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
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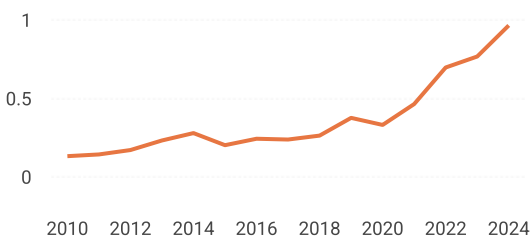
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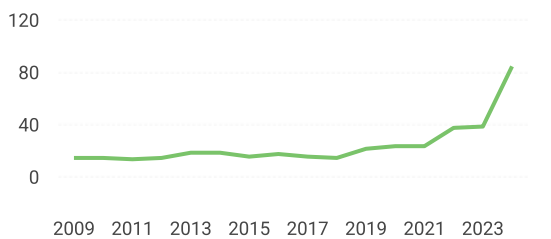
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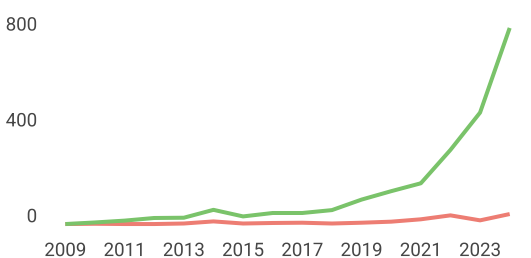
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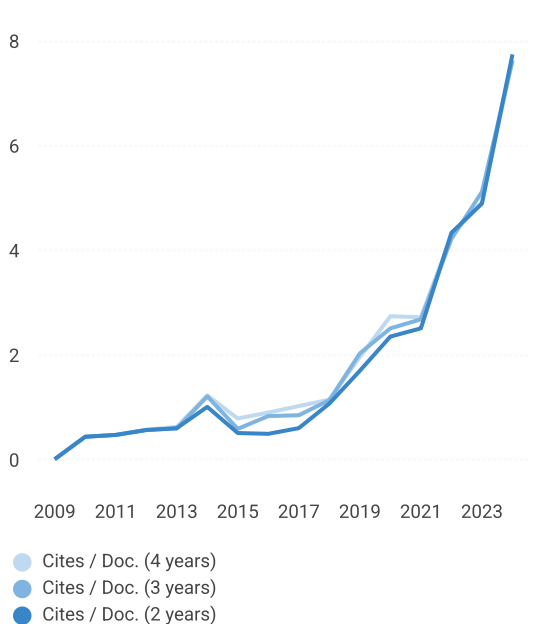
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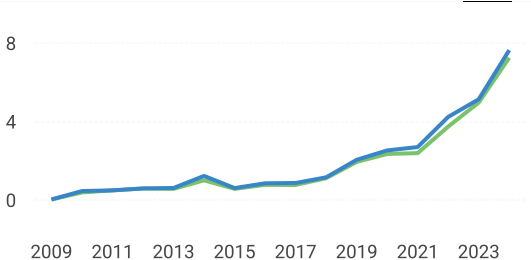
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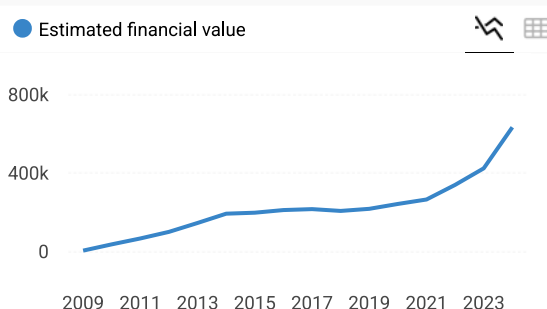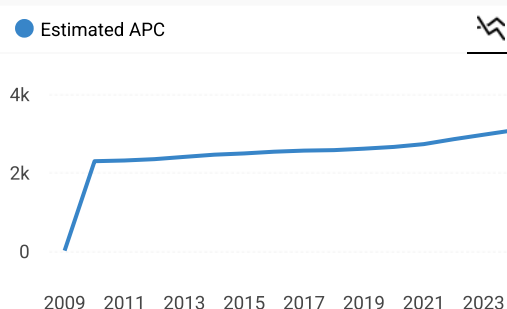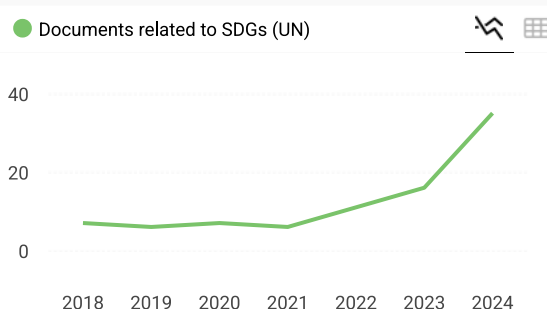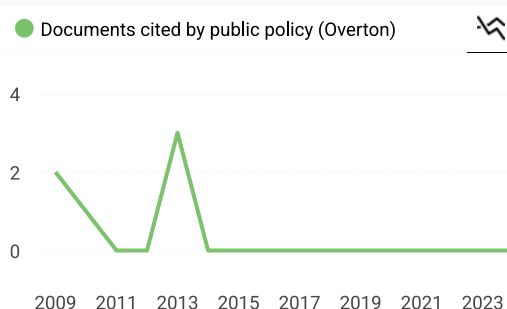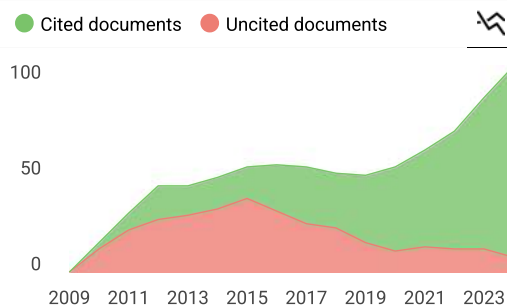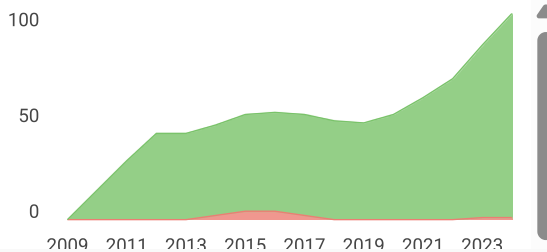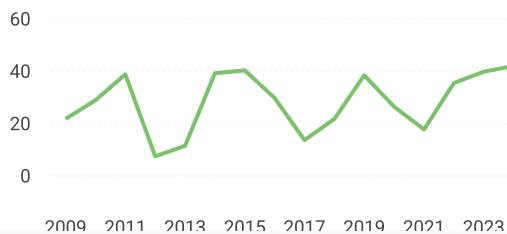
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COVID-19 catastrophes and stock market liquidity: evidence from technology industry of four biggest ASEAN capital market

