity. The information asymmetry component is the θ and it states how strong the adverse selection cost is. The autocorrelation coefficient of order flow is the ρ. The ρ can also be represented as

$\rho = 2\gamma-(1-\beta)$; where γ and β is denoted as the probabilities of trade flow continuation and mid-quote execution respectively.

Empirical research has been conducted on testing the validity of the available spread decomposition models. Wang (1999) used the spread components and stated that adverse information is present in the Sydney Futures Exchange and floor traders can better predict them than screen traders. Menyah and Paudyal (2000) studied the London Stock Exchange and discovered the effects of the spread components on liquidity. Elder et al. (2004) studied the adverse selection component and how tracking stocks by the market makers impact the stock market. Gregoriou and Rhodes (2017) detect the presence of non-stationary behaviour among actual and predicted informed trade prices. Brockman and Chung (1999) studied the bid-ask spread decomposition on the Hong Kong Stock Exchange and presented significant presence of adverse selection and order processing costs. Frijns et al. (2008) looked at the impact of the introduction of new rules on insider trading in New Zealand and presented that after the introduction of the rules, there has been an observable decrease in the information asymmetry component of the spread.

2.5 Hypothesis

Liquidity, as studied through various aspects, measures and forms, has been the centre of attraction by researchers. When a new event arises, the liquidity of the capital markets is disrupted which may lead to eventually a wipe out of the equity. Previous research shows that there are papers which try to capture the liquidity effect of the pandemic in terms of short-term or long-term measures. However, there is a lack of research in comparing both the short-term and long-term effects on countries which can help portfolio selection and financial regulation. Second, there is a gap in the literature on how the pandemic has impacted the liquidity of the tourism industry. Third, even though the liquidity effect has been studied widely due to other political events and the BREXIT referendum, there is no research on how the events surrounding the BREXIT referendum until the transition period have impacted the liquidity of the FTSE 100. Considering these, I propose the following hypothesis for my research:

H1: The liquidity of the USA, European, and Emerging markets has decreased due to the pandemic, COVID-19.

H2: The liquidity of the European tourism industry has decreased due to the pandemic, COVID-19.

H3: The liquidity of the FTSE 100 has decreased due to BREXIT.

Chapter Three: Impact of Coronavirus on liquidity in financial markets

3.1 Abstract

I examine the liquidity impact of the COVID-19 pandemic upon equity markets in the USA, UK, Brazil, China, Germany and Spain. I establish that the pandemic causes a short-term loss in liquidity, confirmed by the significant increases in bid-ask spreads. Further, analysing long-term financial stability using price impact ratios, shows that for China alone, there is an impact of COVID-19. Also, examination of spread decomposition reveals the role of information asymmetry in the widening of spreads, rather than changes in cost of trading around the news of the pandemic. This finding holds for all of the observed capital markets with the exception of China.

3.2 Introduction

Reports of virus spreading across the globe began in early 2020. According to Aljazeera (2020), on December 31, 2019, the World Health Organization (WHO) was alerted by China that a virus with pneumonia like symptoms was spreading in the city of Wuhan. Chinese health officials suspected it to be the return of the severe acute respiratory syndrome (SARS) virus- an illness that originated in China and killed more than 770 people worldwide in 2002-2003. On January 07, 2020, the WHO identified the virus as a member of the coronavirus family which includes SARS and the one causing the common cold, naming it 2019-nCOV. Not surprisingly, given the challenges of quarantining cities, regions and even countries, global trade and travel has led to the COVID virus spreading to nearly every country with great consequences.

Salo (2020) reported that the WHO declared COVID-19 to be a pandemic during March 2020. Governments across the globe responded by imposing various quarantine measures including the closing of borders, restricting various forms of economic activity such as closing restaurants, limiting density levels in public places like shops and requiring the wearing of personal protection surgical masks. Not surprisingly, these drastic actions had large impacts upon economic activity particularly in sectors involving travel and social interaction, notably tourism. The combination of economic restrictions and general fears resulted in a 4.7 percent economic contraction across the OECD in 2020. The financial markets were affected as investors/savers become more risk averse, yield curve steepened and businesses facing reduced profitability, cut-back on capital expenditure. Klebnikov (2020) mentioned that fears grow and savers seek to reduce exposures to particular markets and sectors, liquidating their investments, leading ultimately to falling valuations across capital markets. Falling share volumes signify reduced liquidity and the risk that securities *may* be sold only at significantly lower prices. Without buyers, sellers cannot close positions.

The existing literature has studied how the pandemic has impacted the liquidity effects of the capital markets. Yaseen and Omet (2021) applied the short-term measures of bid-ask spread on the Jordanian Stock Market during a period of March 2020 until May 2020. They found out that there was an increase in the liquidity cost of the stock market during the period. Mdaghri et al. (2020) studied the liquidity impact of 314 firms being listed in the six Middle East and North African (MENA) countries. They used the depth measure to proxy the liquidity effect and reported that the liquidity had decreased in the financial markets. Baker et al. (2020) examined the pandemic in light with the previous pandemics and reported as the shareholders were less in number hence the impact were lower. Papadamou et al. (2020) discover that the more people were searching for the results and implications of the pandemic, the more the panic, risk aversion and volatility in the share market increased. Chatjuthamard, et al. (2021) also support the fact and report that there has been a significant increase in the market volatility with an increase in the confirmed cases. Empirical research has also been done using long-term price impact ratios (Umar et al (2022), Priscilla et al. (2022), Just and Echaust, (2020)). Research has also been undertaken on both the short-term and long-term measures (Tiwari et al. (2019)) in order to capture the liquidity effect via wavelet methodology.

In my first empirical chapter, I have applied the event-study methodology and used both short-term measures (relative spread) and long-term measures, namely the Amihud (2002) and Florackis et al. (2011) price impact ratios. I use these measures to examine how COVID-19 has impacted the liquidity of the capital markets of the USA, UK, China, Brazil, Germany and Spain. As the WHO has declared COVID-19 as a pandemic on March 11, 2020, hence, I have taken a sample of a [-60,+60] day period around March 11, 2020. As a further contribution to the literature, I follow Zhang and Gregoriou (2020), in order to decompose the bid-ask spread by using the Huang and Stoll (1997) model in order to determine whether the effect on the liquidity was due to adverse selection, inventory holding or order processing cost. Critically, my research presents an objective means of predicting the financial consequences of the pandemic which may assist investors in achieving a well-allocated portfolio in light of liquidity risk. While from a regulatory perspective, my research has implications for how bank portfolios are stressed and the adequacy of risk capital.

My results show that upon the financial performance of capital markets in the EU and Latin America the pandemic has had the largest impact. In the short run, the bid-ask spread and the illiquidity ratios have increased for all of the indices except China but in the long run the Chinese stock exchange faces severe liquidity issues. Interestingly, when I decompose the bid-ask spread, I observe that the increases in bid-ask spreads are due to the adverse selection component for all of the indices, except for China. Notwithstanding the above concerns, my research shows the strength of global capital markets in coping with this unique secular stressful event.

3.3 Data and Methodology

3.3.1 Data

My sample consists of the benchmark indices of the USA, UK, China, Brazil, Germany and Spain, namely the S&P 500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX 35. As indicators of conditions in equity markets, all of these indices have merit. Incorporating the 500 largest companies listed on various US exchanges, the S&P 500 is followed globally and is widely viewed as a key indicator of market conditions. Representing approximately 80% of the total trading volume of the London Stock Exchange, the FTSE100 is another important index and may provide insights into how the pandemic affected the liquidity of the financial markets. The Shanghai Composite Index (SHCOMP) is constructed upon the daily price performance of the A-shares and B-shares of the largest of the three mainstream indices representing Chinese share markets. Following around 50 shares traded on the Sao Paulo Share, Mercantile & Futures Exchange, the IBOVESPA Index denotes the benchmark of a key emerging market- Brazil. The Brazilian index incorporates around 80% of the total trading volume during the last 12 months and captures the movement of shares being traded on at least 80% of the trading days. The German index, DAX, represents the performance of the 30 blue-chip companies traded on the Frankfurt Share Exchange, and is the most widely used measure of shares traded in Europe's largest economy. Finally, the IBEX 35 index consists of the 35 most liquid shares of the Madrid Share Exchange.

I further investigate the abnormal returns and trading volume impact. For this, I collect the MSCI World Index data, as it comprises the performance of the global large and mid-cap companies and often considered as an indicator for the world stock market.

For each index, for a period of [-60, +60] days around March 11, 2020, I collect the daily closing price. From this data, to calculate my liquidity metrics, I compute value-weighted daily bid and ask prices, trading volume, number of shares traded and number of shares outstanding for each index. All the data was obtained from Thomson Reuters DataStream.

3.2.2 Methodology

I have calculated the daily abnormal returns (ARs) for each of the six indices for event periods from [-5 to +5] in the short run and up to [-60, +60] in the long run around the pandemic announcement date, March 11, 2020. There are alternative models for computing abnormal returns such as the CAPM of Treynor (1961, 1962,) Sharpe (1964) and Lintner (1965). Given its well-known assumptions, there are several limitations to the CAPM model including, inter alia, that it does not account for the compensation of value premium for risk as articulated by Fama and French (1993, 2004). Thus, following Zhang and Gregoriou (2020), I use the econometric market-adjusted model in order to calculate the abnormal returns:

$$AR_{i,t} = R_{i,t} - R_{m,t} \tag{3.1}$$

Where, $AR_{i,t}$ represents the abnormal return of the index i at time t. $R_{i,t}$ represents the return on index i at time t and $R_{m,t}$ represents the value-weighted market return (MSCI World Index) at time t.

In addition to returns, I also examine trading volume effects as a means of measuring liquidity. Events such as the global pandemic provide unique opportunities to see how markets react with respect to trading volume and liquidity in response to secular shocks. Like Huang and Heian (2010) or Douch, et al., (2018) who looked at trading volume effects for earlier events, I have sought to see the response to the pandemic. Looking at the effects of the COVID pandemic and in particular the response to the WHO announcement of March 11th, 2020, I use the approach of Gregoriou (2015) and compute the impact on trading volume for each of the six indices namely S&P 500, FTSE 100, SHCOMP, IBOVESPA, DAX and the IBEX 35. This is achieved by using the following regression model with a ten-day window [-5, +5], which proved to have the most statistically significant results.

$$Volume_{jt} = \alpha_j + \sum_{-5}^{+5} D_i \beta_i + \varepsilon_{jt} \quad for\ j = 1,6 \tag{3.2}$$

and t = -5, +5

Where, the dependent variable, $Volume_{jt,}$ represents the logarithm of the trading volume for index j at time t. The constant, α_j, shows the variation in trading volume. D_i represents the dummy variables for each trading day in the event window [-5, +5]. The coefficient of the eleven dummy variables, $\beta_{i,}$ represents the impact on the abnormal trading volume of the pandemic over the event period and is the main concern of the regression model. ε_{jt} is a random disturbance term with a mean of zero and a variance of σ^2 .

Liquidity measures

In addition to trading volume, many researchers have focused upon direct measures of market liquidity. In my research, I have used three such metrics:

- Relative Spread
- Spread Decomposition; and
- Price Impact Ratios

I begin by explaining how I looked at Relative Spreads. Although market returns and trading volumes are regarded as manifestations of changes to market liquidity, bid-ask spreads, essentially the transaction cost of a trade, as first proposed by Demsetz (1968), are widely seen as key indicators of liquidity. Following Chordia et al. (2001), the bid-ask spread represents the difference between the highest price a buyer is willing to pay for the asset and the lowest price the seller is willing to accept for it. Although tautological, as bid-ask widens, the transaction cost of executing a trade will rise, the frequency of trading will be lower and as a result asset liquidity will decrease. Arguably, the wider bid-ask spread is the risk adjusted compensation for taking a position. The less liquidity in a market, the wider the spread and thus should be related to the aforementioned "abnormal returns". According to Madhavan et al. (1997) the price impact of a trade is critical to understanding pre-trade and post-trade analysis, and introduces a framework to assess the market price of liquidity risk. Accordingly, while the absolute bid-ask spread may not be useful in measuring an investor's trading costs, the relative spread overcomes this disadvantage, hence following Wang et al. (2020), and using the following equation, I compute the relative spread of the six indices around the 60 days pre- and post- the pandemic announcement date, March 11, 2020:

$$RS_{i,t} = \frac{Ai,t - Bi,t}{(Ai,t + Bi,t)/2} \tag{3.3}$$

Where $RS_{i,t}$ represents the relative spread of index i at time period t and $A_{i,t}$ is the ask price of index i at time t. $B_{i,t}$ denotes the bid price of index i at time period t.

As a further means of measuring liquidity, I have implemented and estimated the Huang and Stoll (1997) model to decompose the *effective spread*, (Effective spread = 2 (transaction price - mid price). According to the model, I define the trader indicator as Q, Q=1 if a transaction is buyer initiated, Q= - 1 if it is seller initiated and Q=0 if the transaction occurs at the midpoint. Therefore, the three-way decomposition model is:

$$E(Q_{t-1}|Q_{t-2})=(1-2\pi)Q_{t-2} \tag{3.4}$$

$$\triangle \textit{Mid-Point} = (\alpha+\beta)\frac{St-1}{2}Q_{t-1}\alpha\frac{St-2}{2}Q_{t-2}\,(1-2\pi)+\varepsilon_t \tag{3.5}$$

Where the spread of index i at time t is indicated by S. π is the probability of a trade flow reversal. The midpoint of the bid-ask spread of index i at time t is indicated by Mid. The adverse selection and inventory holding cost attributes are captured by the coefficients α and β. Since α and β are stated as proportions, the order processing component equal to 1-(α+β). $\frac{St-1}{2}$ is the half-spread at time t-1. The public information component is captured by εt.

Finally, to understand the impact of secular shocks upon liquidity, I use price impact ratios. According to Le and Gregoriou (2020) analysing the impact upon liquidity in terms of bid-ask spread is best applied to short-term effects while for longer terms effects of shocks, metrics based on daily returns and volume are viewed as appropriate. In light of the above, and as my data set incorporates time series analysis, I have applied the Amihud (2002) illiquidity ratio, RtoV, to the six indices:

$$RtoV = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d\,|}{Vi,d} \tag{3.6}$$

Where, $|R_{i,d}|$ and $V_{i,d}$ represent the absolute return and monetary volume of index i on day d respectively and D_i is the number of trading days for index i. The limitations of the illiquidity ratio RtoV should be noted: According to extensive research the Amihud(2002) illiquidity ratio involves size biasedness, since the monetary volume being used is directly correlated with market capitalisation. To overcome this, Florackis et al. (2011) introduced a new liquidity measure RtoTR which controls for size biasedness:

$$RtoTR = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{TRi,d} \tag{3.7}$$

Where, $TR_{i,d}$ represents the turnover ratio of index i on day d, D_i and $R_{i,d}$ are the same as the Amihud ratio shown in equation (3.6). $RtoTR_i$ does not involve any size biasedness as monetary volume is replaced by the turnover ratio. This is because there is no significant association between turnover and market capitalization.

In order to investigate how other exogenous factors besides the pandemic announcement, per se, affected market liquidity, I have used the following multivariate time-pooled regression model as employed by Gregoriou (2015),

$$Liquidity_{jt} = \alpha_j + \beta_1 D_t + \beta_2 Volume_{jt} + \beta_3 (Volume_{jt} * D_t) + \beta_4 Close_{jt} + \beta_5 StdDev_{jt} + \varepsilon_{jt} \tag{3.8}$$

for j = 1 to 6 and t = -60, +5

Where, the dependent variable, $Liquidity_{jt}$, represents Relative Spread, RtoV and RtoTR respectively for index j at time t. The constant, α_j, shows the variation in the liquidity ratios of the index. D_t represents the dummy variable which is equal to 1 in the post pandemic announcement period, and zero otherwise. Volume, Close and StdDev (Standard Deviation) represent the traded volume, closing price and return volatility for index j at time period t for each trading day in the event window [-60, +5]

3.4 Empirical Results

Descriptive Statistics

In Table 3.1, I display the average of the descriptive statistics of the six world indices namely S&P 500, FTSE 100, SHCOMP, IBOVESPA, DAX and IBEX 3 over the period [-60, +60] surrounding the pandemic announcement date, March 11, 2020 by the WHO. I report that over the 121-day period, among the six countries, the USA has the strongest index with an average market capitalisation of £20.40 trillion. When compared, however, with the other five countries over the period, the USA had the second largest fall in the average closing index (2,366,03). On the other hand, among the six countries, China has the second largest share market value with an average market capitalisation of £3.77 trillion. However, China has experienced the lowest average closing price (327.30) among the six indices. Notably, the average volume (25,057.36 trillion) of the Chinese capital markets is the largest with the lowest average relative spread (0.013).

My findings show that despite a fall in the closing price index, the liquidity of the Chinese capital market is superior to the other indices justified by the trading volume and spread. The most volatile index over the period is Brazil with a 1.41% average standard deviation and the largest average relative spread (0.037). US equity markets experience the smallest risk (0.32%) and the second lowest spread (0.0204). A reason for this can be that the capital market of the USA is considered the world leader, suggesting the best financial stability. During our sample, the pharmaceutical companies of the S&P 500 started to develop the vaccine, which has caused the share prices of them to increase leading to an overall index gauge from the pandemic.

Table 3.1. Descriptive Statistics

The following table represents the mean of the mentioned descriptive statistics of the 6 world indices namely S&P 500, FTSE 100, SHCOMP, IBOVESPA, DAX and IBEX 35 for the period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the World Health Organization (WHO).

	S&P 500	**FTSE 100**	**SHCOMP**	**IBOVESPA**	**DAX**	**IBEX 35**
Market Capitalisation (£trillion)	20.3962	1.7527	3.7741	0.5135	0.9468	0.4443
Closing Index	2,366.0344	6,563.2334	327.3049	1,6270.2204	1,0239.0147	70,46.9640
Volume(trillion)	768.4063	1024.9768	25057.3568	903.4534	126.5470	320.8106
Daily Standard Deviation of Return(%)	0.0032	0.0074	0.0105	0.0141	0.0078	0.0074
Bid-Ask Spread	0.0204	0.0247	0.0131	0.0374	0.0221	0.0232

Abnormal Returns

Table 3.2 reports the abnormal returns of the six indices, S&P 500, FTSE 100, SHCOMP, IBOVESPA, DAX and IBEX 35, for a period of [-60, +60] around the pandemic announcement date, March 11, 2020 by the WHO. The table shows significant negative returns for the USA (-1.00 %) and Brazil (-4.97 %) on the event day with a t statistic of -4.44 and -3.44, respectively, significant at the 1% level. The largest positive return (3.30%) on the event day has been experienced by Spain with a 5.31 t statistic, significant at all conventional levels. As markets moved forward from the pandemic, the negative returns being experienced by the USA tend to improve. For instance, the average abnormal return over the [-60, +60] period for the USA capital market is 0.04%. A major cause for this can be that the S&P 500 includes the pharmaceutical companies, which are heavily invested in producing the vaccine for the virus causing the share price of these companies to increase and hence pulling the index up. However, China has experienced a decrease in returns over the pandemic period. For instance, over the [-1, +1] day period, the average abnormal returns of SHCOMP are 3.09% with a t statistic of 2.56. As China is the epicentre of the virus, panic sales have led to a fall in the share price of the index.

The table also shows that over the period, the European and Latin American financial markets have experienced consecutive negative returns. For instance, during the [-1, +1] period, the average abnormal returns (t statistics) for the FTSE 100, IBOVESPA, DAX and IBEX 35 are –1.72% (-3.00), -1.63% (-1.13), -1.82% (-2.77) and -3.03% (-4.86) respectively. The negative returns of the FTSE 100, DAX and IBEX 35 are significant at the 1% level. During the [-60, +60] period, the average abnormal returns (t statistics) for the FTSE 100, IBOVESPA, DAX and IBEX 35 are -0.13% (-0.22), -0.16% (-0.11), -0.0003% (-0.005) and -0.13% (-0.20) respectively. This shows that the magnitude as well as the significance of the negative returns for the European and Latin American countries tend to improve in the long run. As these countries are more invested in tourism and the locked down measures has banned international travel, hence the markets of these regions plummeted in the short run. As the long run period started to approach, the countries slowly started to open up while maintaining the health and safety measures causing the public to gain market confidence and share prices of the companies to improve. The table also reflects that the returns of all nations, except China tend to improve in the long run.

Table 3.2. Abnormal Returns around the COVID-19 pandemic announcement date, March 11, 2020

The following table represents the Average Abnormal Returns (AAR) of the 6 world indices, namely, S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 for a period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the World Health Organization (WHO). The AAR has been calculated using the market model. The t test represents the t-statistic which has been computed following the standard event study methodology. The null hypothesis is that AAR is equal to unity. (***significance at 1%, **significance at 5% and * significance at 10%.)

	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
0	-0.998%	1.922%	2.929%	-4.972%	3.289%	3.304%
T test	*-4.4420****	*3.3516****	*2.4227***	*-3.4373****	*5.0019****	*5.3069****
[-1,+1]	0.513%	-1.720%	3.093%	-1.629%	-1.820%	-3.028%
T test	*2.2846***	*-3.0003****	*2.5579***	*-1.1259*	*-2.7669****	*-4.8631****
[-2,+2]	0.912%	-2.130%	1.243%	-0.618%	-2.235%	-2.364%
T test	*4.0578****	*-3.7143****	*1.0279*	*-0.4269*	*-3.3988****	*-3.7973****
[-5,+5]	0.080%	-1.108%	1.255%	-2.547%	-1.144%	-0.982%
T test	*1.7476*	*-1.9327*	*1.0376*	*-1.7604*	*-1.7395*	*-1.5779*
[-10,+10]	0.080%	-0.338%	0.601%	-0.878%	-0.125%	-0.238%
T test	*0.3578*	*-0.5888*	*0.4967*	*-0.6069*	*-0.1907*	*-0.3820*
[-30,+30]	0.071%	-0.232%	0.109%	-0.824%	-0.165%	-0.334%
T test	*0.3173*	*-0.4042*	*0.0906*	*-0.5698*	*-0.2505*	*-0.5368*
[-60,+60]	0.037%	-0.125%	-0.001%	-0.159%	-0.003%	-0.125%
T test	*0.1641*	*-0.2183*	*-0.0011*	*-0.1100*	*-0.0046*	*-0.2014*

Trading Volume Effects

Table 3.3 observes the impact on trading volume of the six indices namely, S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 for a period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the WHO. The coefficients show that in the short run, the impact on trading volume has the greatest influence on Germany (t test on day +1 is 2.89, significant at the 1% level). The effect on trading volume of Germany tends to persist following the pandemic announcement. The table also reports that in the long run, there is no significant impact on trading volume after the pandemic announcement for any country in our sample.