Sherin Priscilla, Saarce Elsye Hatane and Josua Tarigan
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Abstract

Purpose – This study examines the influence of various COVID-19 catastrophes variables on the stock market liquidity, considering the market depth and market tightness in the technology industry of the four biggest ASEAN capital markets.

Design/methodology/approach – The study utilised the panel data regression analysis obtained from 177 listed technology companies across the four ASEAN countries from March 2, 2020 to June 30, 2021 using the random effect and weighted least squares. The study also supported the result with robustness test, implementing the quantile regression to further present companies' segmentation within the variables.

Findings – The regression results indicate that daily growth COVID-19 confirmed cases and stringency that adversely impacted the stock market liquidity. Confirmed deaths were also found to have a detrimental effect on the stock market liquidity. On the other hand, recoveries and vaccination of COVID-19 enhance the stock market liquidity to escalate.

Research limitations/implications – The study affirms that stock market liquidity is bound to be driven by the COVID-19 variables, but only to be limited to the technology industry observed in four major ASEAN capital markets. Awareness by investors and government could be shifted towards the rise of confirmed cases, recoveries, vaccination and stringency as it improves the liquidity of capital market in aggregate. However, rise of confirmed deaths negatively affect the liquidity. All in all, government and stock market regulator should promote transparency to boost investors' confidence in trading.

Originality/value – This study initiates the investigation in the four biggest ASEAN capital markets, particularly in the technology industry, regarding the COVID-19 catastrophes and stock market liquidity in terms of both market depth and market tightness. Further, this study enriches the impact of COVID-19 by taking the recovery cases and vaccination of COVID-19 as additional consideration.