Table 3.3. Trading Volume around the COVID-19 pandemic announcement date, March 11, 2020

The sample consists of the 6 world indices, namely, S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 for a period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the World Health Organization (WHO). The effect on the trading volume has been examined using the following regression model for a period of [-60, +60] surrounding the event day, March 11, 2020 to investigate the short term and long-term impact on the trading volume. The period of [-5, +5] has been reported for the most significant results.

$Volume_{jt} = \alpha_j + \sum_{-5}^{+5} D_i \beta_i + \varepsilon_j$ for j = 1,7 (representing 7 indices in the order respectively) and t = -60, +5

Where, the dependent variable, $Volume_{jt,}$ represents the logarithm of the trading volume for index j at time t. The constant, α_j, shows the variation in trading volume. D_i represents the dummy variables for each trading day in the event window [-5, +5]. The coefficient of the eleven dummy variables, $\beta_{i,}$ represents the impact on the abnormal trading volume of the pandemic over the event period and is the main concern of the regression model. ε_j is a random disturbance term with a mean of zero and a variance of σ^2. (***significance at 1%, **significance at 5% and * significance at 10%.)

	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
αj	20.3861	20.6378	23.9118	20.5515	18.5562	19.4684
T test	*583.7979****	*464.7821****	*1045.6100****	*588.1463****	*464.1505****	*427.6031****
β_{-5}	0.1795	0.1834	0.3685	-0.0013	0.2576	0.2632
T test	*0.4639*	*0.3726*	*1.4656*	*-0.0034*	*0.5817*	*0.5218*
β_{-4}	0.2456	0.1728	0.6031	0.0210	0.2592	0.4552
T test	*0.6352*	*0.3511*	*2.4363***	*0.0541*	*0.5854*	*0.9044*
β_{-3}	0.4079	0.3751	0.3948	0.3456	0.5369	0.3699
T test	*1.0580*	*0.7634*	*1.5727*	*0.8946*	*1.2183*	*0.7341*
β_{-2}	0.6128	0.8196	0.5310	0.5579	0.9888	0.8202
T test	*1.5991*	*1.6838*	*2.1328***	*1.4522*	*2.2779***	*1.6423*
β_{-1}	0.4891	0.6180	0.4764	0.4782	0.8551	0.6452
T test	*1.2712*	*1.2632*	*1.9064*	*1.2417*	*1.9591*	*1.2864*
β_0	0.4563	0.4720	0.3640	0.3390	0.6431	0.5457
T test	*1.1849*	*0.9621*	*1.4477*	*0.8774*	*1.4633*	*1.0860*
β_{+1}	0.7023	0.8646	0.2305	0.3578	1.2369	1.0527
T test	*1.8386*	*1.7773*	*0.9119*	*0.9264*	*2.8851***	*2.1235***
β_{+2}	0.6631	0.7514	0.4065	0.6323	1.0546	0.5730
T test	*1.7334*	*1.5409*	*1.6201*	*1.6499*	*2.4368***	*1.1407*
β_{+3}	0.6357	0.8087	0.3661	0.4259	0.9785	0.8923
T test	*1.6602*	*1.6689*	*1.4561*	*1.1044*	*2.2530***	*1.7906*
β_{+4}	0.6304	0.7326	0.2250	0.5784	0.6588	0.5527
T test	*1.6460*	*1.5015*	*0.8901*	*1.5065*	*1.4995*	*1.0999*
β_{+5}	0.6148	0.6797	0.1738	0.6934	0.5996	0.4152
T test	*1.6044*	*1.3913*	*0.6866*	*1.8136*	*1.3627*	*0.8246*

Liquidity Measures

Table 3.4 shows the average of the liquidity measures of the six world indices, namely the S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 for a period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the WHO. From Panel A, I observe that the relative bid-ask spread is positive and significant in most cases. This provides evidence that the pandemic has decreased the liquidity in equity markets, resulting in less market efficiency. In China, however, equity markets more or less recovered from the impact of COVID-19, sixty days after the event. This suggests that the share market in China recovered quicker from the impact of COVID. This could be because the pandemic entered China before the rest of the world, and also due to the fact that they had fewer deaths from the virus.

Panel B displays the results of the RtoV price impact ratio. I observe that all equity markets have significant RtoV ratios as a result of COVID-19. The results suggest that the pandemic did not have significant price impact in the UK, Germany, Brazil and Spain. Arguably, this result is because even though they were significantly different from zero, the magnitude of the ratios was relatively small. However, in the USA and China the price impact ratios were greater than 1. Given that RtoV is an illiquidity ratio, this implies that equity markets in the USA and China possess significant price impacts as a result of COVID-19. In both the USA and China, the share price movement continued for up to 60 days post the pandemic.

Panel C shows the findings of the RtoTR price impact ratio. I observe that once I account for the impact of firm size bias in RtoV, the USA equity market does not provide evidence of significant price movement due to the pandemic. In China, the price impact persists for up to 60 days after the event news.

The fall in liquidity as a result of the pandemic for the USA, UK, China, Brazil, Germany and Spain could be linked to volatility spillovers. Laborda and Olmo (2021) report that the effects of the pandemic spills over from the banking industry to the rest of the economy. Our results provide evidence of volatility spillovers across nations, as the escalation in volatility as a result of the pandemic in one country, leads to an increase in uncertainty across the global economy (Shahzad, et al., 2021). This is because Chatjuthamard, et al. (2021) provide evidence that a rise in the number of confirmed COVID-19 cases enhances market volatility. Also, Zaremba et al. (2021) report that COVID-19-related restrictions including lockdowns may adversely affect the trading volume in financial markets.

Table 3.4. Liquidity Ratios around the COVID-19 pandemic announcement date, March 11, 2020

Table 4 represents the average of the liquidity measures of the 6 world indices, namely S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 for a period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the World Health Organization (WHO). The liquidity measures are the Relative Spread, RtoV and RtoTR price impact ratios. Relative Spread is calculated as ask minus bid divided by the midpoint of the bid-ask spread. RtoV is calculated the absolute daily stock return divided by the monetary volume. RtoTR is computed as the absolute daily stock return divided by the turnover ratio. The ratios are tested using a standard t-test with a null hypothesis stating that the mean of the reported ratio is equal to unity. Two tailed tests of significance are reported as(***significance at 1%, **significance at 5% and * significance at 10% level.)

$RS_{i,t} = \frac{Ai,t - Bi,t}{(Ai,t + Bi,t)/2}$ $RtoV = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{Vi,d}$ $RtoTR = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{TRi,d}$

Panel A: Relative Spread

	S&P 500	***FTSE 100***	***SHCOMP***	***IBOVESPA***	***DAX***	***IBEX 35***
0	*0.0428*	*0.0381*	*0.0139*	*0.1319*	*0.0351*	*0.0467*
T test	*55.3433****	*67.2122****	*1.7786*	*191.2465****	*48.9011****	*84.6590****
[-1,+1]	*0.0555*	*0.0677*	*0.0198*	*0.1391*	*0.0583*	*0.0763*
T test	*76.4922****	*138.6499****	*11.6240****	*203.1808****	*95.7477****	*154.3813****
[-2,+2]	*0.0594*	*0.0759*	*0.0229*	*0.1383*	*0.0625*	*0.0758*
T test	*82.9285****	*158.5104****	*16.8770****	*201.8157****	*104.1023****	*153.1729****
[-5,+5]	*0.0552*	*0.0619*	*0.0239*	*0.1123*	*0.0536*	*0.0626*
T test	*75.9359****	*124.6945****	*18.5885****	*158.9376****	*86.1649****	*121.8962****
[-10,+10]	*0.0520*	*0.0558*	*0.0219*	*0.0944*	*0.0497*	*0.0535*
T test	*70.6626****	*109.9389****	*15.2666****	*129.3723****	*78.3160****	*100.5826****
[-30,+30]	*0.0300*	*0.0336*	*0.0167*	*0.0539*	*0.0293*	*0.0305*
T test	*34.0626****	*56.1672****	*6.4852****	*62.6524****	*37.2856****	*46.4375****
[-60,+60]	*0.0204*	*0.0247*	*0.0131*	*0.0374*	*0.0221*	*0.0232*
T test	*18.0550****	*34.7633****	*0.3850****	*35.4432****	*22.7244****	*29.0805****

Panel B: RtoV

	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
0	0.6837	2.1451	0.0986	19.9196	0.0529	0.0831
T test	*27.2442******	*5.1881******	*-9.4915******	*40.7237******	*-14.3505******	*-12.3547******
[-1,+1]	0.8567	5.2731	0.3380	28.7330	3.8213	16.9930
T test	*37.2438******	*32.1469******	*-2.3805******	*64.9817******	*10.6848******	*32.8046******
[-2,+2]	1.0286	5.4663	0.4374	29.7571	4.2008	19.6534
T test	*47.1868******	*33.8125******	*0.5725*	*67.8005******	*13.2059******	*39.9096******
[-5,+5]	0.8561	4.8929	0.3750	23.1422	3.8344	16.9086
T test	*37.2111******	*28.8706******	*-1.2816*	*49.5935******	*10.7717******	*32.5792******
[-10,+10]	0.6325	4.6225	0.3737	17.6222	3.5931	14.4127
T test	*24.2829******	*26.5399******	*-1.3181*	*34.4002******	*9.1686******	*25.9138******
[-30,+30]	0.4539	3.7596	0.3998	10.8355	3.7632	12.0754
T test	*13.9574******	*19.1028******	*-0.5437*	*15.7206******	*10.2982******	*19.6719******
[-60,+60]	0.3493	3.3049	0.3116	8.6873	3.6214	11.2214
T test	*7.9089******	*15.1836******	*-3.1636******	*9.8078*	*9.3564******	*17.3911******

Panel C: RtoTR

	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
0	12.8426	3.3848	0.3801	9.2684	0.0450	0.0340
T test	*27.1607******	*1.8452*	*-9.4518******	*29.7820******	*-14.6238******	*-12.5144******
[-1,+1]	15.6854	7.8859	1.2881	12.5576	3.0879	6.6374
T test	*36.0032******	*22.2327******	*-1.6780*	*45.4406******	*6.2509******	*23.1398******
[-2,+2]	18.8438	8.4063	1.6700	13.0701	3.5043	7.8058
T test	*45.8270******	*24.5899******	*1.5913*	*47.8809******	*9.1079******	*29.4483******
[-5,+5]	15.8739	7.5840	1.4403	10.1283	3.1994	6.7431
T test	*36.5894******	*20.8653******	*-0.3750*	*33.8754******	*7.0159******	*23.7105******
[-10,+10]	11.7441	7.1174	1.4303	7.6802	3.0039	5.8132
T test	*23.7441******	*18.7518******	*-0.4605*	*22.2209******	*5.6753******	*18.6892******
[-30,+30]	8.6872	6.0476	1.4931	4.8486	3.3398	5.0643
T test	*14.2358******	*13.9060******	*0.0764*	*8.7404***********	*7.9795*	*14.6458******
[-60,+60]	6.8832	5.5049	1.1698	3.9658	3.3327	4.7314
T test	*8.6245******	*11.4480******	*-2.6912******	*4.5380******	*7.9304******	*12.8485******

Spread Decomposition

I next examine results for Spread Decomposition and report in Table 3.5 the effective spread decomposition findings for the six indices, namely, the S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and the IBEX35 for a period of [+1, +60]. According to the results with the exception of China, adverse selection components of all the indices show significance. On the other hand, the inventory holding component shows significance except for Germany. I observe that the inventory holding cost is more responsible for increases in spread for the USA, UK, China and Brazil whereas adverse selection is more important for Spain. Moreover, it shows that China has performed well with respect to the other indices, indicating again that China is able to overcome the pandemic crisis better than the other nations in our sample although to put matters in context, US share markets are ten-times the size of those of China and therefore it is not surprising that smaller markets can respond and correct themselves more quickly.

Table 3.5. Spread Decomposition around the COVID-19 pandemic announcement date, March 11, 2020

Table 5 represents the value-weighted components of the bid-ask spread for the S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 indices, estimated 60 days after the pandemic announcement period (March 11, 2020). We use the Huang and Stoll (1997) three-way decomposition model to represent the adverse selection (α) and inventory costs components (β). Two tailed tests of significance are reported as ***significance at 1%, **significance at 5% and * significance at 10%.

	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
α(%)	0.0511%	-0.0397%	0.0697%	0.0241%	-0.0596%	-0.0738%
T test	*2.3254****	*-2.2526***	*1.2980*	*0.7899*	*-4.6372****	*-4.3784****
β(%)	-0.0161%	-0.0144%	-0.4268%	-0.0064%	-0.0090%	-0.0066%
T test	*-3.7649****	*-2.5320****	*-6.7749****	*-3.4557****	*1.3739*	*2.7927****

Multivariate Regression

I estimate equation (3.8) in order to determine if the liquidity of share markets in the respective countries has decreased when we incorporate the volume, closing price and risk of the indices. Panel A of Table 3.6 shows that the coefficients of the dummy variable β_1 is negative for all of the indices except for China (0.01) and Brazil (0.17). This shows that the spread has increased over the event period. The increase in spread does not have a significant impact on the USA (t statistic: -1.64) and China (t statistic: 0.64). The largest index being affected by the pandemic is the UK, with the highest significance level (t statistic of 5.43, significant at the 1% level). The coefficient of the dummy variable, β_3, shows negative values for China and Brazil indicating that trading volume is less affected for these indices. This again validates that the trading volume of the other indices are more widely affected, resulting in a fall in liquidity.

When price impact has been considered in Panel B and Panel C, the coefficient of the dummy variable β_1 is positive for Brazil. As the RtoV and RtoTR are illiquidity ratios, a positive coefficient indicates a decrease in liquidity. The coefficients of the dummy variable $\beta_{3,}$ is negative for China and Brazil for both cases.

Table 3.6. Multivariate Regression around the COVID-19 pandemic announcement date, March 11, 2020

Table 6 represents the average of the multivariate regression model of the 6 world indices, namely S&P500, FTSE100, SHCOMP, IBOVESPA, DAX and IBEX35 for a period of [-60, +60] surrounding the COVID-19 pandemic announcement date, March 11, 2020 by the World Health Organization (WHO). The following regression model has been used for a period of [-60, +5] surrounding the event day to determine whether the average market liquidity of the stocks deteriorates following the COVID-19 pandemic announcement date by the WHO. In addition, the model tests if the slope coefficient on trading volume has changed following the pandemic announcement. The model states as:

$Liquidity_{jt} = \alpha_j + \beta_1 D_t + \beta_2 Volume_{jt} + \beta_3 (Volume_{jt} * D_t) + \beta_4 Close_{jt} + \beta_5 StdDev_{jt} + \varepsilon_{jt}$ for j = 1,6 (representing 6 indices in the order respectively) and t = -60, +5

Where, the dependent variable, $Liquidity_{jt,}$ represents Relative Spread, RtoV and RtoTR respectively for the stock j at time t. The constant, α_j, shows the variation in the liquidity ratios as per the index. D_t represents the dummy variable which is equal to 1 in the post pandemic announcement period, otherwise 0. Volume, Close and StdDev (Standard Deviation) represent the traded volume in shares, closing price and return volatility for the indexj at time period t for each trading day in the event window [-60, +5]. The coefficient, β_1 and β_3 captures the impact of the pandemic on the liquidity as well as on the volume and is of main concern. (***significance at 1%, **significance at 5% and * significance at 10%.)

Panel A: Relative Spread

Var	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
C	0.1141	0.1711	0.0614	0.1280	0.1284	0.2284
T test	*3.8816******	*5.2518******	*2.1755******	*3.0075******	*3.3357******	*8.7153******
β_1	-0.0649	-0.1433	0.0128	0.1681	-0.0418	-0.0322
T test	*-1.6395*	*-5.4311******	*0.4020*	*4.2255******	*-2.7138******	*-2.4982******
β_2	0.1480	0.1790	0.0051	0.0663	0.4130	0.0673
T test	*3.6974******	*4.2409******	*4.4623******	*0.5062*	*1.4029*	*0.9377*
β_3	0.6060	0.7570	-0.0348	-0.9160	1.6300	0.5570
T test	*2.0147******	*5.4108******	*-0.0355*	*-3.3511******	*3.4489******	*2.7489******
β_4	-0.4620	-0.2270	-0.0190	-0.0580	-0.1090	-0.2710
T test	*-4.1134******	*-5.5609******	*-2.2122******	*-3.3890******	*-3.4022******	*-8.7633******
β_5	1.5205	-0.3516	0.0669	0.9900	0.5901	0.4363
T test	*5.7982******	*-1.8582*	*0.6966*	*6.1655******	*3.7382******	*3.3834******

Panel B: RtoV

Var	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
C	3.2798	22.9389	3.4336	38.0523	32.8288	135.0518
T test	*4.6311******	*3.0660******	*2.3934******	*3.0655******	*3.5055******	*4.8510******
β_1	-1.0747	-22.1532	-0.0599	36.9785	-13.3906	-56.7649
T test	*-1.1271*	*-3.6552******	*-0.0370*	*3.1877******	*-3.5758******	*-4.1455******
β_2	-0.0180	0.0572	-0.0115	-0.0838	-0.0626	-0.0203
T test	*-1.8677*	*0.5902*	*-1.9682*	*-2.1943******	*-0.8744*	*-2.6658******
β_3	0.0744	0.1190	-0.2560	-0.2440	0.0411	0.8000
T test	*1.0254*	*3.7036******	*-0.5135*	*-3.0558******	*3.5857******	*3.7170******
β_4	-0.1202	-0.0278	-0.9104	-0.1501	-0.2584	-0.1505
T test	*-4.4456******	*-2.9603******	*-2.0875******	*-3.0060******	*-3.3009******	*-4.5776******
β_5	42.0783	-164.0278	30.4638	413.6703	-137.8712	-215.2889
T test	*6.6590******	*-3.7752******	*6.2387******	*8.8339******	*-3.5903******	*-1.5718*

Panel C : RtoTR

Var	S&P 500	FTSE 100	SHCOMP	IBOVESPA	DAX	IBEX 35
C	61.8809	38.7225	11.1510	18.3161	27.4809	60.0198
T test	*4.2717******	*2.7440******	*2.1240******	*2.6148******	*2.8537******	*4.4172******
β_1	-16.2163	-33.8771	-0.2135	15.7259	-11.8732	-25.0745
T test	*-0.8314*	*-2.9635******	*-0.0360*	*2.4024******	*-3.0834******	*-3.7520******
β_2	-0.0345	0.0525	-0.4070	-0.0436	-0.6030	-0.0102
T test	*-1.7539*	*0.2873*	*-1.9050*	*-2.0252******	*-0.8192*	*-2.7389******
β_3	0.1000	0.1740	-0.0931	-0.1170	0.3500	0.3280
T test	*0.6746*	*2.8682******	*-0.5101*	*-2.6056******	*2.9640******	*3.1263******
β_4	-0.0224	-0.0458	-0.0290	-0.0677	-0.2108	-0.6599
T test	*-4.0547******	*-2.5904******	*-1.8195*	*-2.4027******	*-2.6192******	*-4.1120******
β_5	783.8610	-256.3534	110.9412	196.5922	-114.7856	-93.9113
T test	*6.0645******	*-3.1281******	*6.2082******	*7.4397******	*-2.9069******	*-1.4049*

3.5 Summary

I examine the liquidity impact of COVID-19 upon equity markets in the USA, UK, Brazil, China, Germany, and Spain. I have considered the date of March 11, 2020 as the event day as it was the day which the WHO declared the COVID-19 as a pandemic. I then establish a 60-day pre and post event period to study the short term and long-term effects of COVID-19 on the indices of the mentioned countries. I have used the relative spread as a short term liquidity measure and the Amihud (2002) and Florackis et al. (2011) price impact ratios as the long term liquidity measures. I have further studied the abnormal returns and the trading volume effect of the pandemic on the indices. I then decompose the effective spread using the Huang and Stoll (1997) model.

I establish that the pandemic has caused a short-term loss in liquidity, confirmed by the significant increases in bid-ask spreads. Further, analysing long-term financial stability using price impact ratios, shows that for China alone, there is an impact of COVID-19. I have also pointed out that for the short term period, the indices suffered from negative abnormal returns. In the long term, all of the indices, except China, started to improve in terms of returns. Analysing the trading volume, I find out that there has been no significant effect on the trading volume in the long run. Also, examination of spread decomposition reveals the role of information asymmetry in the widening of spreads, rather than changes in cost of trading around the news of the pandemic. This finding holds true for all of the observed capital markets with the exception of China.

Chapter Four: The Impact of COVID-19 on the liquidity of the European Tourism Industry

4.1 Abstract

I examine the influence of COVID-19 on liquidity of the tourism industry in the UK, Europe and Spain. In the short run the pandemic causes significant negative stock market reaction in the tourism industry. In the long run the tourism industry recovers from the fall in returns due to the pandemic. Liquidity significantly decreases due to COVID-19, for the UK, European and Spanish tourism markets, even when I encapsulate the influence of stock prices, trading volume and volatility. The findings suggest that European equity markets have declined in efficiency due to the pandemic in the tourism industry.