Keywords COVID-19, Stock market liquidity, ASEAN, Technology

Paper type Research paper

1. Introduction

The year 2020 began with the COVID-19 outbreak which had a major impact on the capital market. Whereas most investors were concerned about a wide range of market threats, the focus of attention dramatically has shifted to the damage wrought by this rapidly spreading virus. Affected nations and presumably international investors were bound by this sensational news, given that there was no certainty of cure in the first several months after the pandemic began. Extreme uncertainty emerged, creating disruption towards the global market that result market volatility to soar into unprecedented heights since 2008 (Baker *et al.*, 2020). Worldwide stock markets induced detrimental impact due to its emerged spread, according to studies conducted in Asia, Europe and North America (Al-Qudah and Houcine, 2021; Al-Awadhi *et al.*, 2020; Ashraf, 2020; Liu *et al.*, 2020; Zhang *et al.*, 2020). Nobody would have foreseen that the emergence of this health crisis would influence the global economy and financial markets.

While it is often assumed that the stock market is somehow driven by exploitation and extreme risk, it is a critical indicator for an economy's health due to its pricing element.

Asian countries have been struck tremendously right after the designation of COVID-19 as a global pandemic, with the Asia Dow Index tumbled by 4% in midday. The pandemic's breakthrough induced ASEAN markets into a tailspin and created significant currency rates fluctuations across the region. Thai baht, Indonesian rupiah and Singapore dollar were the major currencies affected (Policy Brief, 2020). The stock markets in Indonesia, the Philippines, Thailand and Vietnam have lost approximately a quarter of their value. In the first three months of 2020, the market index in Vietnam plummeted by 29.3%, while the index in Malaysia declined significantly by 11.8% (Mishra and Mishra, 2020). Massive effect rose in Indonesia Stock Exchange over the same period as it had implied six trading halts of the stock market through sharp drops of more than 5% in one day (Andriani, 2020).

The airborne transmission further prompts a cascade of tremendous government interventions aimed at adhering to stringent restrictions. All sectors were bound by preventive strategies with prohibiting international travel initially, followed by workplace and school closures. As observed in Singapore, the country effectively integrated the Circuit Breaker period on shutting down clusters while retaining primary economic operations (Beaubien, 2020). The government in Thailand and Malaysia indeed has gone to enforce lockdowns and social isolation while at the same time to preserve economic stability (Das *et al.*, 2020). However, the efficiency of lockdown ranges as some countries have difficulty executing the limitations in more densely populated emerging markets (Rhee and Svirydzenka, 2021). Such as in Indonesia, coronavirus infections soared to the highest in Southeast Asia in April 2020 in the apparent lack of stringent control measures (Jaffrey, 2020).

The financial market was expected a return to normality and stability with the initiation of the first coronavirus vaccines in early 2021. Several studies have discovered that mass vaccinations have significantly lifted the stock market performance (Chan *et al.*, 2021; Hartono, 2021; Rouatbi *et al.*, 2021). Considering mass vaccinations have already been pushed out in Southeast Asian countries, this has enlightened the stock market disruption of a substantial chance of bull market position. Almost 10% of Indonesians, Filipinos and Thailand have been fully vaccinated, whilst 11% of Malaysians have been treated with the doses in Southeast Asia (Nguyen and Karunungan, 2021). However, the effect of mass immunisation on financial market stability remains unexplored in ASEAN nations, particularly in stock market liquidity context. As a result, our study covers the loophole in the connection between immunisation and stock exchange liquidity.

COVID-19's unusual situation piques this study offering the opportunity to assess further research in the most significant four ASEAN stock exchange countries to the recent findings on examining the impact of COVID-19 on financial markets, specifically the stock market liquidity (Alaoui Mdaghri *et al.*, 2020; Chebbi *et al.*, 2021; Nguyen *et al.*, 2021; Umar *et al.*, 2020; Baig *et al.*, 2021). Therefore, the research question in this study is whether COVID-19 variables have impact towards the stock market liquidity. While previous studies focus on big markets, research conducted in emerging markets are still relatively unexplored. This study compromised the four major ASEAN countries due to its economic growth stage and the existence of capital markets, and significant contribution to global economic production. These specific regions are comprehended as ASEAN is highly dependent and harmed by the supply and trade disruption in commerce with China and the US since the respected countries had the most prominent confirmed cases since the first halt in 2020 (Chong *et al.*, 2020). The prominence of these countries – Indonesia, Malaysia, Singapore, Thailand, respectively – derives from their rapid economic growth and capital market liberalisation policies. These nations accounted for about 84% of the region's market capitalisation, which is paramount since this study emphasised on stock markets (Statista, 2021).