4.2 Introduction

Boot et al (2020) report that during the start of 2020, there has been a world-wide spread of a disease with large number of people, particularly in China, Korea, Italy and Iran, being infected. According to Aljazeera (2020), on December 31, 2019, the World Health Organization (WHO) was alerted by China that a pneumonia has been spreading in the city of Wuhan and on January 05, 2020, Chinese officials suspected it to be the return of the severe acute respiratory syndrome (SARS) virus-an illness that originated in China and killed more than 770 people worldwide in 2002-2003. On January 07, 2020, the WHO identified the novel virus and gave it a name of 2019-nCOV and declared it as a member of the coronavirus family which includes SARS and the common cold. The first death occurred on January 11th, 2020 in China. Due to the current interlink of the world economy, the disease has spread throughout every country increasing the mortality rates in dramatic fashion. As stated by Salo (2020), the WHO declared COVID-19 as a pandemic during March 2020. As an immediate action, the countries around the world start to impose lockdown measures which include closing borders as well as the domestic economy, by restricting the unnecessary public interaction all of which have drastically impacted the economic activity of the countries.

As the world-wide lockdown measures start to strengthen further and difficulty in continuing business activities begin to take part, the contagion finds its way to the financial markets. The companies find it difficult to carry on production and services. The same scenario has been reflected in the tourism industry. The closing borders and cancellation of trips have started to evolve financial risk for the hotels, restaurants and bars, entertainment and the airline sectors causing them to discontinue services and hence leading them to bankruptcy. Using the Karafiath's (1988) market-based model Sharma and Nicolau (2020) discover in their paper there has been significant fall in the airlines, hotels, cruise lines and rental car indices. Carter et al. (2021) further support this with discovering that the negative effect were visible in the

US travel-related firms (airlines, restaurants, and hotels), especially in hotels. The tourism industry has started to face liquidity risk in the financial markets. A paper by Lee and Chen (2020) states that as the number of deaths rise, there has been a substantial negative effect on the returns of the travel and leisure industry across 65 countries. Undoubtedly, the effects on the tourism industry urge key policymakers to reconsider their strategies with new actions as part of the recovery and restarting period planning (Skare, Soriano, and Porada-Rochon (2021); Akron et al (2020)). Vulnerability is the key component of the industry in relation to financial crises, natural disaster, political instability and health related issues (Duro et al (2021), Gregoriou and Liasidou (2019)).

The purpose of this empirical chapter is to investigate the impact of COVID-19 on the liquidity of the tourism industry of the major European countries, namely the UK, Euronext and Spain. This is accomplished by analysing forty-nine companies listed on the FTSE All Share (forty companies), EURONEXT 100 (seven companies) and IBEX 35 (two companies) of different aspects of the tourism industry, namely restaurants, casinos & gaming, internet & direct marketing retail, hotels, resorts & cruise lines, environmental facilities, airlines, airport services, trucking, movies & entertainment, leisure facilities, railroads, marines ports & services, and highways & rail tracks. The data for these forty-nine companies is collected for a period of 60 days pre- and post the pandemic announcement date, March 11, 2020.

Empirical research has been discovering how the pandemic has affected the tourism industry from various aspects. The existing research draws attention upon the market capitalisation and price-to-book ratio (We et al. (2021), returns (Liew (2020) and hedging strategy (Sikiru and Salisu (2021). Further research has been studied on the impact of the tourism industry from the perspective of data mining (Fotiadis et al. (2020)) and the economic point of view (Carter et al. (2021)). However, there is a lack of research on the liquidity effects of the tourism industry during the COVID-19 period. I contribute to the research by analysing the liquidity effects of the pandemic on the European tourism industry by using both the short-term measures and long-term price impact ratios.

I discover that in the short run the pandemic has caused significant negative stock market reaction in the tourism industry. In the long run the tourism industry recovers from the fall in returns due to the pandemic. Liquidity of the tourism industry significantly declines due to COVID-19, for the UK, European and Spanish capital markets. This result holds true even when I encapsulate the influences of stock prices, trading volume and volatility. My findings suggest that European equity markets have deteriorated in efficiency due to the pandemic in the tourism industry.

4.3 Data and Methodology

4.3.1 Data

My sample consists of the forty-nine tourism and leisure companies being traded on the FTSE All Share index, EURONEXT 100 and IBEX 35. Representing 98% of the UK's market capitalisation, the FTSE All share index gauges the performance of the eligible companies and thus is considered as the best measure of the London capital market. Incorporating more than 80% of the Euronext's total market capitalisation and the most liquid blue-chip stocks across five European exchanges in Amsterdam, Brussels, Lisbon, London, and Paris, the EURONEXT 100 is taken as the benchmark index for European equity markets. The IBEX 35 index represents the 35 most liquid stocks of the Madrid Stock Exchange. From these indices, I obtain data for the companies that are involved with different sectors of the tourism industry. For the FTSE All Share Index, I have forty companies from the sectors of restaurants, casinos & gaming, internet & direct marketing retail, hotels, resorts & cruise lines, environmental facilities, airlines, airport services, trucking, movies & entertainment, leisure facilities, railroads, and marines ports & services. For the EURONEXT 100, there are seven companies from the sectors of airlines, airport services, casinos and gaming, highways and rail tracks, hotels, resorts and cruise lines, movies and entertainment, and restaurants. For the IBEX 35, the data consists of two companies from the sectors of airport services, hotels resorts & cruise lines.

In order to investigate the abnormal returns, I collect data for the MSCI World Index as it comprises the performance of the global large and mid-cap companies of twenty-three world capital markets. For this reason, this is considered as an indicator for the world stock market. The index includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and the United States. The index represents approximately 85% of the free float-adjusted market capitalisation of each country.

For each of the forty-nine companies, I collect the closing price, bid and ask price, volume, number of shares traded and number of shares outstanding from Bloomberg with 60 days pre- and post- the pandemic announcement date, defined as March 11, 2020 by the WHO. For the MSCI World Index, I collect the closing price from Bloomberg with 60 days pre-and post- the pandemic announcement date.

4.3.2 Methodology

Event Studies

I compute the daily average abnormal returns (AARs) for each of the forty-nine companies for event periods from [-5 to +5] in the short run and up to [-60,+60] in the long run around the pandemic announcement date. There are several notable models such as the CAPM used among others by Brown and Warner (1980) and Ma et al. (2009) to determine abnormal returns. As mentioned by Fama and French (1993), the CAPM model does not account for the compensation of value premium for risk. Thus, following Zhang and Gregoriou (2020), I use the econometric market-adjusted model in order to calculate the abnormal returns:

$$AR_{i,t} = R_{i,t} - R_{m,t} \tag{4.1}$$

Where, $AR_{i,t}$ denotes the abnormal return of stock i at time t. $R_{i,t}$ is the return on stock i at time t and $R_{m,t}$ represents the value-weighted market return (MSCI World Index) at time t.

Liquidity measures

Relative Bid-Ask Spread

Following Chordia et al (2001), the bid-ask spread is defined as the difference between the highest price a buyer wants to pay for the asset and the lowest price the seller wants to accept for it. Thus, a higher bid-ask spread will eventually mean that the frequency of a security being traded will be lower and as a result asset liquidity will decrease. Madhavan et al. (1997) indicate that the trade of an asset is settled within the boundary of the bid-ask spread. Hence, the absolute bid-ask spread does not represent a significant measure to gauge the investor's trading costs. As the relative spread overcomes this disadvantage, following Zhang and Gregoriou (2020), I compute the relative spread for the forty-nine companies around the 60 days pre- and post the pandemic announcement date, using the following equation:

$$RS_{i,t} = \frac{Ai,t - Bi,t}{(Ai,t + Bi,t)/2} \tag{4.2}$$

Where $RS_{i,t}$ represents the relative spread of stock i at time period t and $A_{i,t}$ is the ask price of stock i at time t. $B_{i,t}$ denotes the bid price of stock i at time t.

Price Impact Ratios

Although there is a wide acceptance of the bid-ask spread as a liquidity proxy, Le and Gregoriou (2020) state that it is only effective as a short run measure. A measure based on daily returns and volume is more appropriate for long run liquidity effects. Given this evidence, I also apply the Amihud (2002) illiquidity ratio, RtoV, to the forty-nine companies, using the following equation:

$$\text{RtoV} = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{Vi,d} \tag{4.3}$$

Where, $|R_{i,d}|$ and $V_{i,d}$ represent the absolute return and monetary volume of stock i on day d respectively and D_i is the number of trading days for stock i.

However, previous research shows that the Amihud (2002) illiquidity ratio involves size bias, since monetary volume shares a direct relationship with market capitalisation. To overcome this, Florackis et al. (2011) introduce a new liquidity measure (RtoTR), defined below:

$$\text{RtoTR} = \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{TRi,d} \tag{4.4}$$

Where, $TR_{i,d}$ represents the turnover ratio of stock i at day d, D_i and $R_{i,d}$ are the same as the Amihud ratio. RtoTR does not involve any size bias as there is no significant correlation between market capitalisation and the turnover ratio. The RtoTR ratio also incorporates the influence of trading frequency in determining price impact. For completeness I compute both the RtoV and RtoTR ratios in the empirical analysis.

Multivariate Regression Analysis

Following Gregoriou (2015), in order to incorporate the impact of other factors which influence liquidity during the pandemic announcement, I investigate the relationship between the liquidity measures and the external factors by computing the following multivariate time-pooled regression model:

$$Liquidity_{it} = \alpha_i + \beta_1 D_t + \beta_2 Volume_{it} + \beta_3 (Volume_{it} * D_t) + \beta_4 Close_{it} + \beta_5 StdDev_{it} + \varepsilon_{it} \tag{4.5}$$

for i = 1 to 49 and t = -60, +5

Where, the dependent variable, $Liquidity_{it,}$ represents Relative Spread, RtoV and RtoTR respectively for stock i at time t. α_i, captures the time-invariant unobserved stock-specific fixed effects. The fixed effect α_i accounts for differences in the initial level of liquidity of each security in our sample. D_t represents the dummy variable which is equal to 1 in the post pandemic announcement period and zero otherwise. Volume, Close and StdDev (Standard Deviation) represent the traded volume in shares, closing price and return volatility for the stock of the individual forty-nine companies i at time period t for each trading day in the event window [-60, +5].

4.4 Empirical Results

Descriptive Statistics

Table 4.1 displays the mean of the descriptive statistics of the forty-nine companies representing the tourism industry of the FTSE All Share, EURONEXT 100 and IBEX 35 index for the period of [-60,+60] surrounding the COVID-19 pandemic announcement date. I observe that over the 121-event day period, the market capitalisation of the tourism industry of the United Kingdom (UK) (£56,040.95 billion) is more than that of the EURONEXT 100 countries and the Spanish capital market (£11.12 billion and £9.62 billion respectively). However, when comparing with the closing index, the UK (9.85) has the lowest price among the other capital markets (EURONEXT 100: 47.92, Spain: 62.85). The tourism industry of the UK also experiences the highest relative spread (0.35 with the highest average daily standard deviation of 2.42%).

This supports the argument by Emmerson and Johnson (2020) that the tourism industry of the UK has been a risky investment during the first wave of the pandemic. When compared with the EURONEXT 100 countries and Spanish capital markets, the tourism industry of Europe has witnessed a relative spread of 0.19 with a standard deviation of 1.50%, and Spain has observed a relative spread of 0.12 with a standard deviation of 1.75%. This shows that even though the fall in short term liquidity, as measured by the relative spread, is somewhat similar for both the EURONEXT 100 countries and Spain, it is beneficial for individuals to invest in the EURONEXT 100 than in the Spanish capital markets, when compared with risk. A possible reason for this could be as reported by the European Commission (2020), that the EURONEXT 100 comprises of the major countries, some of which had less travel restrictions during the pandemic. This is also justified by the average daily trading volume which is 1,544.92 billion for the EURONEXT 100 countries and 712.90 billion for Spain, indicating less trading for Spain. On the other hand, the daily average trading volume of the tourism industry of the UK is the highest (2,316 billion) over the 121-event day period. However, the closing price index, relative spread and the risk of the UK equity markets clearly indicate a major fall in the liquidity than that of the EURONEXT 100 countries and Spain. Countries such as the UK need to implement new approaches that can lead to recovery by considering its strategic tourism planning. As reported by Navarro-Drarich and Lorenzo (2021), the UK is one of the leading markets in both tourism supply and demand that affects international tourism. In addition, countries that are highly dependent on tourism seem to suffer the most and act with immediate effect to provide health safety measures as part of their initial recovery plan to avoid additional negative impacts.

Table 4.1. Descriptive Statistics

The following table reports the mean of the descriptive statistics of the forty-nine companies representing the tourism industry of the FTSE All Share, EURONEXT 100 and IBEX 35 for the period of [-60, +60] surrounding the COVID-19 pandemic announcement date.

	FTSE ALL Share	EURONEXT100	IBEX35
Market Capitalisation (£billion)	56,040.95	11.12	9.62
Closing Price	9.85	47.92	62.85
Relative Spread	0.35	0.19	0.12
Daily Standard Deviation of Return(%)	2.42%	1.50%	1.75%
Daily Volume(£billion)	2,316.62	1,544.92	712.90

Abnormal Returns

Table 4.2 describes the average abnormal returns of the forty-nine companies under each of the three indices, FTSE All Share, EURONEXT 100 and IBEX 35 around the 60 days pre-and post the pandemic announcement date. The table shows substantial negative returns for all indices over the short run which continues to prolong in the long run. The significance of the negative returns tends to improve in the long run as observed by the significance tests. However, for the UK, the magnitude of the negative returns is more pronounced compared with the other nations in our sample. On the event day, the UK capital market experiences a negative return of -0.32%, whereas the EURONEXT 100 countries and Spain exhibit positive returns of 1.10% and 1.12% respectively. This shows that the announcement of the pandemic has severely impacted the UK capital market. As mentioned previously, the UK is heavily dependent on the tourism industry, implying that a shock like the pandemic has created more substantial impact on investors. The influence of the pandemic on the returns of the UK can also be seen during the [-5,+5] event period. During this period, the return of the UK capital market is -4.85% with a 1% significant level.

On the other hand, the abnormal returns for the EURONEXT 100 countries and Spain are -1.91% and -2.69%, with only Spain being significant at the 10% level, over the event period [-5,+5]. This shows that the European markets recover from the pandemic five days post the announcement. The pandemic did have a minor impact on the Spanish capital markets during the same event period. When I analyse a shorter event window [-2,+2], the returns (t statistics) for the UK, EURONEXT 100 countries and Spain are -4.46% (-2.40), -2.37% (1.90) and -3.23% (-2.49) respectively. This shows that the pandemic had a significant negative stock market reaction in the UK and Spain. This is also true for the European equity markets, but not with the same magnitude as there is only significance at the 10% level.

When I analyse the long run event window [-60,+60], I observe that the stock market impact of the pandemic has disappeared for all three indices. This indicates that the UK, European and Spanish stock markets have been able to fully recover from the first wave of COVID-19. A possible reason could be that the long run event period includes the summer of 2020, where some restrictions were lifted paving the opportunity for leisure trips, which in turn increases stock returns of the tourism industry.

Table 4.2. Abnormal Returns around the COVID-19 pandemic announcement date.

The following table represents the average abnormal returns (AAR) of the forty-nine tourism industry companies for each of the three indices, FTSE All Share, EURONEXT 100 and IBEX 35 around the 60 days pre-and post- the pandemic announcement date. The AAR has been calculated using the market model. The t test represents the t-statistic which has been computed following the standard event study methodology. The null hypothesis is that AAR is equal to 0 (***significance at 1%, **significance at 5% and * significance at 10%.).

	FTSE ALL Share	EURONEXT100	IBEX35
0	-0.32%	1.10%	1.12%
T test	*-0.22*	*0.83*	*1.43*
[-1,+1]	-3.71%	-2.66%	-4.02%
T test	*-2.01***	*-2.17***	*-3.22***
[-2,+2]	-4.46%	-2.37%	-3.23%
T test	*-2.40****	*-1.90**	*-2.49****
[-5,+5]	-4.85%	-1.91%	-2.69%
T test	*-2.62****	*-1.46*	*-1.83**
[-10,+10]	-1.73%	-0.37%	-0.75%
T test	*-0.90*	*-0.31*	*-0.54*
[-60,+60]	-0.14%	-0.08%	-0.15%
T test	*-0.08*	*-0.08*	*-0.11*

Liquidity Impact

Table 4.3 represents the average of the liquidity measures of the tourism industry companies for each of the three indices, FTSE All Share, EURONEXT 100 and IBEX 35 around the 60 days pre-and post- the pandemic announcement date. Panel A reports the results using the relative spread as our liquidity measure. On the announcement date we report positive and significant relative spreads for the UK and European equity markets. Surprisingly, I find that the Spanish capital markets do not have a significant decrease in liquidity on the day of the

COVID announcement. When I look at a three day event window around the news [-1,+1], I report that spreads are positive and significant for all three indices. This implies that the shock of the pandemic has significantly reduced liquidity in UK, European and Spanish equity markets in the short run. This trend continues to persist in the long run, as spreads are positive and significant for all three indices when I look at a 121 event day window [-60,+60], around the announcement of the pandemic. This result suggests that there is a long-term reduction in liquidity of tourism equity markets as a result of COVID-19. This implies that even though abnormal returns recovered as observed in Table 2, the pandemic has caused a long-term reduction in stock market efficiency, due to the significant decline in liquidity of the tourism industry.

Panel B and Panel C show the empirical results when I use price impact ratios to approximate stock market liquidity. I find that the relative spread results reported above remain intact once I incorporate price impact, trading volume, firm size and trading frequency. I believe it is important to also look at price impact ratios to measure liquidity as they are a good approximation of financial stability as mentioned by Le and Gregoriou (2020).

Table 4.3. Liquidity Impact around the COVID-19 pandemic announcement date.

Table 3 represents the average of the liquidity measures of the forty-nine tourism industry companies for each of the three indices, FTSE All Share, EURONEXT 100 and IBEX 35 around the 60 days pre-and post the pandemic announcement date. The liquidity measures are the Relative Spread, RtoV and RtoTR price impact ratios. Relative Spread is calculated as ask price minus bid price divided by the midpoint of the bid-ask spread. RtoV is calculated as the absolute daily stock return divided by the trading volume. RtoTR is computed as the absolute daily stock return divided by the turnover ratio. The ratios are tested using a standard t-test with a null hypothesis stating that the mean of the reported ratio is equal to zero. Two tailed tests of significance are reported as ***significance at 1%, **significance at 5% and * significance at the 10% level.

$RS_{i,t} = \frac{Ai,t - Bi,t}{(Ai,t + Bi,t)/2}$ RtoV $= \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{Vi,d}$ RtoTR $= \frac{1}{Di}\sum_{d=1}^{Di}\frac{|Ri,d|}{TRi,d}$

Panel A: Relative Spread

	FTSE ALL Share	EURONEXT 100	IBEX35
0	0.29	0.23	0.08
T test	*2.45****	*13.79****	*-0.72*
[-1,+1]	0.31	0.23	0.0580
T test	*0.83*	*6.67****	*-4.65****
[-2,+2]	0.27	0.21	0.0583
T test	*0.67*	*4.25****	*-4.61****
[-5,+5]	0.35	0.20	0.131
T test	*4.58****	*2.84****	*6.39****
[-10,+10]	0.42	0.22	0.125
T test	*7.11****	*3.80****	*5.73****
[-60,+60]	0.35	0.19	0.12
T test	*2.63****	*2.25***	*5.90****

Panel B: RtoV

	FTSE ALL Share	EURONEXT 100	IBEX35
0	0.22	0.11	0.40
T test	*7.28****	*-0.02*	*6.54****
[-1,+1]	0.36	0.24	0.52
T test	*18.18****	*7.18****	*26.66****
[-2,+2]	0.35	0.26	0.42
T test	*17.48****	*7.35****	*21.03****
[-5,+5]	0.42	0.24	0.49
T test	*22.26****	*10.02****	*27.87****
[-10,+10]	0.41	0.27	0.57
T test	*21.12****	*12.45****	*30.44****
[-60,+60]	0.31	0.26	0.44
T test	*10.98****	*10.16****	*18.94****

Panel C: RtoTR

	FTSE ALL Share	EURONEXT 100	IBEX35
0	0.20	0.12	0.18
T test	*22.87******	*32.40******	*30.48******
[-1,+1]	0.43	0.47	0.44
T test	*58.87******	*132.23******	*121.59******
[-2,+2]	0.42	0.44	0.37
T test	*58.69******	*119.30******	*106.58******
[-5,+5]	0.55	0.31	0.40
T test	*113.82******	*84.45******	*110.29******
[-10,+10]	0.56	0.25	0.34
T test	*102.00******	*66.42******	*90.57******
[-60,+60]	0.29	0.09	0.17
T test	*35.64******	*19.89******	*34.58******

Multivariate Regression

In this section I conduct multivariate empirical analysis by estimating equation (4.5). I am interested in the significance of $\beta_{1,}$ which indicates if the pandemic has caused changes in liquidity after controlling for the impact of stock prices, trading volume and volatility. The results can be seen in Table 4.4. Panel A displays the results when I approximate liquidity with the relative spread. I find that the pandemic does not influence the liquidity of UK, European and Spanish capital markets once I account for the influence of trading volume, stock prices and volatility. The results remain quantitively similar when I use the RtoV price impact ratio as a representation of liquidity (Panel B of Table 4.4). I observe different results when I use the RtoTR price impact ratio as our liquidity measure (Panel C of Table 4.4). In this instance β_1 is positive and significant for all cases. This implies that liquidity has decreased due to the pandemic for the UK, European and Spanish equity markets. This is because RtoTR is an illiquidity ratio, implying that an increase represents a fall in liquidity. This result holds true once I account for the influence of trading volume, stock prices and volatility. In addition, my findings reflect the importance of encapsulating the influence of firm size and trading frequency in my liquidity measures. My findings suggest that companies need to reinvest more wisely within the tourism sector (Zhang et al 2021). Additionally, governments must provide flexible policies that can ensure both economic recovery and survival during crises (Yang et al. 2020).

Table 4.4. Multivariate Regression around the COVID-19 pandemic announcement date

The sample consists of the forty-nine tourism industry companies listed on the FTSE All Share Index, EURONEXT 100 and IBEX 35 for a period of [-60, +5] surrounding the COVID-19 pandemic announcement date.

$Liquidity_{it} = \alpha_i + \beta_1 D_t + \beta_2 Volume_{it} + \beta_3 (Volume_{it} * D_t) + \beta_4 Close_{it} + \beta_5 StdDev_{it} + \varepsilon_{it}$

for i= 1,49

and t = -60, +5

Where, the dependent variable, $Liquidity_{it,}$ represents Relative Spread, RtoV and RtoTR respectively for stock i at time t. The constant, α_i, shows the variation in liquidity for each index in our sample. D_t represents the dummy variable which is equal to 1 in the post pandemic announcement period and zero otherwise. Volume, Close and StdDev (Standard Deviation) represent the traded volume in shares, closing price and return volatility for stock j at time period t for each trading day in the event window [-60, +5]. ***significance at 1%, **significance at 5% and * significance at the 10% level.

Panel A: Relative Spread

Var	FTSE ALL Share	EURONEXT 100	IBEX35
C	0.41	0.31	0.22
T test	*1.14*	*0.39*	*0.87*
β_1	-0.37	0.23	-0.17
T test	*-0.43*	*1.38*	*-0.85*
β_2	-0.15	0.07	-0.08
T test	*-0.42*	*0.10*	*-1.59*
β_3	0.29	-0.25	0.11
T test	*1.03*	*-0.83*	*1.30*
β_4	-0.04	-0.01	-0.03
T test	*-0.42*	*0.03*	*-0.43*
β_5	0.58	-1.45	1.07
T test	*0.32*	*-0.63*	*0.93*

Panel B: RtoV

Var	FTSE ALL Share	EURONEXT 100	IBEX35
C	0.93	0.50	0.75
T test	*1.68*	*1.71*	*1.59*
β_1	0.16	-0.09	-1.02
T test	*0.28*	*-0.49*	*-1.53*
β_2	-0.15	-0.16	-0.23
T test	*-2.58****	*-1.89**	*-2.16***
β_3	0.12	0.69	0.78
T test	*0.38*	*1.09*	*2.25****
β_4	-0.17	-0.02	-0.05
T test	*-1.10*	*-1.31*	*-1.10*
β_5	7.38	1.21	4.24
T test	*4.73****	*1.69**	*1.63**

Panel C : RtoTR

Var	FTSE ALL Share	EURONEXT 100	IBEX35
C	-0.21	0.40	0.25
T test	*-0.25*	*1.02*	*1.54*
β_1	0.56	0.78	0.95
T test	*3.41****	*3.75****	*4.86***
β_2	0.63	0.12	0.85
T test	*4.35****	*2.72****	*1.29*
β_3	0.13	0.54	0.12
T test	*5.55****	*5.47****	*6.56****
β_4	0.02	-0.02	-0.02
T test	*-0.07*	*-1.20*	*-1.70*
β_5	7.53	-0.47	1.22
T test	*4.67****	*0.49*	*1.41*

4.5 Summary

I examine the influence of COVID-19 on liquidity of the tourism industry in the UK, Europe and Spain. I have used March 11, 2020 as the event day as this is the date which has been declared as the pandemic by the WHO. I study the forty-nine companies of the tourism sectors of the three nations mentioned above. I create a 60-day pre and post event study period around March 11, 2020. I then use the relative spread as a short-term measure of liquidity and the Amihud (2002) and Florackis et al (2011) price impact ratios as a long term measure of liquidity. I have also studied the abnormal returns around the sample period.

I discover that in the short run the pandemic has caused significant negative stock market reaction in the tourism industry. In the long run the tourism industry recovers from the fall in returns due to the pandemic. Liquidity significantly decreases due to COVID-19, for the UK, European and Spanish tourism markets, even when I encapsulate the influence of stock prices, trading volume and volatility. I also find out that the UK has suffered most in terms of negative return due to the announcement of the pandemic. In the long run, the abnormal returns start to improve. My findings suggest that European equity markets have declined in efficiency due to the pandemic in the tourism industry.

Chapter Five: BREXIT and the Liquidity of the FTSE 100 Index

5.1 Abstract

I examine the effect of BREXIT on the liquidity of the FTSE 100 Index by investigating twenty-four events from the BREXIT referendum until the transition period. I report that the liquidity of the index has improved as the referendum has been absorbed by the market but deteriorated further as the transition period has approached.

5.2 Introduction

Recently, the UK leaving the EU (Brexit) caused significant effects on the financial market worldwide, especially for the UK market. On the 23rd of June 2016, the British referendum was held with the final result of 51% voting for the UK's withdrawal from the EU. The study of Brexit and its impacts has attracted significant attention from researchers. From a theoretical perspective, Wielechowski and Czech (2016) suggest an increase in economic uncertainty for the UK market post referendum. Furthermore, they forecast that Britain's exit from the EU would negatively impact on the gross domestic product (GDP) growth rate between 2016 and 2020. Cox and Griffith (2018) report that the Brexit Referendum increased information asymmetry among market participants, which caused a transitory decline in stock market liquidity. Kong et al (2018) discover that the Brexit referendum generated fatter tails on liquidity measures' distributions. This indicates that low levels of liquidity occurred more frequently during the Brexit referendum.

On the 31 January 2020, 11:00 pm GMT Brexit occurred. This is because the UK left the European Union and the European Atomic Energy Community. This is the first study that will examine the impact of Brexit on stock trading activity and liquidity – reaction of the market – in order to correct stock prices following new information. In order to shed new light in this emerging field of research, this chapter aims to examine the impacts of Brexit on the financial stability of UK companies.

The primary objective of this chapter is to investigate the effect of Brexit on the financial stability of the UK market, using stock liquidity as a proxy for financial stability. The relationship of liquidity and stability is highlighted by Bryant (1980) and Diamond and Dybvig (1983), who mention the inherent instability in banking due to maturity mismatch between assets and liabilities. In this research, the impact of Brexit is examined by comparing the liquidity of the FTSE 100 index pre and post Brexit.

BREXIT and its effects have been studied by several researchers. Van Reenen (2016) report in a theoretical paper that BREXIT will lead to higher trade costs and as a result, there will be a long-term loss in trade and investment in the UK. Using the agent-based modelling method, Samitas et al. (2018) report that the financial channel of the EU would suffer more than that of the UK. Kong et al. (2018) investigate that how the different liquidity measures behave in times of stressed conditions. The period also include the BREXIT referendum. The paper highlights fatter tails indicating the presence of low liquidity in the capital markets. A related paper by Cox and Griffith (2018) investigate the liquidity effect of the BREXIT referendum during 2016. Their paper has used the data sets of the NYSE daily trade quote and applied the quoted, effective and realized spread with their percentages as a proxy for liquidity. The paper supports the idea that in times of political noises, spreads tend to increase.

According to the paper being published by the House of Commons Library on 6th January 2021, the Brexit referendum occurred on 23rd June 2016 and 31st January 2020 was the Brexit day, meaning the United Kingdom (UK) leaving the EU. This in turn makes 3rd February 2020 as the first trading day post Brexit. The paper also mentions that the transition period, the period through which the UK has officially left the EU, ends on 31st December 2020. The paper from the House of Commons Library describes multiple events from the referendum till the transition period after the Brexit. This paper intends to examine the abnormal liquidity of the FTSE 100 index by analysing twenty-four major events from the Brexit referendum till the transition period. In particular, I intend to examine the abnormal liquidity of stocks around t 3rd February 2020, the first trading day post Brexit. As the twenty-four events overlap each other, hence I deploy an event period of [-10,+10] for each of the twenty-four events and investigate the abnormal liquidity of the FTSE 100 index by using short-term liquidity measures namely, quoted spread, relative spread and effective spread. In order to further investigate how much impact the Brexit and its related events have had on the investments, I analyse the abnormal returns and the standardized trading volume of the FTSE 100 index for during each of the twenty-four events. I also compute a multivariate regression analysis on each of the liquidity measures for each of the twenty-four events in order to capture how the liquidity has performed when I take the volume, closing index and standard deviation into account.

I make the following contributions to the previous literature. This chapter is the only study to provide a comprehensive analysis of liquidity costs and Brexit on the UK stock market. Prior research has analysed the association between liquidity and the Brexit Referendum (Cox and Griffith, 2018). This paper examines the liquidity effects after the referendum and till the transition period with the market impact on the actual Brexit day, that is 3rd February 2020. Second, this research examines the abnormal returns and standardized volume along with the liquidity measures in order to further realise the impact of the Brexit on the investments. Previous research has only described the liquidity effects of the referendum (Cox and Griffith, 2018).

The empirical results suggests that the abnormal returns has significantly decreased during the twenty-four events leading to the BREXIT. The volume of the FTSE 100 during the sample period has deteriorated further. The liquidity measures, quoted spread, relative spread and effective spread, individually and along with the multivariate regression suggests that the FTSE 100 index has experienced significant positive spreads over our sample period. This shows a decrease in liquidity in the market. The results further highlights as during the days after the referendum, the significance, and the ratio of the spreads in higher which tend to absorb in the market with a lower spread. However, as the market approaches towards the transition period, the spreads tend to increase.

5.3.Data and Methodology

5.3.1 Data

The BREXIT referendum, where the majority of the UK citizens voted to move out of EU, has occurred on June 23, 2016. From then, the transition period has been delayed until December 31, 2020. The UK and the EU have faced several major events between the referendum and the transition period. In order to capture the effect of liquidity due to BREXIT, I examine the liquidity effects of the twenty-four major events between the referendum and the transition period.

Consistently, my sample period includes ten days pre the referendum, June 23, 2016, until ten days post the Brexit transition period, December 31, 2020. Thus my sample period starts from June 10, 2016, and ends on January 15, 2021. As I am interested in examining how Brexit has impacted the liquidity of the UK capital market, hence I have collected the data set for the FTSE 100 index. The FTSE 100 index incorporates the 100 largest companies in the UK and includes approximately 80% of the total trading volume of the London Stock Exchange. The index is considered as a key indicator by financial experts.

As I am also interested in capturing abnormal returns and trading volume impact during these twenty-four events, I collect the data set for the MSCI world index. The MSCI World Index represents the performance of the large and mid-cap companies of twenty-three world capital markets, namely Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States. Approximately 85% of the free float-adjusted market capitalisation of each country is captured by the MSCI World Index.

For the FTSE 100 Index and the MSCI World Index, I collect daily closing index, bid and ask prices, trading volume, number of shares traded and number of shares outstanding. All of the data has been obtained from the Bloomberg Terminal.

5.3.2 Methodology

Event Studies

In order to capture how the FTSE 100 has performed in terms of abnormal returns during the period from the Brexit referendum, June 23, 2016 until the transition period, January 31, 2020, I compute the daily average abnormal returns (AAR) for each of the twenty-four events. As the events overlap, I have considered the time period for the AARs as [-10,+10] as the long-run and [-5,+5] as the short run. The AARs can be calculated by using the CAPM as stated by Treynor (1961, 1962), Sharpe (1964) and Lintner (1965). However as mentioned by Fama and French (1993), the CAPM model has limitations; the most important of them being that the model shows a lack of compensating for the value premium for risk. Thus, following Zhang and Gregoriou (2020), I use the econometric market-adjusted model to calculate the abnormal returns:

$$AR_{i,t} = R_{i,t} - R_{m,t} \tag{5.1}$$

Where, $AR_{i,t}$ stands for the abnormal return of the FTSE 100 index i at time t. $R_{i,t}$ stands for the return of the FTSE 100 index i at time t and $R_{m,t}$ stands for the value-weighted market return (MSCI World Index) at time t.

Trading Volume Effects

In addition to the abnormal returns, I analyse the trading volume effects of each of the twenty-four events. Following Gregoriou (2015), I use a Post/Pre ratio of standardized trading volume in the post event period [+1,+10] to the standardized volume in the pre-event period [-1,-10].

Standardized trading volume is calculated by dividing daily trading volume of the FTSE 100 by the total trading volume of the MSCI World Index for the same day.

$$\text{Standardized Trading Volume} = \frac{Daily\ Trading\ Volume\ of\ FTSE\ 100}{Total\ Daily\ Trading\ Volume\ of\ MSCI\ World\ Index} \quad (5.2)$$

Liquidity Measures

In order to encapsulate the impact of liquidity due to the different events between the Brexit referendum, June 23, 2016, until the end of the transition period, December 31, 2020, I compute three different liquidity measures, namely, quoted, relative and effective spread on each of the twenty-four events.

Quoted Spread

The bid-ask spread represents the transaction cost of a trade. According to Demsetz (1968), the bid-ask spread is indicated as a foremost way to capture how liquid a stock is. Reported by Chordia et al. (2001), bid-ask spread is defined as the difference between the highest price a buyer is willing to pay for the asset and the lowest price the seller is willing to accept for it. The higher the bid-ask spread, the greater the cost of trade. This leads to low levels of liquidity in the stock market. The quoted spread is represented by the following equation:

$$QS_{i,t} = A_{i,t} - B_{i,t} \quad (5.3)$$

Where, $QS_{i,t}$ represents the quoted spread of the FTSE 100 index i at time period t. $A_{i,t}$ represents the ask price of the FTSE 100 index i at time t. $B_{i,t}$ denotes the bid price of the FTSE 100 index i at time period t.

Relative Spread

Even though the quoted spread is widely used as the basic and foremost method to capture the liquidity, as reported by Madhavan et al. (1997), in order to analyse the market price of liquidity risk, it is necessary to incorporate pre-trade and post-trade analysis. Thus, there are arguments that the quoted spread may not calculate the investor's trading costs. The relative spread however overcomes this disadvantage of the quoted spread. Hence, considering these and following Zhang and Gregoriou (2020), I compute the relative spread of the twenty-four events around 10 days pre- and post each event by using the following equation:

$$RS_{i,t} = \frac{Ai,t - Bi,t}{(Ai,t + Bi,t)/2} \tag{5.4}$$

Where $RS_{i,t}$ denotes the relative spread of the FTSE 100 index i at time period t and $A_{i,t}$ denotes the ask price of the FTSE 100 index i at time t. $B_{i,t}$ represents the bid price of the FTSE 100 index i at time period t.

Effective Spread

Although, the relative spread overcomes the shortcomings of the quoted spread, Lee and Ready (1991) states that the relative spread does not consider the price increase following a purchase and price decrease following a sale. Moreover, as mentioned by Gregoriou (2011), the relative spread is not a valid measure when the trade occurs between the bid and ask price. In my dataset, the trade occurs within the bid and ask price at approximately 92% of the time. Considering these, and following Gregoriou (2011), I also calculate the effective spread for the twenty-four events around 10 days pre-and post each event using the following equation:

$$ES_{i,t} = 2(C_{i,t} - (\frac{Ai,t + Bi,t}{2})) \tag{5.5}$$

Where, $ES_{i,t}$ denotes the effective spread of the FTSE 100 index i at time period t and $C_{i,t}$ represents the closing index i of the FTSE 100 at time period t. $A_{i,t}$ denotes the ask price of the FTSE 100 index i at time t. $B_{i,t}$ represents the bid price of the FTSE 100 index i at time period t.

Multivariate Regression

In order to further capture how the liquidity of the FTSE 100 has changed due to BREXIT, I, following Gregoriou (2011), construct a multivariate regression model of the quoted, relative and effective spread. I construct the model by representing the liquidity of the FTSE 100 index surrounding the twenty-four events from 24 June 2016 to 15 January 2021. This period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. For each event, a period of [-10,+10] has been computed to determine whether the liquidity of the FTSE 100 index has decreased when I encapsulate the trading volume, closing price and standard deviation of the index. The following regression model has been applied to each of the events:

$$Liquidity_{jt} = \alpha_j + \beta_1 D_t + \beta_2 Volume_{jt} + \beta_3 (Volume_{jt} * D_t) + \beta_4 Close_{jt} + \beta_5 StdDev_{jt} + \varepsilon_{jt} \quad (5.6)$$

for j = 1,24 (representing 24 events in the order respectively) and t = -10, +10

Where, the dependent variable, $Liquidity_{jt}$, represents Quoted Spread, Relative Spread and Effective Spread respectively for the FTSE 100 Index at time t. The constant, α_j, shows the variation in the liquidity ratios as per the index. D_t represents the dummy variable which is equal to 1 in the post event period, otherwise 0. Volume, Close and StdDev (Standard Deviation) represent the traded volume in shares, closing price and return volatility for the index at time period t for each trading day in the event window [-10, +10]. The coefficient, β_1 and β_3 captures the impact of BREXIT on the liquidity and trading volume.

5.4 Empirical Results

Abnormal Returns

Table 5.1 represents the mean of the average abnormal returns (AARs) of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. The AAR has been calculated using the market adjusted model. The t test represents the t-statistic which has been computed following the standard event study methodology. Panel A represents the short-term AARs for a period of [-5,+5] for each event and Panel B shows a long-term average of [-10,+10] AARs for each event. In Panel A, as I compare the average abnormal returns from event 1 to event 8, the percentage of negative returns and their significance level increase. For instance, at 5 days prior to event 1, the percentage of abnormal returns is -2.05% with a 1% significance level of -2.89. And, at 5 days prior to event 8, the percentage of abnormal returns is -14.42% with a 1% significant level of -31.10. On the other hand, when I compare 5 days post event 1, the percentage of abnormal returns is 3.62% with a significance level of 5.57 at 1 % significant level. And, at 5 days post event 8, the percentage of abnormal returns is -15.76% with a significance level of -33.98 at 1 % significant level. The Panel A also highlights that from event 6, there is a subsequent increase in negative returns (pre and post each events) with a simultaneous increase in the significance level. For instance, at 1 day post event 6, the percentage of negative return is -7.34% with a 1% significant level of -15.97. And, at 1 day post event 8, the percentage of negative return is -15.20% with a 1% significant level of -32.78. Overall if I consider an average of [-5,+5] for each event, I discover that the negative average abnormal returns increase with the significance levels. For instance, for event 1, the average abnormal returns for [-5,+5] is 1.39% with a significance level of 0.94. And for event 8, the average abnormal returns for [-5,+5] is -14.51% with a 1% significance level of -31.29.

As I move to compare from event 9 to event 16, I find that the percentage of negative returns decrease with a decrease in the significance level. For instance, if I consider the event 9 , the percentage of negative returns is -6.22% with a 1% significance level of -11.97. And at event 16, the percentage of negative returns is -5.91% with a 1% significance level of -9.74. The same pattern also holds when I average [-5,+5] from event 9 to event 16. At the average of [-5,+5], the percentage of negative returns at event 9 is -5.85% with a 1% significance level of -11.26 and, the percentage of negative returns at event 16 is -5.71% with a 1% significance level of -9.42.

As I move to the event period of 17 to 24, I observe some significant scenarios. The whole period shows consecutive negative returns pre and post -5 to +5 days for each event. The negative returns also generate statistically significant levels at the 1% level. The highest level of negative average abnormal returns has occurred for event 23 . During the event day at event 23, the percentage of negative returns is -27.21% with a t statistic of -27.03 at the 1% significant level. This has also been true when I compute an average of [-5,+5] for each event. During the [-5,+5] period, the average percentage of the negative return is -28.32% with a t statistic of -28.40 at 1% significant level.

In order to encapsulate how the average abnormal returns have performed for each event over a pre and post 10 days period, I compute averages for [-10,0], [0,+10] and [-10,+10] for each event and report in Panel B. Following the five days pre and post analysis, the results show a similar approach when I compare the events. For instance, during [-10,+10] average of event 1, the percentage of abnormal return is 1.69% with a t statistic of 1.92 at 5 % significant level which has decreased to -14.26% with a t statistic of -30.75 at 1% significant level at event 8. Again, when I compare the events from 9 to 16, I discover that at event 9, the percentage of negative returns at [-10,+10] period is -6.14% with a t statistic of -11.82 at 1% significant level. On the other hand, at event 16, the percentage of negative returns at [-10,+10] is -6.08% with a t statistic of -10.02. The events from 17 to 24 show ranges of consecutive negative average abnormal returns with event 23 being the highest. At event 23, during the average of [-10,+10] period, the percentage of negative returns is -28.58% with a t statistic of -28.40 at 1% significant level.

The table reports that since the referendum until the transition period, the percentage of negative average abnormal returns has increased with a strong increase in the t statistic. During the event 23, which comprised off of the UK internal and BREXIT deals, holds the highest percentage of the negative returns. My research is consistent with existing research that state that when political uncertainty prevails in the market, the volatility of the equity returns increase (see among others, Baker et al. (2016), Voth (2002), Mei and Guo (2004)).

Table 5.1. Abnormal Returns for the twenty-four events from the BREXIT referendum until the transition period

The following table represents the mean of the average abnormal returns (AARs) of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. The AAR has been calculated using the market model. The t test represents the t-statistic which has been computed following the standard event study methodology. Panel A represents the short-term AARs for a period of [-5,+5] for each event and Panel B shows a long-term average of [-10,+10] AARs for each event. The null hypothesis is that AAR is equal to unity. (***significance at 1%, **significance at 5% and * significance at 10%.)