The recent capital market crisis has acted as a wake-up call to market participants in investing in the volatile condition. Figures 1 and 2 present the traded volume in four of the biggest capital markets in ASEAN – Indonesia, Thailand, Malaysia and Singapore, respectively. As presented in the pre-pandemic period in 2019, volume traded was increasing from the early year until it started to diminish by the end of 2019 as COVID-19 outbreak began to emerge. During the beginning of post-pandemic 2020, volumes traded were low indicating how investors in ASEAN were in fear on trading stocks in the capital market. In consonance with market efficiency theory, uncertainty leads to dissent within market players, not just amongst the uninformed but also amongst the knowledgeable. This ambiguity is reflected in their buy and sell trading activity (Hasan *et al.*, 2018).

Concerning this, stock market liquidity measurement is an essential tool for providing a comprehensive evaluation of financial stability and economic growth. This study contributes to the market liquidity research by examining the impact of good news and
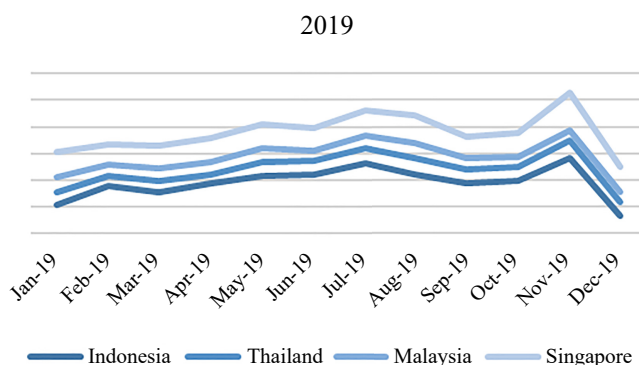
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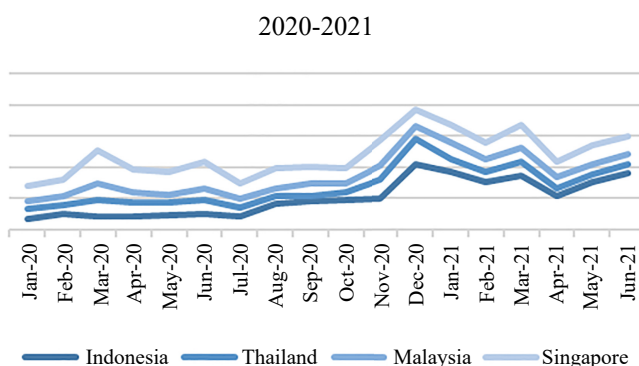
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Source(s): Yahoo Finance

bad news from COVID-19 on market liquidity and illiquidity. The proxy for market liquidity is Closing Percent Quoted Spread (CPQS), introduced by Chung and Zhang (2014), which is known as the best approximation to convey the market tightness in estimating the bid-ask spread. While the market liquidity is proxied by Amihud's illiquidity (Amihud, 2002); this indicator allows various stakeholders to hold and trade stock market securities safely, especially to this fragility of indexes worldwide. Investors can respond to shifting financial needs as an essential part of a company's cost of capital, which influences the portfolio decisions because lower transaction costs imply higher liquidity and vice versa (Ahmed et al., 2020). In addition, the research behind stock market provides insights to the government in relation to a country's economy condition, especially during the epidemic. The consideration of a government controls towards the virus can be adjusted as a way to promote the liquidity in the capital market, thus preserving the outbreak while boost the country's economy health. This implies how the assessment of market liquidity in response to the COVID-19 variables in ASEAN capital market is necessary.

Preceding research has predominantly focussed on the influence of fast-spread virus responses in cases, deaths and stringency. At the same time, the additional impact of COVID-19 recoveries and vaccination is relatively unexplored towards stock market liquidity, especially in the ASEAN countries. Given the above, this research provides a whole package of the crucial aspect of global markets: COVID-19 cases, deaths, stringency, recoveries and vaccination, to fill in the gap of undiscovered problems in the stock market. The novelty of the present epidemic and new developing worldwide patterns such as aggressive globalisation, quickly evolving technology and media banalisation are the driving forces behind this study. The recent scenario allows this study to examine how market participants have responded to the epidemic discussed in the market liquidity context. Remote working, study-from-home, telemedicine and international disputes have been established in the meantime, but with the emphasis on minimising the spread of COVID-19, these practices have rapidly expanded (Bradley and Stumpner, 2021). Previous research has primarily focussed on aggregate sectors, leaving the influence of specific industries on financial markets unexplored. This study addressed this void, at least in part, by concentrating on the sector that mainly took on the lead during the pandemic: the technology industry.

Further, the paper is organised as follow: The second section introduces the literature review and research hypotheses. Section three comprises the data and empirical approach. Empirical findings alongside robustness test are presented in section four. Last but not least, conclusion and limitation of this research will be in section five.

2. Literature review
2.1 Efficient market hypothesis theory
The Efficient Market Hypothesis (EMH) has been the prevailing paradigm in the stock market. An efficient capital market depicts how stock prices adequately reflect all available information (Fama, 1970). It tackles how security market prices adjust and change, which is a significant implication for both investors and financial managers, especially in a fragile market condition caused by the COVID-19 crisis. Information accessibility is essential for EMH to analyse market reaction to news and events following the publication of the information. The press plays an essential role in conveying information to capital markets (Frendy and Hu, 2014). Depending on the investor's level of expectation, such events and news may have both ordinary and exceptional effects on investment decisions.

The majority of researchers viewed EMH as a theory that needed to be adjusted based on market conditions at the time. In order to test the relevance, the three levels of market efficiency classified as "weak-form, semi-strong form, and strong form" require varying levels of knowledge. Just as the information is equally accessible and disseminated directly to the stock market, technological advancements quickly impact the rise in the efficient market. Institutional investors have the capacity to evaluate publicly accessible data as well as the ability to gain access to private data. Individual investors, on average, increase their information demand during moments of heightened market uncertainty. Market uncertainty considerably impacts individual investors' need for information (Hasan *et al.*, 2018). As a result, these investors will respond immediately when new information emerges, and prices will act accordingly. This can be seen through the conveyance of COVID-19 illness, as seen by the deflected stock market performance during the outbreak peak. Several studies examine investors' reactions in the equity market segment across countries due to the COVID-19 disease outbreak (Salisu and Vo, 2020; Shaikh and Huynh, 2022). The stock market performance is dependent on both private and public information that is immediately accessible and is reflected in the stock's fair price.

2.2 Stock market liquidity

The issue of market liquidity is a contentious issue amongst investors. Market liquidity is one of the most essential tools for measuring financial stability and economic growth. Liquid markets are commonly regarded as desirable due to the various advantages, such as better allocation and information quality. The indicator is used by a wide range of decision-makers seeking safeguard stability in the stock market, as liquid stock indicates that prices are informative (ElBannan and Farooq, 2019). This is also one of the key indicators of a company's cost of capital, which impacts investors' portfolio decisions because cheaper transaction costs indicate higher liquidity. Market liquidity is defined as the capacity of a particular asset to be exchanged in the market in a relatively short period of time with a minimum cost or loss of value (Kyle, 1985). This means, if market participants may quickly sell large quantities of a financial asset without negatively impacting its price, the asset is considered liquid.

Several liquidity interventions have been proposed in the growing empirical literature to capture all of the aforementioned dimensions. The decision to use one liquidity measure over another is inextricably linked to the data's availability. Several researchers have investigated Liquid markets (Lybek and Sarr, 2002; Wyss, 2004) to have four primary characteristics: tightness, depth, breath and resiliency. Tightness refers to low transaction costs, such as the disparity between buying and selling rates, as well as implied costs, such as bid-ask spreads in quote-driven markets. Depth refers to the presence of several orders from potential buyers and sellers, either actual or easily discovered, both above and below the current price at which a security trade. The term "breadth" refers to orders that are both numerous and wide in number, with minor price effects. Resiliency is a business trait in which new orders flow rapidly to correct order imbalances, which appear to drive prices away from what fundamentals warrant. No single liquidity indicator, however, adequately account for all of the aforementioned elements.

More benefits arise from stocks' various liquidity capabilities, which play an essential role in enabling investors to minimise substantial costs. According to the liquidity-adjusted Capital Asset Pricing Model (CAPM), the liquidity component must be considered for anticipating stock market returns (Acharya and Pedersen, 2005). Several papers have been undertaken to respond to this, emphasising the significance of market liquidity in stock market returns. Researchers have shown that capital market liquidity strongly influences stock returns (Abdullahi and Fakunmoju, 2019; Naik and Reddy, 2021). Since it is convenient

to exchange securities, it triggers investor to purchase shares and cause a company's stock price to rise. Conversely, low liquidity is deemed to have a higher risk, resulting in higher stock market returns as observed in small structures (Sammakhi and Mehrabi, 2016).