Panel A: Short-term

	Event 1	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**	**Event 7**	**Event 8**
-5	-2.05%	3.27%	5.75%	4.83%	5.06%	-9.37%	-9.56%	-14.42%
T test	*-2.89****	*5.16****	*9.11****	*9.03****	*9.42****	*-20.39****	*-23.85****	*-31.10****
-4	-0.71%	2.76%	5.98%	5.03%	4.46%	-9.02%	-9.08%	-14.76%
T test	*-0.99*	*4.36****	*9.48****	*9.41****	*8.31****	*-19.65****	*-22.66****	*-31.83****
-3	-0.66%	3.09%	5.63%	4.92%	4.29%	-8.96%	-8.96%	-13.92%
T test	*-0.93*	*4.88****	*8.92****	*9.21****	*7.98****	*-19.52****	*-22.36****	*-30.01****
-2	-0.09%	4.35%	5.94%	4.40%	4.39%	-9.13%	-8.50%	-13.60%
T test	*-0.12*	*6.88****	*9.42****	*8.22****	*8.17****	*-19.87****	*-21.21****	*-29.32****
-1	-0.21%	3.77%	6.01%	4.27%	3.86%	-8.91%	-9.09%	-13.04%
T test	*-0.29*	*5.96****	*9.53****	*7.98****	*7.19****	*-19.39****	*-22.67****	*-28.12****
0	2.85%	5.24%	3.63%	4.75%	4.10%	-7.35%	-8.23%	-14.88%
T test	*1.19*	*8.29****	*5.75****	*8.88****	*7.63****	*-16.01****	*-20.52****	*-32.09****
1	2.71%	6.76%	3.31%	4.56%	4.10%	-7.34%	-7.80%	-15.20%
T test	*-0.20*	*10.69*	*5.57****	*8.53****	*7.64****	*-15.97****	*-19.47****	*-32.78****
2	2.99%	5.95%	3.49%	4.34%	3.88%	-7.39%	-7.90%	-15.43%
T test	*1.28*	*9.42****	*5.39****	*8.10****	*7.23****	*-16.10****	*-19.71****	*-33.27****
3	3.26%	5.64%	3.87%	4.12%	3.68%	-7.91%	-8.16%	-14.97%
T test	*3.13****	*8.92****	*5.25****	*7.70****	*6.86****	*-17.23****	*-20.35****	*-32.27****
4	3.62%	6.41%	3.67%	4.57%	3.36%	-7.51%	-8.03%	-13.64%
T test	*4.57****	*10.13****	*5.15****	*8.54****	*6.25****	*-16.35****	*-20.04****	*-29.42****
5	3.62%	6.62%	3.87%	4.94%	3.48%	-7.76%	-8.23%	-15.76%
T test	*5.57****	*10.47****	*5.14****	*9.24****	*6.48****	*-16.89****	*-20.53****	*-33.98****
[-5, +5]	1.39%	4.90%	4.65%	4.61%	4.06%	-8.24%	-8.50%	-14.51%
T test	*0.94*	*7.74****	*7.15****	*8.62****	*7.56****	*-17.94****	*-21.22****	*-31.29****

	Event 9	**Event 10**	**Event 11**	**Event 12**	**Event 13**	**Event 14**	**Event 15**	**Event 16**
-5	-6.56%	-5.99%	-6.36%	-6.48%	2.30%	2.39%	-1.56%	-6.14%
T test	*-12.62****	*-10.96****	*-11.57****	*-11.16****	*3.45****	*3.68****	*-2.51****	*-10.12****
-4	-6.53%	-5.54%	-6.68%	-6.02%	1.44%	2.63%	-1.78%	-6.05%
T test	*-12.56****	*-10.15****	*-12.16****	*-10.36****	*2.16****	*4.04****	*-2.86****	*-9.98****
-3	-6.90%	-5.17%	-6.58%	-5.63%	1.03%	2.39%	-1.58%	-6.01%
T test	*-13.28****	*-9.48****	*-11.98****	*-9.70****	*1.55*	*3.67****	*-2.54****	*-9.91****
-2	-5.71%	-5.42%	-7.08%	-4.83%	-0.01%	1.59%	-1.68%	-5.65%
T test	*-10.99****	*-9.92****	*-12.88****	*-8.31****	*-0.01*	*2.44****	*-2.70****	*-9.31****
-1	-6.38%	-5.80%	-7.18%	-4.56%	-0.23%	1.45%	-1.60%	-5.65%
T test	*-12.28****	*-10.63****	*-13.07****	*-7.86****	*-0.35*	*2.23***	*-2.56****	*-9.31****
0	-6.22%	-5.70%	-6.97%	-4.19%	0.97%	1.63%	-1.82%	-5.91%
T test	*-11.97****	*-10.44****	*-12.68****	*-7.21****	*1.45*	*2.51****	*-2.92****	*-9.74****
1	-4.65%	-6.83%	-7.37%	-3.97%	1.32%	1.45%	-1.73%	-5.75%
T test	*-8.94****	*-12.50****	*-13.41****	*-6.84****	*1.98*	*2.61****	*-2.78****	*-9.47****
2	-5.00%	-6.77%	-8.22%	-5.62%	0.67%	1.30%	-1.99%	-5.81%
T test	*-9.63****	*-12.40****	*-14.95****	*-9.68****	*1.01*	*2.60****	*-3.20****	*-9.58****
3	-5.12%	-6.01%	-7.77%	-5.49%	1.33%	0.86%	-2.00%	-5.28%
T test	*-9.85****	*-11.00****	*-14.14****	*-9.45****	*1.99*	*2.47****	*-3.21****	*-8.71****
4	-5.92%	-5.64%	-8.83%	-6.62%	1.12%	1.24%	-1.62%	-5.52%
T test	*-11.40****	*-10.32****	*-16.07****	*-11.40****	*1.68*	*2.35***	*-2.60****	*-9.09****
5	-5.37%	-5.34%	-8.96%	-6.80%	2.28%	1.67%	-1.56%	-5.07%
T test	*-10.34****	*-9.79****	*-16.32****	*-11.70****	*3.42****	*2.26***	*-2.50****	*-8.36****
[-5, +5]	-5.85%	-5.84%	-7.45%	-5.47%	1.11%	1.69%	-1.72%	-5.71%
T test	*-11.26****	*-10.69****	*-13.57****	*-9.42****	*1.67*	*2.81****	*-2.76***	*-9.42****

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
-5	-5.62%	-2.01%	-7.59%	-7.18%	-8.16%	-18.11%	-32.32%	-26.81%
T test	*-9.71****	*-3.41****	*-14.22****	*-15.15****	*-17.21****	*-19.14****	*-32.11****	*-24.51****
-4	-5.66%	-0.66%	-7.01%	-7.81%	-7.99%	-18.68%	-31.07%	-26.92%
T test	*-9.77****	*-1.13*	*-13.12****	*-16.46****	*-16.84****	*-19.74****	*-30.87****	*-24.61****
-3	-6.21%	-1.10%	-6.91%	-7.64%	-7.97%	-19.01%	-30.83%	-27.92%
T test	*-10.73****	*-1.87*	*-12.95****	*-16.10****	*-16.80****	*-20.08****	*-30.63****	*-25.52****
-2	-5.80%	-0.71%	-7.14%	-7.62%	-9.17%	-17.19%	-28.92%	-27.14%
T test	*-10.01****	*-1.20*	*-13.36****	*-16.06****	*-19.34****	*-18.16****	*-28.74****	*-24.81****
-1	-5.84%	-2.02%	-7.45%	-8.82%	-9.12%	-17.10%	-26.81%	-26.61%
T test	*-10.10****	*-3.43****	*-13.96****	*-18.59****	*-19.23****	*-18.07****	*-26.64****	*-24.32****
0	-6.35%	-3.53%	-5.40%	-8.77%	-9.03%	-19.09%	-27.21%	-27.11%
T test	*-10.96****	*-6.00****	*-10.12****	*-18.48****	*-19.05****	*-20.17****	*-27.03****	*-24.78****
1	-6.11%	-4.42%	-4.85%	-8.68%	-8.88%	-19.61%	-27.74%	-26.11%
T test	*-10.55****	*-7.51****	*-9.08****	*-18.30****	*-18.72****	*-20.73****	*-27.06****	*-24.71****
2	-4.41%	-2.14%	-4.30%	-8.53%	-9.25%	-19.07%	-27.22%	-25.98%
T test	*-7.62****	*-3.64****	*-8.06****	*-17.97****	*-19.50****	*-20.15****	*-27.19****	*-24.63****
3	-4.53%	-2.53%	-4.15%	-8.90%	-9.44%	-20.18%	-26.48%	-23.48%
T test	*-7.82****	*-4.30****	*-7.77****	*-18.75****	*-19.90****	*-21.33****	*-27.28****	*-24.14****
4	-4.56%	-2.83%	-4.12%	-9.09%	-9.43%	-19.90%	-26.68%	-24.55%
T test	*-7.87****	*-4.81****	*-7.72****	*-19.15****	*-19.89****	*-21.03****	*-27.36****	*-23.96****
5	-3.95%	-2.79%	-4.50%	-9.08%	-10.00%	-20.43%	-26.29%	-25.01%
T test	*-6.81****	*-4.74****	*-8.43****	*-19.14****	*-21.10****	*-21.60****	*-27.50****	*-23.73****
[-5, +5]	-5.37%	-2.25%	-5.77%	-8.37%	-8.95%	-18.94%	-28.32%	-26.15%
T test	*-9.27****	*-3.82****	*-10.80****	*-17.65****	*-18.87****	*-20.02****	*-28.40****	*-24.52****

Panel B: Long-term

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
[-10, 0]	0.95%	3.72%	4.42%	4.88%	4.57%	-7.58%	-8.58%	-14.37%
T test	1.33	5.88***	7.00***	9.12***	8.51***	-16.50***	-21.41***	-31.00***
[0, +10]	3.11%	6.52%	3.60%	4.87%	3.61%	-7.45%	-7.85%	-14.48%
T test	1.62	10.31***	5.71***	9.10***	6.72***	-16.23***	-19.58***	-31.23***
[-10, +10]	1.69%	5.11%	4.16%	4.88%	4.09%	-7.60%	-8.20%	-14.26%
T test	1.92**	8.09***	6.60***	9.12***	7.61***	-16.55***	-20.45***	-30.75***

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
[-10, 0]	-6.49%	-5.58%	-6.31%	-4.62%	1.48%	1.56%	-1.84%	-6.47%
T test	*-12.49****	*-10.22****	*-11.48****	*-7.95****	*2.22***	*2.39***	*-2.95***	*-10.67****
[0, +10]	-5.80%	-6.31%	-8.58%	-5.12%	1.80%	1.58%	-1.74%	-5.64%
T test	*-11.16****	*-11.56****	*-15.62****	*-8.82****	*2.69***	*2.43***	*-2.80***	*-9.30****
[-10, +10]	-6.14%	-5.96%	-7.47%	-5.08%	1.67%	1.55%	-1.79%	-6.08%
T test	*-11.82****	*-10.91****	*-13.59****	*-8.75****	*2.50***	*2.39***	*-2.87****	*-10.02****

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
[-10, 0]	-6.10%	-2.97%	-6.19%	-7.84%	-8.34%	-18.20%	-28.29%	-26.67%
T test	*-10.54****	*-5.04****	*-11.59****	*-16.52****	*-17.60****	*-19.24****	*-28.11****	*-24.38****
[0, +10]	-5.52%	-4.01%	-4.99%	-9.28%	-9.76%	-20.72%	-28.00%	-26.11%
T test	*-9.54****	*-6.82****	*-9.35****	*-19.55****	*-20.59****	*-21.90****	*-27.82****	*-23.86****
[-10, +10]	-5.74%	-3.47%	-5.64%	-8.55%	-9.05%	-19.48%	-28.58%	-26.20%
T test	*-9.92****	*-5.90****	*-10.55****	*-18.02****	*-19.09****	*-20.58****	*-28.40****	*-23.95****

Trading Volume

The table 5.2 represents the standardized trading volume of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. The standardized trading volume has been computed by dividing the daily volume of the FTSE 100 by the daily volume of the MSCI World Index. The table reports the standardized trading volume for a period of [-10,+10] for each of the twenty-four events. The t test is constructed to assume that the standardized trading volume is unchanged in the post event period compared to the pre-event period. When I compare the events from 1 to 8, I observe that the mean (median) of event 1 is 0.89 (1.13) with a t statistic of -11.86 at 1% significant level which is 1.81 (0.53) at event 8 at the t statistic of 81.53 at 1 % significant level. When I compare the events from 9 to event 16, the mean (median) of event 9 is 1.06 (0.94) with a t statistic of 7.82 at 1% significant level which increases to 1.22 (0.82) at event 16 with a t statistic of 26.96 at 1 % significant level. Lastly, when I compare from event 17 to event 24, the mean (median) of event 17 is 1.10 (0.90) with a t statistic of 9.84 at 1 % significant level which decreases to 0.92 (1.13) at event 24 with a t statistic of -6.47 at 1 % significant level. As I compare the events, I observe that from the referendum until the transition period, overall the trading volume has decreased with the post/pre ratio being lower than 1. The decreasing trading volume signals a fall in liquidity of the FTSE 100 index.

Table 5.2: Trading Volume for the twenty-four events from the BREXIT referendum until the transition period

The following table represents the standardized trading volume of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. The standardized trading volume has been computed by dividing the daily volume of the FTSE 100 by the daily volume of the MSCI World Index. The table shows the standardized trading volume for a period of [-10,+10] period for each of the twenty four events. The t test is constructed to assume that the standardized trading volume is unchanged in the post event period compared to the pre event period. (***significance at 1%, **significance at 5% and * significance at 10%.)

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
Mean (Pre-event)	0.09	0.23	0.25	0.25	0.25	0.29	0.24	0.26
Mean (Post-event)	0.08	0.27	0.22	0.23	0.26	0.27	0.19	0.46
Median (Pre-event)	0.09	0.22	0.25	0.24	0.26	0.29	0.23	0.25
Median (Post-event)	0.08	0.24	0.22	0.23	0.26	0.25	0.21	0.26
Mean (Post/Pre Ratio)	0.89	1.17	0.86	0.93	1.06	0.92	0.80	1.81
Median (Pre/Post Ratio)	1.13	0.84	1.14	1.05	0.99	1.08	1.23	0.53
T Test	-11.86***	10.63***	-10.35***	-7.02***	1.52***	-6.54***	-22.50***	81.53***

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
Mean (Pre-event)	0.26	0.26	0.25	0.23	0.23	0.24	0.25	0.23
Mean (Post-event)	0.27	0.26	0.22	0.26	0.22	0.23	0.39	0.28
Median (Pre-event)	0.26	0.26	0.25	0.21	0.23	0.25	0.24	0.23
Median (Post-event)	0.26	0.26	0.24	0.26	0.22	0.22	0.23	0.25
Mean (Post/Pre Ratio)	1.06	0.99	0.89	1.13	0.98	0.93	1.60	1.22
Median (Pre/Post Ratio)	0.94	1.00	1.09	0.82	1.02	1.09	0.60	0.82
T Test	7.82***	-0.73***	-9.77***	10.19***	-3.14***	-7.14***	48.29***	26.96***

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
Mean (Pre-event)	0.24	0.27	0.27	0.23	0.22	0.24	0.22	0.29
Mean (Post-event)	0.27	0.21	6.25	0.22	0.22	0.25	0.28	0.27
Median (Pre-event)	0.24	0.27	0.27	0.22	0.22	0.24	0.23	0.30
Median (Post-event)	0.27	0.21	0.22	0.22	0.22	0.24	0.29	0.25
Mean (Post/Pre Ratio)	1.10	0.77	22.93	0.97	1.00	1.05	1.31	0.92
Median (Pre/Post Ratio)	0.90	1.28	0.04	1.01	0.97	0.96	0.82	1.13
T Test	9.84***	-15.64***	1798.38***	-2.78***	0.37***	4.60***	7.75***	-6.47***

Liquidity Measures

The table 5.3 represents the average of the effective spread surrounding the twenty-four events of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. The average of the quoted and relative spreads are reported in the appendix. For each spread, Panel A describes the spreads for a period of [-5,+5] period and Panel B describes the average spreads for a period of [-10,+10].

Panel A of the table 5.3 highlights that the effective spread decreases first and then increases with the events closer to the transition period. For instance, during the average of the spread at [-5,+5] for event 1, the effective spread is 20.18 with a t statistic of 2.58 at 1 % significant level which decreases to -9.74 with a t statistic of -1.91 at 5% significant level at event 8. The effective spread for the same period at event 9 is -8.67 with a t statistic of -1.76 which increases to 8.34 with a t statistic of 1.66 at event 16. As I compare the spread for the same period from event 17 to 24, I observe that the spread at event 17 is -0.08 with a t statistic is 0.13 which tend to increase to 16 with a t statistic of 1.22 at event 24.

The Panel B of the effective spread of table 5.3 describes a similar pattern. As I compare the spreads for the period of [-10,+10], it decreases first and then tend to increase. For instance during the [-10,+10] period, for event 1, the spread is 2.45 with a t statistic of 0.45 at 1 % significant level which decreases to -2.38 with a t statistic of -0.42 at 1 % significant level at event 8. As I compare from event 9 to event 16, the spread at event 9 is -5.31 with a t statistic of -1.12 at 1 % significant level which increases to -0.21 with a t statistic of 0.30 at 1 % significant level at event 16. Moreover, when I compare the spread from event 17 to event 24, the spread at event 17 is -9.01 with a t statistic of -1.36 at 1 % significant level which increases to 1.17 with a t statistic of 0.09 at 1 % significant level at event 24.

The results of the quoted and relative bid-ask spread over the sample period are reported in the appendix part of the thesis. The results are similar to that of the effective spread and therefore, are not reported in order to save space.

Overall, I observe that during the days post the BREXIT referendum, the market participants tend to face a loss in liquidity with an increase in spread. As I move past the referendum, the market absorbs the shock and the spreads tend to decrease. However, as I approach to the transition period, the market again faces a panic-stricken environment which tend to increase the spread and decrease in the liquidity.

Table 5.3. Liquidity Measures for the twenty-four events from the BREXIT referendum until the transition period

The following table represents the average of the quoted, relative and effective spread surrounding the twenty events of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. For each spread, Panel A describes the spreads for a period of [-5,+5] period and Panel B describes the average for a period of [-10,+10]. Quoted Spread is calculated as the difference between ask and bid. Relative Spread is calculated as ask minus bid divided by the midpoint of the bid-ask spread. Effective Spread is calculated as the twice the closing index minus average of the ask and bid. The ratios are tested using a standard t-test with a null hypothesis stating that the mean of the reported ratio is equal to unity. Two tailed tests of significance are reported as(***significance at 1%, **significance at 5% and * significance at 10% level).

$$ES_{i,t} = 2(C_{i,t} - (\frac{A_{i,t} + B_{i,t}}{2}))$$

Effective Spread

Panel A: Period covering [-5,+5]

	Event 1	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**	**Event 7**	**Event 8**
-5	37.43	-43.50	14.03	-17.64	4.74	-31.87	-23.40	6.99
T test	*4.65****	*-5.70****	*1.33*	*-3.18****	*0.26*	*-6.37****	*-5.55****	*1.48*
-4	86.68	-11.29	-2.17	18.45	-21.68	17.72	5.20	10.84
T test	*10.57****	*-1.65*	*-0.76*	*2.32***	*-3.92****	*3.27****	*0.85*	*2.27***
-3	23.02	10.69	6.79	-0.35	-20.04	12.94	-23.39	-17.80
T test	*2.92****	*1.11*	*0.40*	*-0.54*	*-3.66****	*2.34***	*-5.55****	*-3.55****
-2	-3.99	23.66	23.32	-4.27	0.66	2.18	19.51	-32.95
T test	*-0.33*	*2.74****	*2.52****	*-1.14*	*-0.38*	*0.25*	*4.05****	*-6.63****
-1	26.38	42.00	-10.66	26.67	-36.58	-10.87	-22.97	-19.50
T test	*3.32****	*5.05****	*-1.85*	*3.57****	*-6.27****	*-2.29***	*-5.45****	*-3.90****
0	22.21	46.97	-12.59	29.63	-0.50	8.31	30.47	-7.40
T test	*2.82****	*5.67****	*-2.10***	*4.03****	*-0.57*	*1.44*	*6.49****	*-1.44*
1	-40.76	17.80	22.23	9.10	-46.37	-1.87	24.06	0.22
T test	*-4.74****	*2.00***	*2.38***	*0.90*	*-7.82****	*-0.54*	*5.06****	*0.11*
2	26.80	-21.34	-14.60	-21.39	-2.07	4.77	-6.49	-2.49
T test	*3.38****	*-2.91****	*-2.36***	*-3.75****	*-0.81*	*0.75*	*-1.77*	*-0.44*
3	14.10	-27.07	-0.73	-32.37	15.24	-34.58	-24.36	-30.33
T test	*1.85*	*-3.63****	*-0.57*	*-5.43****	*1.92*	*-6.90****	*-5.76****	*-6.10****
4	14.47	-5.30	16.78	18.71	5.88	24.19	28.77	11.72
T test	*1.89*	*-0.90*	*1.68*	*2.36***	*0.44*	*4.52****	*6.12****	*2.45***
5	15.63	29.69	18.46	-7.88	-7.28	1.36	25.41	-26.42
T test	*2.03****	*3.50****	*1.90*	*-1.69*	*-1.64*	*0.09*	*5.36****	*-5.30****
[-5, +5]	20.18	5.66	5.53	1.70	-9.82	-0.70	2.98	-9.74
T test	*2.58****	*0.48*	*0.23*	*-0.23*	*-2.04***	*-0.31*	*0.35*	*-1.91***

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
-5	9.70	14.51	27.59	29.37	-23.75	1.24	22.10	44.40
T test	*1.76*	*2.55****	*4.81****	*4.95****	*-3.15****	*0.38*	*3.61****	*7.41****
-4	-25.46	21.30	13.07	-0.55	-26.45	-8.22	7.68	27.85
T test	*-4.98****	*3.75****	*2.23***	*0.07*	*-3.55****	*-1.06*	*1.37*	*4.77****
-3	-57.88	2.37	5.04	-5.50	-8.22	-15.05	15.96	45.71
T test	*-11.19****	*0.40*	*0.81*	*-0.74*	*-0.85*	*-2.09***	*2.66****	*7.62****
-2	64.95	13.52	-10.04	-76.90	-23.07	-11.32	11.34	17.91
T test	*12.35****	*2.38****	*-1.86*	*-12.38****	*-3.05****	*-1.53*	*1.94***	*3.19****
-1	-87.25	-1.92	3.47	-2.01	-27.91	23.38	-21.03	-8.02
T test	*-16.82****	*-0.35*	*0.53*	*-0.17*	*-3.76****	*3.73****	*-3.09****	*-0.95*
0	-1.28	14.61	-18.38	-2.78	32.71	9.31	-2.35	-24.58
T test	*-0.35*	*2.57****	*-3.34****	*-0.29*	*5.21****	*1.60*	*-0.19*	*-3.59****
1	51.74	-18.33	5.22	2.12	42.51	-74.25	9.47	11.78
T test	*9.81****	*-3.26****	*0.84*	*0.51*	*6.67****	*-11.07****	*1.65*	*2.21***
2	10.52	0.82	5.22	-17.41	-8.05	-7.13	8.64	11.78
T test	*1.91*	*0.13*	*0.84*	*-2.68****	*-0.82*	*-0.89*	*1.52*	*2.21***
3	-17.98	14.55	14.77	-6.41	25.21	2.86	5.52	-16.18
T test	*-3.55****	*2.56****	*2.53****	*-0.89*	*4.10****	*0.62*	*1.03*	*-2.25***
4	-47.54	13.80	-29.41	-25.53	10.21	1.20	12.56	-33.07
T test	*-9.21*	*2.43***	*-5.29****	*-4.00****	*1.88*	*0.37*	*2.13***	*-4.95****
5	5.08***	6.24	-11.97	-3.12	71.15	4.45	5.83	14.20
T test	*0.87*	*1.09*	*-2.20***	*-0.35*	*10.91***	*0.86*	*1.08*	*2.60****
[-5, +5]	-8.67	7.41	0.42	-9.88	5.85	-6.68	6.88	8.34
T test	*-1.76*	*1.30*	*-0.01*	*-1.45*	*1.24*	*-0.83*	*1.25*	*1.66*