2.3 COVID-19 catastrophes

In terms of events, stock markets are remarkably vulnerable to significant and unusual occurrences. It covers media coverage, political events, natural disasters, terrorism threats and market crashes (Fauzi and Wahyudi, 2016; Liu and Zhang, 2015; Tavor and Teitler-Regev, 2019; Nguyen and Chaiechi, 2021; Wu and Lin, 2017). Several papers also observed initial outbreaks such as SARS and Ebola towards the stock market (Chen *et al.*, 2007; Marinč, 2016; Ichev and Marinc, 2018). Nonetheless, studies found that COVID-19 influences the stock market more than any previous outbreaks that ever struck the world (Kaur and Saxena, 2020; Feng and Li, 2021). COVID-19 is a worldwide emergency that significantly disrupted economic activities, halting the movement of goods and people and affecting various industries across the country.

Previous studies have been conducted specifically on the stock market performance in the context of this rapidly spreading illness. While the stock market has grown particularly volatile and unpredictable, the severity of the pandemic in each state is directly linked to individual stock market fluctuations (Zhang *et al.*, 2020). As observed in six major affected regions – Africa, Americas, Eastern Mediterranean, Europe, South-East Asia and Western Pacific – the virus breakout has had a substantial negative impact on the performance of key stock indices to the surge in reported COVID-19 cases (Al-Qudah and Houcine, 2021). The findings are also consistent with studies conducted in 64 countries, which discovered that stock markets respond quickly to pandemics and that this response evolves over time due to the severity of the pandemic (Ashraf, 2020).

Preventive measures such as lockdown that are applied to inhibit the spread also influence the capital market. Stricter regulations by government interventions significantly impact the stock markets in relation to how investors incorporate this implementation, as observed in big emerging countries (Scherf *et al.*, 2021). However, when stringent restrictions are toned down, market participants react negatively and positively to later relaxations. In diminishing the high rate of cases, lockdown is implemented in Vietnam and surprisingly positively influences the stock market performance (Anh and Gan, 2020). Investor confidence has risen as a result of government interference during the lockdown and increased capital inflow from appealing undervalued stocks, which has helped restore the Vietnam stock market.

Despite various results, the findings are all related to the COVID-19 outbreak influence towards the stock market performance. However, as shown in Table 1, numerous former COVID-19 research studies have only focussed primarily on stock market return, and there has been limited examination of stock market liquidity. During the pandemic, the Indian stock market was the most illiquid of the examined countries (Umar *et al.*, 2020). The research also highlights how illiquidity and volatility spiked in the aftermath of the COVID-19 announcement, but that the issue was only temporary as it soon recovered. It is aligned with the research conducted by Baig *et al.* (2021) as stock market liquidity deteriorates and volatility emerged to 580% as correspondence to the rapid spread of the coronavirus, including restrictions and lockdowns. Observed in the S&P500 index, it implies how pandemics also decrease the firm liquidity affected by the growth of confirmed cases and total deaths (Chebbi *et al.*, 2021). Previous research was also performed in six MENA countries indicate that COVID-19 influenced the stock market liquidity in the measurement of market depth and tightness (Alaoui Mdaghri *et al.*, 2020). The previous finding is confirmed in the study observed in Vietnam, as the increased intensity of COVID converts the stock market to more illiquid, thus increasing the transaction cost. However, strict preventive

No	Authors	Variables	Key findings
1	Umar *et al.* (2020)	Independent variable: Covid-19 new cases and recorded deaths Dependent variable: Stock market's liquidity	Illiquidity and volatility rose in response to the Covid-19 breaking news, but the negative impact on stock market liquidity was short-lived, as liquidity quickly returned to normal. Furthermore, there is no longer-term link between Covid-19 incidence and stock market liquidity
2	Nguyen *et al.* (2021)	Independent variable: Government's disease control and daily Covid-19 case growth Dependent variable: Stock market return and liquidity	COVID-19-related daily increases in the total number of confirmed cases have a considerable adverse impact on stock market returns and liquidity. Despite this, the government's lockdown has a big and favourable impact on stock performance
3	Baig *et al.* (2021)	Independent variable: reported number of confirmed Covid-19 cases, Covid-19 death, government restriction, news and mobility restriction Dependent variable: KSE-100 Index in Pakistan	At the individual stock level, the reported number of confirmed coronavirus infections and deaths, overall bad attitude caused by news, limited mobility and stricter government restrictions have a detrimental influence on the stock market's liquidity and volatility
4	Chebbi *et al.* (2021)	Independent Variable: Daily growth rate of Covid-19 confirmed cases and Daily growth of Covid-19 confirmed death Dependent variable: S&P 500 stock liquidity	The correlation between COVID-19 and stock liquidity is negative and significant
5	Alaoui Mdaghri *et al.* (2020)	Independent variable: Daily growth rate of Covid-19 confirmed cases, daily growth of Covid-19 confirmed death and stringency index Dependent variable: Market depth and market tightness	The rise in the confirmed number of cases and deaths, as well as the stringency index, were all positively connected with the liquidity related to the depth measure. Furthermore, market depth was favourably connected to verified COVID-19 instances

Table 1.
Previous studies about
COVID-19 on market
liquidity

intervention such as lockdown brings a significant and positive influence towards the stock market liquidity of financial sectors in the Vietnam Stock Exchange (Nguyen *et al.*, 2021).

2.4 COVID-19 cases and stock market liquidity
The high breakthrough of COVID-19 cases has captured the world's attention towards the health crisis ever since the first case in Wuhan, China, was discovered on December 31, 2019 (Archived: WHO Timeline COVID-19, 2020). Regardless of the fact that it has a lower fatality rate than most outbreaks, the transmission rate of COVID-19 is currently estimated to be considerably higher (Abiad *et al.*, 2020). The outbreak of COVID-19 did, in effect, boost investors' fear about the safety of trading stocks without incurring substantial losses, referring to stock market liquidity. In consonance with EMH theory, technological advances result in the emergence of information, which would trigger the investors to respond and force them into price protection to process and analyse the shocks. This matter results in postponing the trading activity, which decreases the liquidity of the stock market (Boubaker *et al.*, 2019).

Previous studies have shown that growth cases of confirmed COVID-19 influence the stock market liquidity, as shown in Table 1. As the growth confirmed cases rise at an alarming rate, stock liquidity is negatively correlated as conducted in MENA countries.

Market depth is associated with the growth rate of COVID-19 cases, indicating that the market converting into illiquid due to a decrease in trading volume. It also applies to market tightness as the gap within the bid-ask spread is more comprehensive due to higher transaction cost in trading the securities (Alaoui Mdaghri *et al.*, 2020). Observed in the Vietnam Stock Exchange using the random effects, the research confirms that higher growth rate of confirmed people intact with the virus to drop the stock market liquidity. Then, as of now, the depth of the market is more profound, and transaction cost within the spread in terms of tightness is higher (Nguyen *et al.*, 2021). A significant negative correlation was also confirmed in the study examined in the S&P500 index. It implies that the daily growth of confirmed cases increases the firm's stock performance (Chebbi *et al.*, 2021). The US capital market is also similarly experiencing a detrimental impact on market liquidity. Throughout terms of the market depth, every percent growth in confirmed cases appears to increase illiquidity by 0.041%. While a 1% rise in the bid-ask spread widens the spread gap by 0.038%, all of this confirms that confirmed cases degrade stock market liquidity. In that regard, the purpose of this research is to examine the following hypotheses:

H1. COVID-19 cases impact towards the stock market liquidity.

2.5 COVID-19 death cases, recoveries and vaccinations

Throughout history, there have been many epidemic diseases that have resulted in many deaths. As of 25 April 2021, the total recorded death cases by COVID-19 worldwide have reached 3,092,497 deaths (WHO, 2021). People have become mournfully aware of the death tolls that their governments publish each day as COVID-19 has spread worldwide. This issue is reflected in the stock market liquidity as observed in S&P500; growing death cases by the novel coronavirus has induced a decrease in company liquidity (Chebbi *et al.*, 2021). Utilising the market tightness, the spread measurement is positively correlated with the growth of deaths, resulting in higher transaction costs as deaths of COVID-19 occurred. Death cases also decrease the liquidity but only in terms of market depth, as observed in six MENA countries (Alaoui Mdaghri *et al.*, 2020). On the other side, the US equity market captures how both measurement of stock market liquidity (depth and tightness) is negatively affected by the increase of death cases (Baig *et al.*, 2021). As opposed to all previous findings, the growth rate of death caused by the airborne virus results in no significant impact towards the stock market liquidity as examined in Vietnam (Nguyen *et al.*, 2021). Nonetheless, recovery cases have not been explored; as most research predominantly focussed on deaths. This study enhances the research on assessing the recovery cases of COVID-19 towards the stock market liquidity.