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
-5	20.47	18.04	-22.28	18.20	-89.27	24.49	20.63	-16.64
T test	*3.57****	*3.10****	*-4.02****	*2.71****	*-15.58****	*1.99***	*1.58*	*-1.26*
-4	-12.68	34.95	54.99	-89.27	30.85	-108.40	-75.23	-34.83
T test	*-1.97***	*5.74****	*8.77****	*-15.55***	*4.88****	*-8.63****	*-5.90****	*-2.65***
-3	-17.39	-13.24	2.63	30.85	-4.67	56.72	-46.81	-9.68
T test	*-2.76****	*-1.79*	*0.10*	*4.86****	*-1.17*	*4.57****	*-3.69****	*-0.73*
-2	-0.18	-33.88	22.67	-4.67	-40.55	-49.70	69.33	37.53
T test	*0.12*	*-5.02****	*3.42****	*-1.18*	*-7.28****	*-3.94****	*5.38****	*2.85****
-1	-3.61	-122.89	-7.77	-40.55	-58.66	42.30	6.54	41.09
T test	*-0.46*	*-18.93****	*-1.62*	*-7.27****	*-10.37****	*3.41****	*0.48*	*3.13****
0	-8.61	10.15	27.53	-58.66	1.79	-22.26	-3.27	-13.96
T test	*-1.29*	*1.86*	*4.22****	*-10.35****	*-0.07*	*-1.75*	*-0.29*	*-1.06*
1	27.74	6.21	3.51	1.79	61.45	16.82	47.98	2.05
T test	*4.78****	*1.25*	*0.25*	*-0.08*	*10.09****	*1.38*	*3.72****	*0.16*
2	52.06	25.03	30.83	61.45	21.82	32.91	12.57	39.67
T test	*8.85****	*4.19****	*4.77****	*10.06****	*3.34****	*2.66****	*0.95*	*3.02****
3	-40.81	-43.07	15.22	21.82	-4.80	-46.01	18.46	109.02
T test	*-6.68****	*-6.46****	*2.19***	*3.33****	*-1.19*	*-3.64****	*1.41*	*8.29****
4	-28.84	28.06	15.22	-4.80	-7.14	58.71	-7.48	10.22
T test	*-4.68****	*4.66****	*2.19***	*-1.20*	*-1.59*	*4.72****	*-0.62*	*0.78*
5	10.92	23.87	15.22	-7.14	1.18	-46.50	13.48	11.52
T test	*1.97***	*4.01****	*2.19***	*-1.60*	*-0.17*	*-3.68****	*1.02*	*0.88*
[-5, +5]	-0.08	-6.07	14.34	-6.45	-8.00	-3.72	5.11	16.00
T test	*0.13*	*-0.67*	*2.04****	*-1.48*	*-1.74*	*-0.26*	*0.37*	*1.22*

Effective Spread

Panel B: Period covering [-10,+10]

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
0	22.21	46.97	-12.59	29.63	-0.50	8.31	30.47	-7.40
T test	*2.82****	*5.67****	*-2.10****	*4.03****	*-0.57*	*1.44*	*6.49****	*-1.44*
[-1,+1]	18.54	35.59	-10.14	21.80	-8.70	7.04	15.51	-7.72
T test	*2.38***	*4.24****	*-1.78***	*2.83****	*-1.86*	*1.19*	*3.15****	*-1.50*
[-2,+2]	17.74	21.82	-8.44	7.95	-7.37	6.75	12.51	-8.97
T test	*2.29****	*2.51****	*-1.56*	*0.72*	*-1.65*	*1.13*	*2.48****	*-1.76*
[-10,+10]	2.45	1.81	-0.85	2.13	-6.37	3.13	1.34	-2.38
T test	*0.45*	*-0.01*	*-0.59*	*-0.17*	*-1.49*	*0.43*	*-0.02*	*-0.42*

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
0	-1.28	14.61	-18.38	-2.78	32.71	9.31	-2.35	-24.58
T test	*-0.35*	*2.57****	*-3.34****	*-0.29*	*5.21****	*1.60*	*-0.19*	*-3.59****
[-1,+1]	-12.26	-1.88	-3.23	-2.27	15.77	1.59	-4.64	-14.00
T test	*-2.45****	*-0.35*	*-0.66*	*-0.21*	*2.70****	*0.43*	*-0.54*	*-1.90*
[-2,+2]	7.74	1.74	-2.90	-9.17	6.06	-0.38	-0.64	-5.76
T test	*1.38*	*0.29*	*-0.60*	*-1.34*	*1.27*	*0.13*	*0.08*	*-0.59*
[-10,+10]	-5.31	-0.06	-10.49	-15.03	4.12	3.95	8.67	-0.21
T test	*-1.12*	*-0.03*	*-1.94***	*-2.29****	*0.98*	*0.79*	*1.52*	*0.30*

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
0	-8.61	10.15	27.53	-58.66	1.79	-22.26	-3.27	-13.96
T test	*-1.29*	*1.86*	*4.22****	*-10.35****	*-0.07*	*-1.75*	*-0.29*	*-1.06*
[-1,+1]	-0.34	3.30	20.11	-32.47	1.53	12.29	-0.06	-6.06
T test	*0.09*	*0.79*	*3.00****	*-5.90****	*-0.11*	*1.01*	*-0.04*	*-0.46*
[-2,+2]	7.17	2.60	21.44	-8.13	-2.83	4.01	3.85	2.06
T test	*1.34*	*0.68*	*3.22****	*-1.76*	*-0.86*	*0.35*	*0.27*	*0.16*
[-10,+10]	-9.01	4.38	6.09	-5.53	-6.75	1.39	-4.42	1.17
T test	*-1.36*	*0.96*	*0.68*	*-1.32*	*-1.52*	*0.14*	*-0.38*	*0.09*

Multivariate Regression

In order to further capture how the liquidity of the FTSE 100 has performed over the period from the BREXIT referendum until the transition period, I encapsulate the factors such as trading volume, closing index and standard deviation in a multivariate regression for each of the twenty-four events and for each of the liquidity measures. The results are represented in Table 5.4. When I compare the events , I observe that the coefficient of the dummy variable β_1 is negative for most of the events for the three spreads. The coefficient further decreases as the markets move from the referendum and increases as the market approaches the transition period. This reports that the spread has increased, and the liquidity of the FTSE 100 index has reduced during the sample period.

Table 5.4 represents the multivariate regression of the effective spread. The results of the quoted and relative bid-ask spread can be seen in the appendix. The results are similar to that of the effective spread and therefore, are not reported in order to save space.

Table 5.4. Multivariate Regression for the twenty-four events from the BREXIT referendum until the transition period

The following table represents the multivariate regression of the effective spread surrounding the twenty events of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. For each event, a period of [-10,+10] has been computed to determine whether the liquidity of the FTSE 100 index has decreased when we encapsulate the volume, closing index and standard deviation of the index. The following regression model has been applied on each of the events

$Liquidity_{jt} = \alpha_j + \beta_1 D_t + \beta_2 Volume_{jt} + \beta_3 (Volume_{jt} * D_t) + \beta_4 Close_{jt} + \beta_5 StdDev_{jt} + \varepsilon_{jt}$ for j = 1,24 (representing 24 events in the order respectively) and t = -10, +10

Where, the dependent variable, $Liquidity_{jt,}$ represents Quoted Spread, Relative Spread and Effective Spread respectively for the FTSE 100 Index at time t. The constant, α_j, shows the variation in the liquidity ratios as per the index. D_t represents the dummy variable which is equal to 1 in the post event period, otherwise 0. Volume, Close and StdDev (Standard Deviation) represent the traded volume in shares, closing index and return volatility for the index at time period t for each trading day in the event window [-10, +10]. The coefficient, β_1 and β_3 captures the impact of the pandemic on the liquidity as well as on the volume and is of main concern. (***significance at 1%, **significance at 5% and * significance at 10%.)

Effective Spread

Var	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
C	-1036.27	-1646.12	-235.75	-1666.10	-959.90	-292.79	-1428.28	-980.65
T test	*-2.26****	*-1.54*	*-0.64*	*-1.70*	*-1.29*	*-0.43*	*-1.59*	*-1.26*
β1	19.25	26.33	-27.98	27.65	86.96	-53.50	-90.95	155.50
T test	*0.21*	*0.37*	*-0.64*	*0.44*	*2.20****	*-1.39*	*-2.26****	*1.68*
β2	0.15	0.04	0.02	-0.01	-0.01	-0.03	-0.05	0.01
T test	*1.78*	*0.86*	*0.87*	*-0.55*	*-1.48*	*-1.16*	*-1.65*	*0.26*
β3	-0.09	-0.06	0.02	-0.02	-0.06	0.04	0.08	-0.11
T test	*-0.99*	*-1.10*	*0.55*	*-0.45*	*-2.00****	*1.24*	*2.51****	*-1.46*
β4	0.26	0.42	0.05	0.41	0.23	0.08	0.36	0.24
T test	*2.01*	*1.48*	*0.58*	*1.69*	*1.31*	*0.49*	*1.64*	*1.25*
β5	-139.90	2582.97	-86.26	6117.35	239.23	-500.18	3315.94	2747.67
T test	*-0.04*	*1.21*	*-0.04*	*1.76*	*0.11*	*-0.15*	*1.05*	*0.86*

Var	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
C	-3287.47	-2170.83	-284.66	-563.55	-667.12	-1278.28	-222.44	-1607.02
T test	*-3.75****	*-2.32****	*-0.46*	*-0.87*	*-0.99*	*-1.94*	*-0.65*	*-1.35*
β_1	-43.91	116.21	-26.91	-0.45	34.99	29.48	18.77	-61.18
T test	*-0.85*	*1.64*	*-0.48*	*0.00*	*0.37*	*0.32*	*0.30*	*-0.50*
β_2	-0.06	0.06	-0.07	0.03	0.04	0.03	0.04	-0.13
T test	*-2.19****	*0.89*	*-1.21*	*0.53*	*0.52*	*0.57*	*0.85*	*-1.15*
β_3	0.07	-0.11	0.03	0.01	-0.04	-0.05	-0.02	0.08
T test	*1.58*	*-1.58*	*0.47*	*0.10*	*-0.44*	*-0.51*	*-0.36*	*0.65*
β_4	0.78	0.50	0.08	0.13	0.16	0.31	0.05	0.43
T test	*3.78****	*2.30****	*0.57*	*0.81*	*0.91*	*1.89*	*0.55*	*1.49*
β_5	3959.10	-1488.00	-1658.05	-669.84	3697.78	-1604.23	2280.34	3876.71
T test	*1.35*	*-0.71*	*-0.63*	*-0.33*	*1.30*	*-0.54*	*1.01*	*1.12*

Var	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
C	21.25	-2266.44	757.35	-1620.79	-1740.08	-1717.89	-1215.26	-15.72
T test	0.05	-2.72***	0.69	-2.25***	-2.02***	-1.63	-1.49	-0.03
β_1	273.56	-70.66	-53.76	33.69	78.28	-9.04	-82.88	-162.74
T test	1.94	-0.76	-0.79	0.28	0.91	-0.10	-0.66	-2.25***
β_2	0.07	-0.01	-0.10	-0.01	0.01	0.03	-0.03	-0.06
T test	0.46	-0.46	-1.20	-0.12	0.70	0.85	-0.80	-1.63
β_3	-0.26	0.08	0.10	0.00	-0.01	0.04	0.10	0.15
T test	-1.59	0.81	1.22	-0.03	-0.57	0.45	0.81	2.06***
β_4	-0.02	0.56	-0.16	0.38	0.40	0.49	0.36	0.02
T test	-0.21	2.73***	-0.63	2.36***	2.06***	1.60	1.50	0.14
β_5	893.30	-3460.17	-4071.29	-1184.63	-1680.42	-4644.43	2845.68	1414.88
T test	0.43	-1.28	-1.02	-0.40	-0.67	-1.72	1.55	0.70

4.5 Summary

I study the events from the BREXIT referendum until the transition period to capture the liquidity effect on the FTSE 100 index. As the events were overlapping, hence I have grouped them into twenty-four major events and created a 10 pre and post day period around each event. My findings clearly stand out that the liquidity of the FTSE 100 index has decreased during the BREXIT period. The abnormal returns and the trading volume have also decreased.

Specifically, my research shows that the market experiences a shock as a decrease in liquidity during the BREXIT referendum until the transition period. The liquidity increases for a slight change and then decreases as the market approaches to the transition period. The results hold true even if I take other exogeneous factors into account. The market has also experienced negative abnormal returns throughout the period.

My findings would help the market makers as well as the policy makers to establish a portfolio to reduce the losses during the political announcements.

Conclusion

One of the most prominent and discussed issues in financial markets is the liquidity of the stock exchanges and its various segments. Noteworthy research has been conducted in order to capture the true definition and method of calculating liquidity. Among these, mentionable studies include Amihud and Mendelson (1986a), Amihud (2002), Hasbrouck (2009) and Le and Gregoriou (2020). Considering all of these, it can be concluded that as liquidity involves its aspects into the quantity of trade, trading time, and price impact, it is difficult to attain a single persistent measure to calculate liquidity for all markets.

There shows a substantial previous literature on capturing liquidity due to financial crisis (Liu, (2006), Lesmond (2005)), news (Lakhal (2008), Tabibian et al. (2020)) and political instability (Dash et al. (2019). These research papers show that the liquidity of the capital markets have been affected due to noise and information. The information asymmetry theory states that the specialists require liquidity premium in order to trade with the informed traders (Demsetz, 1968). These noises create information asymmetry in the capital markets which increases the liquidity premium for holding and ordering costs. Thus, the market participants increase the bid-ask spread.

A significant number of research has been conducted when the recent pandemic, COVID-19, has raised a concern (see among others, Tiwari et al (2022)), Priscilla et al (2022)). This research has attempted to capture how the liquidity of capital has been impacted due to COVID-19. However, there is a lack of research which demonstrates how the liquidity has been impacted both in the short and long term as a comparison in a single paper. My first empirical chapter of the thesis fills this gap, while incorporating both the short-term measure of spread and the long-term measure of the price impact ratios in a single paper to capture the liquidity effects of the USA, UK, Brazil, China, Germany, and Spain. The WHO declared COVID-19 as a pandemic on March 11, 2020. I study a 60 pre and post period of March 11, 2020 to capture the liquidity effect. I report that during the pandemic the impact upon returns and trading volume was the greatest for European and Latin American, as measured by respective indices. When I estimate relative spreads, I observe that in all equity markets a decrease in liquidity was observed following the pandemic. The exception is China, where the liquidity effect disappears from 10 to 60 days, post the announcement of the pandemic but as noted above, in relation to the scale of its economy and absolute size, its share capitalisation is less than Japan and one-tenth that of the United States. Using price impact ratios, however, to capture long run financial stability and eliminate size bias, I have also discovered that China alone exhibits long run liquidity issues. According to my results, the pandemic caused a short-term loss in liquidity, observed by a significant impact upon bid-ask spreads. When I look at long run financial stability, however, through price impact ratios, only China is affected by the impact of COVID-19. Moreover, when I decompose the spread, it shows that the adverse selection component was more important for all indices except China. This proves my first hypothesis that COVID-19 has significant impact on the liquidity of the indices.

The literature also shows a gap in capturing the liquidity effect of the pandemic on the tourism industry. In my second empirical chapter, I study that how COVID-19 has affected the liquidity of the UK, Europe, and Spain by analysing forty-nine different companies of the tourism sector of the FTSE ALL Share Index, EURONEXT 100 and the IBEX 35 index. I use 60 days pre and post period around the March 11, 2020 period to study the short term effect by spread and the long term effect by the price impact ratios. In the short run the pandemic has a significant negative stock market reaction in the UK and Spain. This is also true for the European equity markets, but only at the 10% significant level. When I examine the stock market reaction for up to three months post the announcement date, the impact of the pandemic has disappeared for the UK, Europe and Spain with respect to abnormal returns. When I observe the influence of COVID on stock market liquidity, I obtain more interesting results. I find a significant decline in liquidity as a result of the pandemic regardless of the liquidity measure that we employ to undertake our empirical analysis. The decline in liquidity occurs in the short run and continues to persist in the long run. Finally, I analyze if the decline in liquidity still exists for the tourism industry as a result of the pandemic once I account for the effect of stock prices, trading volume and volatility. I find that if I use the RtoTR liquidity measure that liquidity of the tourism industry significantly decreases due to COVID-19, for the UK European and Spanish capital markets. This result shows the importance of encapsulating the impact of firm size and stock turnover when we attempt to measure liquidity in financial markets. This implies that liquidity has decreased due to the pandemic for the UK, European and Spanish equity markets. This is because RtoTR is an illiquidity ratio, implying that an increase represents a fall in liquidity. This result holds when I account for the influence of trading volume, stock prices and volatility. My findings suggest that European equity markets have declined in efficiency due to the pandemic in the tourism industry. The effect of the pandemic has fundamental implications for all tourism stakeholders. Economic viability of the tourism sector should be set high in the agenda of governmental policies since its multiple social and economic contribution. Recovery for the industry needs to be aligned with the release of strict governmental regulations, so tourism firms have flexibility in their financial decisions and actions that can ensure viability (Sharma and Nicolau (2020); Qiu et al (2020)).

The literatures further shows a gap in capturing the liquidity of capital markets due to BREXIT. Previous research, Cox and Griffith (2018) shows the liquidity effect of the BREXIT referendum on the NYSE. I study the twenty-four events from the BREXIT referendum until the transition period to capture the liquidity effect on the FTSE 100 index. I create a 10 days pre and post study period around each event. I report that the liquidity decreases around the referendum, improves slightly as the referendum has been absorbed and then decreases again close to the transition period. When I analyse the abnormal returns and the trading volume, I discover that there shows significant negative abnormal returns and trading volume effects. This proved my third hypothesis that the liquidity of the FTSE 100 has decreased due to BREXIT.

The contribution of the thesis to the literature can be divided into many ways. In this thesis, I study the two most recent environmental and political noise in the stock market which have severely impacted the liquidity. In my first empirical chapter, I am the only study that represents the impact on the equity indices by showing a comparative analysis in a time-series model. Previous researchers have tried to capture the short-term effect (Yaseen and Omet (2021), Mdaghri et al. (2020)) or the long term effect (Umar et al. (2022), Priscilla et al. (2022), Just and Echaust, (2020)). I am the first to study the effect as an event-study methodology by creating a 60 days pre and post pandemic announcement event period. Tiwari et al. (2019) capture the long term and short-term effect using wavelet methodology. By studying an event-study method, my research can point out that on what period the COVID-19 effect has been absorbed by the market, which can be used as a proxy for an investor to structure the portfolio and select stocks depending on the period for future pandemics. My research is the only study which has decomposed the spread using the Huang and Stoll (1997) model. No other previous research has been done on capturing the information asymmetry and the adverse selection costs due to COVID-19.

Following previous research, it can also be observed that due to the locked down measures of the governments during COVID-19, the tourism industry has been severely impacted as it was impossible to control transmission of the virus without controlling travel. Hence, there has been substantial research on the impact of COVID-19 to the tourism industry. Wu et al. (2021) shows the effect as per economic terms and Fotiadis et al. (2020) shows the effect on data mining terms. My research contributes as the first study to encapsulate the short term and long-term effects of COVID-19 on the liquidity of the European tourism industry.

As a further contribution, I am the first to study the liquidity effects of the events from the BREXIT referendum until the transition period. Previous research has been conducted on other political events (see among other, Mbanyele (2023), Kwabi et al. (2023)) and on the BREXIT referendum itself (Cox and Griffith (2008), Reenem (2016), Carreras et al. (2019)).

My research provides evidence of the information cost/ liquidity hypothesis in stating that the during the crisis period such as the pandemic and the political instability, there exists information asymmetry in the capital markets. During crisis period, the specialists require liquidity premium in order to compensate trading with the informed investors. My research shows that during crisis period, this information asymmetry arises in the capital markets increasing illiquidity.

The findings of my research are very useful in determining how to construct a portfolio when events such as the pandemic and political noises arise. As soon as any signals of crisis arise, the investors can shuffle their portfolio based on the liquidity aspects of my research. From a policy point of view, my research can be used to determine the sectors and markets to target for liquidity injection.

As a further extension of the work, I would like to expand the research in different markets, specially comparing a significant number of developed, developing and emerging markets in order to obtain a further gasp on how the liquidity has been impacted due to COVID-19. Also, I would like to expand my research with an increasing time frame, which can lead to further implications of how long the pandemic effect has been observed. Second, I would like to expand my research in determining how other sectors has been affected due to the pandemic. Third, I would like to continue my research in trying to validate the information cost/liquidity theory by capturing the short-term and long-term effects, of any noises which arise on a day-to-day basis on the capital markets and how they impact the liquidity. In such ways, my work will surely be helpful towards impactful research for portfolio selection and monitoring policy works.

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Appendix

Table A1. The following table shows the list of companies by industry in the sample for Chapter 2 from the FTSE ALL Share, EURONEXT 100 and IBEX35 indices.

FTSE ALL Share	
Industry	**Company**
Restaurants	Compass Group PLC
	Greggs PLC
	SSP Group PLC
	Domino's Pizza Group PLC
	J D Wetherspoon PLC
	Mitchells & Butlers PLC
	Marston's PLC
	Restaurant Group PLC/The
	Fuller Smith & Turner PLC
Casinos & Gaming	Flutter Entertainment PLC
	Entain PLC
	William Hill PLC
	Playtech Plc
	Gamesys Group PLC
	888 Holdings PLC
	Rank Group PLC
Internet & Direct Marketing Retail	On the Beach Group PLC
	Hostelworld Group PLC
Hotels, Resorts & Cruise Lines	InterContinental Hotels Group PLC
	Whitbread PLC
	TUI AG
	Carnival PLC
	PPHE Hotel Group Ltd
Environmental & Facilities Services	Biffa PLC
	Renewi PLC
	RPS Group PLC
Airlines	International Consolidated Airlines
	Wizz Air Holdings Plc
	easyJet PLC
	Esken Ltd
Airport Services	Signature Aviation PLC
	John Menzies PLC
Trucking	National Express Group PLC
	Firstgroup PLC
	Stagecoach Group PLC
Movies & Entertainment	Cineworld Group PLC
Leisure Facilities	Hollywood Bowl Group PLC

	TEN Entertainment Group PLC
Railroads	Go-Ahead Group PLC/The
Marine Ports & Services	James Fisher & Sons PLC

EURONEXT 100	
Industry	**Company**
Airlines	Ryanair Holdings PLC
Airport Services	Aeroports de Paris
Casinos & Gaming	Flutter Entertainment PLC
Highways & Railtracks	Getlink SE
Hotels, Resorts & Cruise Lines	Accor SA
Movies & Entertainment	Vivendi SE
Restaurants	Sodexo SA

IBEX 35	
Industry	**Company**
Airport Services	Aena SME SA
Hotels, Resorts & Cruise Lines	Melia Hotels International

Table A2. The following table represents the major events from the BREXIT Referendum to the Transition Period being collected from the Briefing Papers published by the House of Commons Library on 6 January 2021.

		Referendum-General Election
Event 1	24-Jun-16	David Cameron's announcement of resignation
	13-Jul-16	Theresa May becomes UK Prime Minister
Event 2	02-Oct-16	In her Party Conference speech, Theresa May announces a 'Great Repeal Bill' and confirms Article 50 will be triggered before the end of March 2017.
Event 3	17-Jan-17	Prime Minister gives her Lancaster House speech, setting out the Government's 'Plan for Britain' and the priorities that the UK will use to negotiate Brexit.
	26-Jan-17	Government publishes European Union (Notification of Withdrawal) Bill
	02-Feb-17	Government publishes its Brexit White Paper, formally setting out its strategy for the UK to leave the EU.
Event 4	29-Mar-17	Prime Minister triggers Article 50 of the Treaty on European Union
		General Election-Close of Phase 1
Event 5	08-Jun-17	General Election results in a hung Parliament, with the Conservatives winning the most seats and Theresa May forming a government.
	19-Jun-17	First round of UK-EU exit negotiations begin
Event 6	22-Sep-17	Prime Minister delivers her key Brexit speech in Florence, setting out the UK's position on moving the Brexit talks forward.
	19-20 Oct-2017	European Council meeting to assess progress on the first phase of Brexit negotiations
Event 7	08-Dec-17	UK and EU publish a Joint Report on progress made during Phase 1 of negotiations. This concludes Phase 1 of negotiations and both sides move to Phase 2.
		Close of Phase 1-EU (Withdrawal) Act becomes law
	11-Dec-17	Prime Minister updates Parliament on Brexit negotiations.
Event 8	02-Mar-18	Prime Minister gives a speech at Mansion House on the UK's future economic partnership with the European Union
	14-Mar-18	The European Parliament endorses a resolution laying out a possible association agreement framework for future EU-UK relations after Brexit
	19-Mar-18	The amended Draft Withdrawal Agreement is published.
Event 9	26-Jun-18	The European Union (Withdrawal) Bill receives Royal Assent and becomes an Act of Parliament: the European Union (Withdrawal) Act.
		EU(Withdrawal) Act becomes law-the Meaningful Vote
Event 10	24-Jul-18	Government publishes White Paper on future UK-EU relations
Event 11	23-Aug-18	The government publishes the first collection of technical notices providing guidance on how to prepare for a no-deal Brexit

Event 12	14-Nov-18	The Withdrawal Agreement is agreed and published
	25-Nov-18	At a special meeting of the European Council, EU27 leaders endorse the Withdrawal Agreement and approve the political declaration on future EU-UK relations
		The 'Meaningful Vote-Boris Johnson becomes PM
Event 13	29-Jan-19	MPs debate the Prime Minister's 'Plan B' deal, which is then approved following two amendments
Event 14	13-Mar-19	In a defeat for the Prime Minister, MPs vote to rule out a 'no-deal Brexit
	14-Mar-19	MPs approve the amended government's motion, instructing the government to seek permission from the EU to extend Article 50
	20-Mar-19	The Prime Minister writes to European Council President Donald Tusk, asking to extend Article 50 until 30 June 2019
	21-Mar-19	Following a meeting of the European Council, EU27 leaders agree to grant an extension comprising two possible dates: 22 May 2019, should the Withdrawal Agreement gain approval from MPs next week; or 12 April 2019, should the Withdrawal Agreement not be approved by the House of Commons
Event 15	10-Apr-19	The European Council meets. The UK and EU27 agree to extend Article 50 until 31 October 2019.
Event 16	21-May-19	The Prime Minister unveils her new Brexit deal
	23-May-19	The UK votes in the European Parliament elections
Event 17	23-Jul-19	Boris Johnson wins the Conservative Party leadership race
		Boris Johnson Becomes PM-Brexit Day (31 Jan 2020)
	24-Jul-19	Boris Johnson formally takes over as Prime Minister
	25-Jul-19	Prime Minister Johnson makes a statement in the House of Commons and commits to the October date for Brexit and – while hoping for a renegotiation of the Withdrawal Agreement – refuses to rule out the possibility of a 'no-deal' Brexit
Event 18	03-Oct-19	The Prime Minister delivers a statement to the Commons, outlining the Government's proposals for a new Brexit deal
	08-Oct-19	The Government publishes the No-Deal Readiness Report, detailing the UK's preparedness ahead of Brexit on 31 October.
	19-Oct-19	A rare Saturday sitting of Parliament. The Prime Minister presents his new Brexit deal, but is defeated when the Letwin amendment is passed. The PM later writes to Donald Tusk, in accordance with the Benn Act, to ask for a Brexit extension
	28-Oct-19	EU Ambassadors agree to a Brexit extension to 31 January 2020. The Prime Minister confirms the UK's agreement to this extension
Event 19	12-Dec-19	General Election results in Conservative Party majority. The Prime Minister pledges "to get Brexit done" by 31 January 2020.
	19-Dec-19	The Government publishes the European Union (Withdrawal Agreement) Bill
Event 20	Friday 31 Jan 2020=BREXIT DAY	
		The transition period (1 Feb-31 Dec 2020)
Event 22	30-Jun-20	The deadline to request an extension to the transition period, currently due to conclude at the end of December, passes.
Event 23	09-Sep-20	The UK Internal Market Bill is introduced and receives criticism from EU leaders

	16-Sep-20	The European Commission President warns the UK Government against reneging on the Brexit deal
	01-Oct-20	The European Commission President announces the EU will initiate legal proceedings to prevent the UK from trying to use domestic legislation to override aspects of the Brexit Withdrawal Agreement
Event 24	24-Dec-20	The Brexit deal (the EU-UK Trade and Cooperation Agreement) is sealed
	30-Dec-20	Parliament is recalled to pass the European Union (Future Relationship) Bill
	31-Dec-20	The transition period ends at 11pm and the UK leaves the EU single market and customs union
	Jan 1 2021-First trading Day after The Transition Period	

Table A3. The following table represents the average of the quoted and relative and effective spread surrounding the twenty events of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. For each spread, Panel A describes the spreads for a period of [-5,+5] period and Panel B describes the average for a period of [-10,+10]. Quoted Spread is calculated as the difference between ask and bid. Relative Spread is calculated as ask minus bid divided by the midpoint of the bid-ask spread. Effective Spread is calculated as the twice the closing index minus average of the ask and bid. The ratios are tested using a standard t-test with a null hypothesis stating that the mean of the reported ratio is equal to unity. Two tailed tests of significance are reported as(***significance at 1%, **significance at 5% and * significance at 10% level.)

$$QS_{i,t} = A_{i,t} - B_{i,t} \qquad RS_{i,t} = \frac{A_{i,t} - B_{i,t}}{(A_{i,t} + B_{i,t})/2}$$

Quoted Spread

Panel A: Period showing [-5,+5]

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
-5	55.07	54.92	23.39	42.84	21.14	52.13	34.12	18.97
T test	*1.27*	*1.38*	*-3.56****	*0.74*	*-2.64****	*6.11****	*2.33***	*-3.21****
-4	119.96	52.75	34.87	25.51	30.52	21.36	36.06	32.90
T test	*13.15****	*1.03*	*-1.70*	*-2.26***	*-1.05*	*-3.15****	*3.05****	*1.04*
-3	44.86	39.03	19.05	15.11	25.52	22.38	25.11	26.30
T test	*-0.59*	*-1.19*	*-4.26****	*-4.05****	*-1.89*	*-2.84****	*-1.01*	*-0.98*
-2	48.71	46.04	23.36	41.33	16.76	19.42	41.17	32.95
T test	*0.11*	*-0.06*	*-3.56****	*0.48*	*-3.38****	*-3.73****	*4.94****	*1.06*
-1	65.08	60.04	17.38	32.67	39.42	15.29	29.05	41.98
T test	*3.11****	*2.21***	*-4.53****	*-1.02*	*0.46*	*-4.98****	*0.45*	*3.81****
0	88.92	56.91	29.00	29.63	33.71	21.82	41.62	37.12
T test	*7.47****	*1.70*	*-2.65****	*-1.54*	*-0.50*	*-3.01****	*5.11****	*2.33***
1	0.20	77.12	35.81	22.18	46.37	15.17	24.80	19.98
T test	*0.01*	*4.97****	*-1.54*	*-2.83****	*1.64*	*-5.01****	*-1.12*	*-2.91****
2	-3.90	26.98	21.76	24.33	31.77	13.81	8.71	26.41
T test	*0.01*	*-3.14****	*-3.82****	*-2.46***	*-0.83*	*-5.42****	*-7.08****	*-0.94*
3	-2.37	27.07	38.39	34.19	25.70	43.28	24.36	68.69
T test	*0.01*	*-3.13****	*-1.13*	*-0.75*	*-1.86*	*3.45****	*-1.29*	*11.97****
4	-3.41	37.52	22.30	22.01	22.98	24.97	28.77	45.24
T test	*0.01*	*-1.44*	*-3.73****	*-2.86****	*-2.32***	*-2.06***	*0.35*	*4.81****
5	-4.69	40.07	27.22	20.48	28.06	18.22	32.01	49.38
T test	*0.01*	*-1.02*	*-2.94****	*-3.13****	*-1.46*	*-4.10****	*1.55*	*6.07***
[-5, +5]	37.13	47.13	26.59	28.21	29.27	24.35	29.62	36.36
T test	*2.23***	*0.12*	*-3.04****	*-1.79*	*-1.26*	*-2.25***	*0.66*	*2.10***

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
-5	46.40	30.43	36.43	48.97	46.15	19.26	22.10	44.40
T test	*4.37****	*-0.72*	*0.86*	*3.29****	*0.98*	*-5.43****	*-4.68****	*1.03*
-4	53.52	33.06	32.49	29.73	34.79	39.62	26.68	41.09
T test	*6.50****	*0.00*	*-0.22*	*-1.83*	*-1.70*	*-0.38*	*-3.52****	*0.19*
-3	66.14	19.53	31.24	37.54	26.40	43.69	30.34	45.71
T test	*10.26****	*-3.72****	*-0.57*	*0.25*	*-3.69****	*0.63*	*-2.59***	*1.37*
-2	71.31	38.58	20.94	76.90	25.45	39.02	20.04	24.75
T test	*11.80****	*1.52*	*-3.41****	*10.72****	*-3.91****	*-0.53*	*-5.21****	*-3.96****
-1	89.03	30.00	37.97	41.73	39.97	40.92	32.85	48.16
T test	*17.09****	*-0.84*	*1.29*	*1.36*	*-0.48*	*-0.06*	*-1.96*	*1.99*
0	26.26	46.89	20.78	55.17	59.87	31.68	13.69	43.60
T test	*-1.64*	*3.81****	*-3.45****	*4.94****	*4.23****	*-2.35***	*-6.82****	*0.83*
1	64.22	36.89	14.92	31.90	66.19	88.83	30.51	38.24
T test	*9.69****	*1.06*	*-5.06****	*-1.25*	*5.73****	*11.83****	*-2.55****	*-0.53*
2	32.54	22.34	14.92	35.73	31.99	34.27	23.14	38.24
T test	*0.23*	*-2.95****	*-5.06****	*-0.23*	*-2.37***	*-1.71*	*-4.42****	*-0.53*
3	47.76	28.17	32.89	36.43	29.35	29.62	13.84	27.30
T test	*4.78****	*-1.34*	*-0.11*	*-0.05*	****	*-2.86****	*-6.78****	*-3.32****
4	50.56	28.44	47.91	40.35	20.83	32.70	26.10	62.27
T test	*5.61****	*-1.27*	*4.02****	*1.00*	*-5.01****	*-2.10***	*-3.67****	*5.58****
5	42.30	41.20	34.97	85.26	72.19	37.81	15.03	32.12
T test	*3.15****	*2.24***	*0.46*	*12.94****	*7.15****	*-0.83*	*-6.48****	*-2.09***
[-5, +5]	53.64	32.32	29.59	47.25	41.20	39.77	23.12	40.53
T test	*6.53****	*-0.20*	*-1.02*	*2.83****	*-0.19*	*-0.34*	*-4.43****	*0.05*

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
-5	32.93	55.04	30.64	69.78	18.01	51.27	59.83	22.04
T test	*-1.69*	*3.52****	*-2.09***	*8.78****	*0.02*	*-0.95*	*-0.44*	*-4.27****
-4	30.00	45.23	54.99	103.73	1.75	108.40	85.67	45.21
T test	*-2.46***	*1.08*	*4.52****	*17.88****	*0.01*	*4.25****	*1.94*	*-2.11***
-3	27.39	19.24	19.19	43.43	-2.73	71.58	68.89	123.82
T test	*-3.14****	*-5.40****	*-5.19****	*1.71*	*0.01*	*0.90*	*0.39*	*5.19****
-2	36.36	41.54	51.59	26.83	7.84	61.12	78.95	41.19
T test	*-0.79*	*0.16*	*3.60****	*-2.74****	*0.02*	*-0.05*	*1.32*	*-2.49****
-1	29.37	125.03	33.61	66.01	8.44	68.20	63.14	42.33
T test	*-2.62****	*20.97****	*-1.28*	*7.77****	*0.02*	*0.59*	*-0.13*	*-2.38***
0	40.34	38.94	56.11	68.24	0.21	46.82	48.48	48.31
T test	*0.25*	*-0.49*	*4.82****	*8.37****	*0.01*	*-1.35*	*-1.48*	*-1.82*
1	32.06	35.59	18.03	37.73	7.04	63.98	47.98	105.65
T test	*-1.92*	*-1.33*	*-5.51****	*0.19*	*0.02*	*0.21*	*-1.53*	*3.50****
2	78.44	27.97	38.25	63.07	4.29	55.89	38.05	42.51
T test	*10.21****	*-3.23****	*-0.02*	*6.98****	*0.01*	*-0.53*	*-2.44****	*-2.36***
3	44.75	44.29	16.96	52.84	-2.11	66.59	35.50	123.34
T test	*1.40*	*0.84*	*-5.80****	*4.24****	*0.01*	*0.45*	*-2.67****	*5.15****
4	35.64	31.50	16.96	29.14	-0.42	77.87	23.66	58.62
T test	*-0.98*	*-2.35***	*-5.80****	*-2.12***	*0.01*	*1.47*	*-3.76****	*-0.87*
5	36.76	44.79	16.96	35.38	-4.55	56.46	38.08	26.42
T test	*-0.69*	*0.97*	*-5.80****	*-0.44*	*0.00*	*-0.47*	*-2.44***	*-3.86****
[-5, +5]	38.55	46.29	32.12	54.20	3.43	66.20	53.48	61.77
T test	*-0.22*	*1.34*	*-1.68*	*4.60****	*0.01*	*0.41*	*-1.02*	*-0.57*

Quoted Spread

Panel B: Period covering [-10,+10]

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
0	88.92	56.91	29.00	29.63	33.71	21.82	41.62	37.12
T test	*7.47*	*1.70*	*-2.65*	*-1.54*	*-0.50*	*-3.01****	*5.11****	*2.33***
[-1,+1]	84.95	64.69	28.68	28.16	35.54	21.25	34.27	36.24
T test	*6.74*	*2.96*	*-2.70*	*-1.80*	*-0.19*	*-3.18****	*2.39****	*2.06***
[-2,+2]	79.70	53.42	27.96	30.03	33.66	20.88	31.16	35.42
T test	*5.78*	*1.13*	*-2.82*	*-1.47*	*-0.51*	*-3.30****	*1.24*	*1.81*
[-10,+10]	46.28	42.81	25.73	28.11	30.72	23.86	29.79	38.87
T test	*-0.33*	*-0.58*	*-3.18*	*-1.81*	*-1.01*	*-2.40***	*0.73*	*2.86****

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
0	26.26	46.89	20.78	55.17	59.87	31.68	13.69	43.60
T test	*-1.64*	*3.81****	*-3.45****	*4.94****	*4.23****	*-2.35****	*-6.82****	*0.83*
[-1,+1]	59.84	37.93	24.56	51.83	55.34	39.06	25.68	43.44
T test	*8.38****	*1.34*	*-2.41***	*4.05****	*3.16****	*-0.52*	*-3.77****	*0.79*
[-2,+2]	56.67	34.94	21.91	52.52	47.87	38.62	24.27	40.03
T test	*7.44****	*0.52*	*-3.14****	*4.23****	*1.39*	*-0.63*	*-4.13****	*-0.08*
[-10,+10]	46.08	37.40	36.89	54.12	38.33	35.45	26.89	41.75
T test	*4.27****	*1.20*	*0.99*	*4.66****	*-0.87*	*-1.41*	*-3.47****	*0.36*

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
0	40.34	38.94	56.11	68.24	37.73	46.82	48.48	48.31
T test	*0.25*	*-0.49*	*4.82****	*8.37****	*0.21*	*-1.35*	*-1.48*	*-1.82*
[-1,+1]	36.49	43.07	48.54	57.33	56.35	59.67	49.22	54.02
T test	*-0.76*	*0.54*	*2.77****	*5.44****	*5.23****	*-0.18*	*-1.41*	*-1.29*
[-2,+2]	42.46	42.32	47.82	52.38	57.58	59.20	50.10	51.80
T test	*0.80*	*0.35*	*2.57****	*4.11****	*5.56****	*-0.23*	*-1.33*	*-1.50*
[-10,+10]	42.00	39.37	39.21	46.63	45.63	62.24	48.39	51.86
T test	*0.68*	*-0.38*	*0.24*	*2.57****	*2.34***	*0.05*	*-1.49*	*-1.49*

Relative Spread

Panel A: Period covering [-5,+5]

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
-5	0.16	0.14	0.06	0.11	0.05	0.13	0.08	0.05
T test	*1.51*	*0.56*	*-3.75****	*0.04*	*-2.71*	*5.69****	*2.27***	*-3.04****
-4	0.35	0.14	0.09	0.06	0.07	0.05	0.09	0.08
T test	*12.73****	*0.30*	*-2.22***	*-2.47****	*-1.42*	*-3.12****	*2.96****	*1.16*
-3	0.13	0.10	0.05	0.04	0.06	0.06	0.06	0.06
T test	*-0.62*	*-1.67*	*-4.34****	*-3.99****	*-2.10***	*-2.85****	*-1.06*	*-0.87*
-2	0.14	0.12	0.06	0.10	0.04	0.05	0.10	0.08
T test	*-0.02*	*-0.72*	*-3.77****	*-0.15*	*-3.30****	*-3.70****	*4.85****	*1.20*
-1	0.18	0.16	0.04	0.08	0.09	0.04	0.07	0.10
T test	*2.71****	*1.28*	*-4.58****	*-1.43*	*-0.14*	*-4.88****	*0.39*	*4.07****
0	0.26	0.15	0.07	0.07	0.08	0.05	0.10	0.09
T test	*7.03****	*0.74*	*-2.95****	*-1.88*	*-0.92*	*-3.15****	*4.89****	*2.62****
1	0.13	0.20	0.09	0.05	0.11	0.04	0.06	0.05
T test	*-0.38*	*3.39****	*-2.03***	*-2.97****	*0.82*	*-5.06****	*-1.31*	*-2.61****
2	0.07	0.07	0.05	0.06	0.08	0.03	0.02	0.07
T test	*-4.01****	*-3.49****	*-3.94****	*-2.66****	*-1.17*	*-5.43****	*-7.11****	*-0.58*
3	0.10	0.07	0.10	0.08	0.06	0.10	0.06	0.18
T test	*-2.67****	*-3.46****	*-1.70*	*-1.21*	*-2.02***	*2.76****	*-1.47*	*12.84****
4	0.08	0.10	0.06	0.05	0.06	0.06	0.07	0.12
T test	*-3.60****	*-2.02***	*-3.87****	*-2.98****	*-2.40***	*-2.31***	*0.13*	*5.58****
5	0.06	0.10	0.07	0.05	0.07	0.04	0.08	0.13
T test	*-4.77****	*-1.68*	*-3.22****	*-3.21****	*-1.70*	*-4.21****	*1.22*	*6.90****
[-5, +5]	0.15	0.12	0.07	0.07	0.07	0.06	0.07	0.09
T test	*0.72*	*-0.62*	*-3.31****	*-2.08****	*-1.55*	*-2.39***	*0.52*	*2.48****

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
-5	0.11	0.07	0.09	0.12	0.12	0.05	0.05	0.11
T test	*3.86****	*-0.93*	*0.73*	*3.80****	*1.43*	*-5.15****	*-4.56****	*1.04*
-4	0.13	0.08	0.08	0.07	0.09	0.10	0.07	0.10
T test	*5.75****	*-0.29*	*-0.34*	*-1.48*	*-1.19*	*-0.27*	*-3.47****	*0.15*
-3	0.16	0.05	0.07	0.09	0.07	0.11	0.07	0.11
T test	*9.39****	*-3.84****	*-0.71*	*0.67*	*-3.16****	*0.77*	*-2.63****	*1.20*
-2	0.17	0.09	0.05	0.19	0.07	0.10	0.05	0.06
T test	*10.81****	*1.15*	*-3.45****	*11.30****	*-3.39****	*-0.38*	*-5.07****	*-3.85****
-1	0.21	0.07	0.09	0.11	0.11	0.10	0.08	0.12
T test	*15.86****	*-1.08*	*1.08*	*1.89*	*0.16*	*0.09*	*-2.05***	*1.79*
0	0.06	0.11	0.05	0.14	0.16	0.08	0.03	0.11
T test	*-1.77*	*3.29****	*-3.50****	*5.68****	*4.90****	*-2.26***	*-6.57****	*0.72*
1	0.15	0.09	0.04	0.08	0.17	0.22	0.07	0.09
T test	*8.93****	*0.71*	*-5.05****	*-0.72*	*6.21****	*11.21****	*-2.58****	*-0.52*
2	0.08	0.05	0.04	0.09	0.08	0.09	0.06	0.09
T test	*-0.05*	*-3.09****	*-5.05****	*0.32*	*-1.96*	*-1.54*	*-4.34****	*-0.52*
3	0.11	0.07	0.08	0.09	0.08	0.07	0.03	0.07
T test	*4.15****	*-1.59*	*-0.31*	*0.49*	*-2.60****	*-2.66****	*-6.54****	*-3.19****
4	0.12	0.07	0.11	0.10	0.05	0.08	0.06	0.16
T test	*5.05****	*-1.52*	*3.68****	*1.63*	*-4.61****	*-1.93*	*-3.67****	*5.41****
5	0.10	0.10	0.08	0.22	0.18	0.09	0.04	0.08
T test	*2.73****	*1.75*	*0.32*	*13.80****	*7.19****	*-0.75*	*-6.28****	*-1.94*
[-5, +5]	0.13	0.08	0.07	0.12	0.11	0.10	0.06	0.10
T test	*5.88****	*-0.50*	*-1.14*	*3.40****	*0.27*	*-0.26*	*-4.34****	*0.03*

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
-5	0.08	0.13	0.08	0.16	0.25	0.15	0.18	0.06
T test	*-1.99*	*3.02****	*-2.09***	*7.88****	*16.93****	*-0.73*	*-0.15*	*-4.06****
-4	0.07	0.11	0.14	0.25	0.10	0.31	0.26	0.12
T test	*-2.68****	*0.64*	*4.20****	*16.77****	*1.40*	*3.90****	*2.04***	*-2.27***
-3	0.07	0.05	0.05	0.10	0.06	0.21	0.21	0.34
T test	*-3.27****	*-5.39****	*-5.13****	*1.36*	*-2.95****	*1.07*	*0.69*	*4.02****
-2	0.09	0.10	0.13	0.06	0.16	0.18	0.24	0.11
T test	*-1.13*	*-0.21*	*3.32****	*-2.96****	*7.33****	*0.13*	*1.52*	*-2.51***
-1	0.07	0.31	0.08	0.16	0.17	0.20	0.19	0.11
T test	*-2.81****	*19.70****	*-1.38*	*7.25****	*8.09****	*0.72*	*0.13*	*-2.45****
0	0.10	0.10	0.13	0.17	0.09	0.14	0.14	0.13
T test	*-0.21*	*-0.59*	*4.08****	*8.00****	*0.08*	*-1.02*	*-1.10*	*-2.03***
1	0.08	0.09	0.04	0.09	0.15	0.19	0.14	0.28
T test	*-2.18***	*-1.52*	*-5.64****	*0.05*	*6.64****	*0.40*	*-1.10*	*2.37***
2	0.19	0.07	0.09	0.15	0.13	0.16	0.11	0.11
T test	*8.61****	*-3.30****	*-0.66*	*6.56****	*3.82****	*-0.30*	*-1.99***	*-2.49****
3	0.11	0.11	0.04	0.13	0.07	0.19	0.11	0.32
T test	*0.64*	*0.53*	*-5.93****	*3.76****	*-2.37***	*0.56*	*-2.21***	*3.52****
4	0.08	0.08	0.04	0.07	0.08	0.22	0.07	0.15
T test	*-1.41*	*-2.45***	*-5.93****	*-2.39***	*-0.72*	*1.44*	*-3.22****	*-1.42*
5	0.09	0.11	0.04	0.08	0.05	0.16	0.11	0.07
T test	*-1.10*	*0.57*	*-5.93****	*-0.75*	*-4.67****	*-0.28*	*-2.02****	*-3.81****
[-5, +5]	0.09	0.11	0.08	0.13	0.12	0.19	0.16	0.16
T test	*-0.68*	*1.00*	*-1.92*	*4.14****	*3.05****	*0.54*	*-0.68*	*-1.01*

Relative Spread

Panel B: Period covering [-10,+10]

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
0	0.26	0.15	0.07	0.07	0.08	0.05	0.10	0.09
T test	*7.03****	*0.74*	*-2.95****	*-1.88*	*-0.92*	*-3.15****	*4.89****	*2.62****
[-1,+1]	0.24	0.17	0.07	0.07	0.09	0.05	0.08	0.09
T test	*6.30****	*1.80*	*-3.00****	*-2.09***	*-0.67*	*-3.31****	*2.22***	*2.35****
[-2,+2]	0.23	0.14	0.07	0.07	0.08	0.05	0.08	0.09
T test	*5.37****	*0.24*	*-3.10****	*-1.82*	*-0.93*	*-3.41****	*1.10*	*2.09***
[-10,+10]	0.13	0.11	0.06	0.07	0.07	0.06	0.07	0.10
T test	*-0.82*	*-1.21*	*-3.41****	*-2.11****	*-1.33*	*-2.56****	*0.54*	*3.22****

	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
0	0.06	0.11	0.05	0.14	0.16	0.08	0.03	0.11
T test	*-1.77*	*3.29****	*-3.50****	*5.68****	*4.90****	*-2.26***	*-6.57****	*0.72*
[-1,+1]	0.14	0.09	0.06	0.13	0.15	0.10	0.06	0.11
T test	*7.67****	*0.97*	*-2.49****	*4.76****	*3.75****	*-0.50*	*-3.73****	*0.68*
[-2,+2]	0.13	0.08	0.05	0.13	0.13	0.10	0.06	0.10
T test	*6.76****	*0.19*	*-3.19****	*4.92****	*1.97*	*-0.58*	*-4.07****	*-0.14*
[-10,+10]	0.11	0.09	0.09	0.14	0.10	0.09	0.07	0.10
T test	*3.70****	*0.85*	*0.82*	*5.41****	*-0.44*	*-1.32*	*-3.41****	*0.34*

	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
0	0.10	0.10	0.13	0.17	0.09	0.14	0.14	0.13
T test	*-0.21*	*-0.59*	*4.08****	*8.00****	*0.08*	*-1.02*	*-1.10*	*-2.03***
[-1,+1]	0.09	0.11	0.12	0.14	0.14	0.17	0.15	0.14
T test	*-1.12*	*0.38*	*2.19****	*5.10****	*4.94****	*0.03*	*-1.04*	*-1.59*
[-2,+2]	0.10	0.11	0.12	0.13	0.14	0.17	0.15	0.14
T test	*0.26*	*0.18*	*2.01***	*3.78****	*5.19****	*-0.01*	*-0.96*	*-1.75*
[-10,+10]	0.10	0.10	0.09	0.11	0.11	0.18	0.14	0.14
T test	*0.26*	*-0.57*	*-0.16*	*2.13****	*1.93*	*0.22*	*-1.12*	*-1.78*

Quoted Spread

The Panel A highlights the quoted spread from event 1 to event 8. It can be observed that most of the events show positive spreads with significant t statistics. This indicates a decrease in liquidity during the BREXIT period. However, as I move from event 1 to event 8, I observe that the spreads have decreased over the period. For instance, during event 1, the quoted spread is 88.92 with a t statistic of 7.47 at 1 % significant level whereas during event 8, the quoted spread is 37.12 with a t statistic of 2.33 at 1 % significant level. When I report the quoted spread for an average period of [-5,+5], I observe that the spread has decreased from 37.13 to 36.36 from event 1 to event 8 with a corresponding t statistic of 2.23 to 2.10 at 1 % significant level. When I compare the quoted spread from event 9 to event 16, I observe that the quoted spread has increased. For instance, during the event day of event 9, the quoted spread is 26.26 with a t statistic of -1.64 which has increased to 43.60 with a t statistic of 0.83 at event 16.

However, when as I move post 5 days from the events, for event 9, 10 and 11 I observe that the spread has increased. As I compare the average of [-5,+5], I compute that for event 9, the spread is 53.64 with a t statistic of 6.53 at 1 % significant level. For the same period, the spread for event 16 has decreased to 40.53 with a t statistic of 0.05 at 1% significant level. As I move to compare from event 17 to event 24, I observe a different scenario. With event 23 and event 24 approaching, which are close to the transition period of BREXIT, I observe that the spreads increase with significant increase in the t statistic. For instance, the spread at event 17 during the event day is 40.34 with a t statistic of 0.25 at 1 % significant level. The spread at event 24 during the event day is 48.31 with a t statistic of -1.82 at 1% significant level.

The panel B of the quoted spread represents the average quoted spreads for a period of [-10.+10] for each event. The panel B of the quoted spread shows similar pattern such as panel A. When I compare the event 1 to event 8, for event 1, the spread is 46.28 with a t statistic of -0.33, and for event 8, the spread is 38.87 with a t statistic of 2.86 at 1 % significant level. When I compare the event 9 to event 16, for event 9, the spread is 46.08 with a t statistic of 4.27 at 1 % significant level, and for event 16, the spread is 41.75 with a t statistic of 0.36 at 1 % significant level. Lastly, when I compare from event 17 to event 24, the spread is 42 with a t statistic of 0.68 at 1 % significant level and for event 24, the spread is 51.86 with a t statistic of -1.49 at 1 % significant level.

Overall, it can be indicated that during the period following the BREXIT referendum until the transition period, there shows positive quoted spread which indicate a decrease in liquidity. The spreads tend to decrease during the period but increase significantly as the events approach to the transition period.

Relative Spread

Panel A of the table 5.3 also represents that the relative spread exhibits similar pattern as the quoted spread. Panel A shows positive and significant relative spread in most cases. When I compare event 1 to event 8, I observe a decrease in spread. For instance, during the event day of the event 1, the spread is 0.26 with a t statistic of 7.03 at 1 % significant level. And, during the event 8, the spread is 0.09 with a t statistic of 2.62 at 1 % significant level. When I compare the relative spread for [-5,+5] period, I observe that the spread for event 1 is 0.15 with a t statistic of 0.72 and the spread for event 8 is 0.09 with a t statistic of 2.48 at 1 % significant level. As I compare the relative spreads from event 9 to event 16, I observe that the relative spread has decreased. For instance, during the [-5,+5] period for event 9, the spread is 0.13 with a t statistic of 5.88 at 1 % significant level. And, for event 16, this has decreased to 0.10 with a t statistic of 0.0 at 1 % significant level 3. However, when I compare the spread from event 17 to event 24, I observe that the spread has increased with the events. For instance, during the [-5,+5] period for event 17, the spread is 0.09 with a t statistic of -0.68 which has increased to 0.16 with a t statistic of -1.01 at event 24.

In Panel B, I represent the average of the [-10,+10] period of the relative spread for each of the events. Following Panel A of the relative spread, I observe that the relative spread is positive and significant at the pre and post 10 days for each of the evenst. The spreads decrease when I compare from event 1 to event 8 and event 9 to event 16. However, they tend to increase as I approach to event 24.

Overall as consistent with the quoted spread, the positive and significant relative spread indicates a decrease in liquidity from BREXIT referendum until the transition period. The spread increases as I approach to the transition period during event 23 and 24.

Table A4. The following table represents the multivariate regression of the quoted and relative and spread surrounding the twenty events of the FTSE 100 index for a period of 24 June 2016 until 15 January 2021. The period covers the time frame of the 10 days pre the BREXIT referendum until the first 10 trading day after the end of the transition period. For each event, a period of [-10,+10] has been computed to determine whether the liquidity of the FTSE 100 index has decreased when we encapsulate the volume, closing index and standard deviation of the index. The following regression model has been applied on each of the events

$Liquidity_{jt} = \alpha_j + \beta_1 D_t + \beta_2 Volume_{jt} + \beta_3 (Volume_{jt} * D_t) + \beta_4 Close_{jt} + \beta_5 StdDev_{jt} + \varepsilon_{jt}$ **for j = 1,24 (representing 24 events in the order respectively) and t = -10, +10**

Where, the dependent variable, $Liquidity_{jt}$, represents Quoted Spread, Relative Spread and Effective Spread respectively for the FTSE 100 Index at time t. The constant, α_j, shows the variation in the liquidity ratios as per the index. D_t represents the dummy variable which is equal to 1 in the post event period, otherwise 0. Volume, Close and StdDev (Standard Deviation) represent the traded volume in shares, closing index and return volatility for the index at time period t for each trading day in the event window [-10, +10]. The coefficient, β_1 and β_3 captures the impact of the pandemic on the liquidity as well as on the volume and is of main concern. (*significance at 1%, **significance at 5% and * significance at 10%.)**

Quoted Spread

Var	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
C	-306.46	598.21	255.53	550.98	586.88	-165.51	-95.45	732.81
T test	*-2.00****	*1.20*	*1.21*	*0.98*	*2.05****	*-0.71*	*-0.22*	*1.71*
β1	-141.66	27.32	35.42	-30.24	-39.27	-10.85	-12.36	47.32
T test	*-4.53****	*0.82*	*1.43*	*-0.84*	*-2.58****	*-0.84*	*-0.64*	*0.92*
β2	-0.48	0.04	0.03	0.16	0.04	0.06	0.01	0.16
T test	*-1.71*	*1.83*	*2.11****	*0.21*	*1.16*	*0.68*	*0.06*	*0.70*
β3	0.11	-0.02	-0.03	0.02	0.03	0.004	0.004	-0.05
T test	*3.83****	*-0.72*	*-1.30*	*0.78*	*2.76****	*0.42*	*0.29*	*-1.21*
β4	0.11	-0.16	-0.07	-0.13	-0.14	0.04	0.03	-0.18
T test	*2.59****	*-1.21*	*-1.27*	*-0.93*	*-1.98*	*0.77*	*0.28*	*-1.69*
β5	7067.66	1253.73	-1284.50	612.01	-281.97	4162.46	2095.71	584.49
T test	*5.48****	*1.26*	*-1.12*	*0.31*	*-0.34*	*3.68****	*1.38*	*0.33*

Var	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
C	485.95	916.59	271.42	54.68	-41.84	678.84	121.86	679.79
T test	*1.06*	*1.62*	*0.89*	*0.20*	*-0.11*	*1.60*	*0.78*	*1.66*
β1	-27.76	-4.43	47.18	113.69	56.57	-18.52	-12.99	55.94
T test	*-1.03*	*-0.10*	*1.73*	*2.27****	*1.06*	*-0.32*	*-0.46*	*1.33*
β2	0.10	0.28	0.82	0.33	0.64	-0.13	0.13	0.59
T test	*0.72*	*0.73*	*2.97****	*1.34*	*1.30*	*-0.34*	*0.66*	*1.57*
β3	0.01	0.00	-0.06	-0.10	-0.06	0.03	0.01	-0.06
T test	*0.32*	*0.09*	*-1.96*	*-2.32****	*-1.09*	*0.53*	*0.34*	*-1.51*
β4	-0.11	-0.21	-0.07	-0.01	0.00	-0.16	-0.03	-0.17
T test	*-0.98*	*-1.63*	*-1.05*	*-0.17*	*0.04*	*-1.49*	*-0.69*	*-1.73*
β5	2809.79	1211.92	595.69	817.36	1175.16	1539.70	2694.69	-2199.10
T test	*1.83*	*0.95*	*0.46*	*0.94*	*0.72*	*0.81*	*2.63*	*-1.84*

Var	Event 17	Event 18	Event 19	Event 20	Event 21	Event 22	Event 23	Event 24
C	73.35	1682.76	278.05	586.21	1039.68	808.66	0.45	1028.37

T test	*0.26*	*5.34****	*0.50*	*1.70*	*2.06****	*1.47*	*4.99****	*2.60****
β1	-56.80	50.57	19.90	-81.88	-75.63	-0.45	0.01	-3.38
T test	*-0.58*	*1.45*	*0.58*	*-1.40*	*-1.50*	*-0.01*	*0.45*	*-0.07*
β2	-0.05	-0.07	0.20	0.59	-0.05	0.09	0.10	0.46
T test	*-0.05*	*-0.79*	*0.47*	*1.20*	*-0.44*	*0.52*	*0.27*	*1.98*
β3	0.07	-0.06	-0.02	0.07	0.02	-0.01	-0.09	0.05
T test	*0.61*	*-1.69*	*-0.48*	*1.10*	*1.26*	*-0.25*	*-0.66*	*1.04*
β4	-0.01	-0.40	-0.06	-0.14	-0.23	-0.21	0.00	-0.28
T test	*-0.17*	*-5.20****	*-0.49*	*-1.80*	*-2.06****	*-1.34*	*-4.88****	*-2.68****
β5	2179.53	3399.02	3361.88	2105.50	3427.99	-1598.09	0.21	2342.27
T test	*1.53*	*3.34****	*1.66*	*1.47*	*2.33****	*-1.14*	*1.05*	*1.72*

Relative Spread

Var	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8
C	-0.08	0.17	0.07	0.14	0.15	-0.04	-0.02	-33.88
T test	*-1.73*	*1.27*	*1.32*	*1.02*	*2.19****	*-0.64*	*-0.15*	*-2.34****
β1	-0.04	0.01	0.01	-0.01	-0.01	0.00	0.00	1.09
T test	*-4.41****	*0.86*	*1.42*	*-0.84*	*-2.60****	*-0.77*	*-0.63*	*0.63*
β2	-0.14	0.12	0.08	0.00	0.01	0.02	0.00	1.68
T test	*-1.64*	*1.86*	*2.10****	*0.21*	*1.14*	*0.76*	*0.06*	*0.21*
β3	0.33	-0.05	-0.07	0.06	0.07	0.01	0.01	0.69
T test	*3.73****	*-0.76*	*-1.29*	*0.77*	*2.77****	*0.33*	*0.28*	*0.05*
β4	0.03	-0.04	-0.02	-0.03	-0.03	0.01	0.01	0.08
T test	*2.29****	*-1.28*	*-1.37*	*-0.97*	*-2.12****	*0.69*	*0.22*	*2.36****
β5	2.06	0.33	-0.33	0.16	-0.07	1.00	0.51	-29.80
T test	*5.48****	*1.26*	*-1.13*	*0.32*	*-0.35*	*3.68****	*1.37*	*-0.50*

Var	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14	Event 15	Event 16
C	0.12	0.22	0.07	0.01	0.00	0.18	0.04	0.18
T test	*1.12*	*1.68*	*1.03*	*0.20*	*0.00*	*1.67*	*0.99*	*1.75*
β1	-0.01	0.00	0.01	0.03	0.01	0.00	0.00	0.01
T test	*-1.06*	*-0.09*	*1.73*	*2.27****	*1.07*	*-0.32*	*-0.45*	*1.31*
β2	0.02	0.07	0.19	0.08	0.17	-0.03	0.03	0.14
T test	*0.67*	*0.73*	*2.97****	*1.34*	*1.31*	*-0.35*	*0.66*	*1.53*
β3	0.02	0.01	-0.13	-0.25	-0.15	0.08	0.02	-0.15
T test	*0.36*	*0.08*	*-1.96*	*-2.32****	*-1.10*	*0.54*	*0.33*	*-1.48*
β4	-0.03	-0.05	-0.02	-0.003	-0.004	-0.01	-0.04	-0.01
T test	*-1.04*	*-1.70*	*-1.18*	*-0.17*	*-0.07*	*-1.56*	*-0.90*	*-1.82*
β5	0.67	0.28	0.14	0.20	0.30	0.37	0.66	-0.54
T test	*1.85*	*0.95*	*0.45*	*0.93*	*0.72*	*0.80*	*2.65****	*-1.82*

Var	**Event 17**	**Event 18**	**Event 19**	**Event 20**	**Event 21**	**Event 22**	**Event 23**	**Event 24**
C	0.03	0.42	0.07	0.15	0.26	0.25	0.45	0.29
T test	*0.43*	*5.45****	*0.54*	*1.81*	*2.14****	*1.55*	*4.99****	*2.72****
β_1	-0.01	0.01	0.00	-0.02	-0.02	0.00	0.01	0.00
T test	*-0.57*	*1.45*	*0.58*	*-1.43*	*-1.50*	*-0.01*	*0.45*	*-0.04*
β_2	-0.01	-0.02	0.05	0.14	-0.01	0.03	0.01	0.12
T test	*-0.03*	*-0.78*	*0.48*	*1.18*	*-0.44*	*0.53*	*0.27*	*1.97*
β_3	1.63	-0.15	-0.05	0.18	0.04	-0.03	-0.09	0.13
T test	*0.59*	*-1.70*	*-0.49*	*1.12*	*1.27*	*-0.24*	*-0.66*	*1.01*
β_4	-0.01	-0.01	-0.02	-0.04	-0.06	-0.07	-0.13	-0.08
T test	*-0.35*	*-5.31****	*-0.54*	*-1.92*	*-2.14****	*-1.42*	*-4.88****	*-2.79****
β_5	0.51	0.83	0.82	0.49	0.81	-0.47	0.21	0.63
T test	*1.48*	*3.33****	*1.68*	*1.46*	*2.31****	*-1.17*	*1.05*	*1.70*