The year 2021 has brought to light the dark tunnel brought by COVID-19, as vaccinations arise as a treatment to boost immunity towards the virus. This topic is remained limited as vaccination had just started in the early year 2021. Several findings integrated that vaccinations of the COVID-19 brought light to the stock market performance (Hartono, 2021; Chan *et al.*, 2021). As evidenced by the contribution of the Diphtheria, Tetanus and Pertussis (DTP) vaccination, it is found to have a long-term effect on economic development (Masia *et al.*, 2018). The outcome was determined to be substantial, and it is thus vital to place more emphasis priority on vaccination programs in an attempt to optimise economic performance. The COVID-19 vaccination helps promote stability and reduce the volatility level of the global financial market (Acharya *et al.*, 2021; Rouatbi *et al.*, 2021). This reflects how financial markets throughout the world deliver significant information on market anticipation for COVID-19 vaccine development. Regardless, a specific indicator of stock market performance such as stock market liquidity is yet remained conducted. This research further assesses the vaccination influence on the stock market liquidity, mainly in the four ASEAN countries. Taking all into account, generated hypotheses would be:

H2a. COVID-19 death cases impact towards stock market liquidity.

H2b. COVID-19 recovery cases impact towards stock market liquidity.

H2c. COVID-19 vaccination impact towards stock market liquidity.

2.6 COVID-19 stringency and stock market liquidity

The widespread coronavirus epidemic (COVID-19) is a disease that has propagated to approximately every country around the world. The spread and intensity of the outbreak prompted government actions such as travel restrictions and quarantines, which halted production and all other economic activities (Ramelli and Wagner, 2020). Aside from the fact that the severity of these impacts varies greatly between countries, some have been somewhat effective in attenuating disease transmission and reducing fatalities. Variability in government policy responses may account for any discrepancies of this stringent control in relation to each country condition. However, the integration of the lockdown must be conducted at the opportune timing to get the most benefit in terms of disease control (Oraby *et al.*, 2021). Das *et al.* (2020) explained that the time required for the virus to decrease would rise as the number of days it takes to begin lockdown surges, especially in the absence of any particular treatment for COVID-19 in the early year.

The Oxford Coronavirus Government Response Tracker provided the analysis on related policy responses (OxCGRT). OxCGRT compiles publicly accessible data on the composite measure on nine of the response metrics covering public closures, movement restrictions, stay-at-home orders and international travel ban. The daily index ranges from 1 to 100, representing the level of government intervention on the COVID-19 outbreak (COVID-19 Government Response Tracker, 2020). On the other hand, these indicators represent the magnitude of government policies, not the efficiency of a government's responses.

Many economic activities were interrupted as a result of the government's interference. As examined of stringent implementation in 49 countries, workplace and school closures degrade market performance, especially in emerging countries (Zaremba *et al.*, 2021). The restrictions on controlling the virus impact the trading activity since it disrupts investment decision-making in the capital market. Further research agrees with the effect of restriction, as 1% increase of stringency attributed to the increase of 0.11% in illiquidity and 0.1% in widening the gap of bid-ask spread as observed in the US equity market (Baig *et al.*, 2021). The governments' responses in six MENA countries have also precipitated a liquidity jolt on the stock market due to the rise of the stringency index (Alaoui Mdaghri *et al.*, 2020). On the other note, however, the implementation of lockdowns in the financial sectors, as observed in Vietnam, brought higher liquidity on the stock market (Nguyen *et al.*, 2021). Government's containment strategy on combating the pandemic trust investors' confidence which revives and boost the stock market liquidity. The enforcement of constraints and lockdowns has seemed to be underlying factors to drive the market liquidity. Furthermore, this research integrates the implication towards the four major ASEAN capital markets. This suggests hypotheses for analysing:

H3. COVID-19 stringency impact towards stock market liquidity.

3. Data and methodology

3.1 Data

In terms of sampling, the unit analysis for this research was derived from 177 technology industry firms listed on four major ASEAN capital markets: the Indonesia Stock Exchange, the Stock Exchange of Thailand, Bursa Malaysia and the Singapore Exchange. Studies within the technology sectors are conducted as the new reality of COVID-19 led to

subsequent migration of daily activities to the digital realm. Strong fundamentals have supported the IT sector's extraordinary rise, and according to experts, is well-positioned to give investors favourable returns in the following years (Schaefer *et al.*, 2020). In the scope of the study, 50,268 daily-firms panel sample units are examined, spanning the period from March 2, 2020 to June 30, 2021, correspondingly, to cover active trading days across the respected countries. The period's start date was also implemented to consider the reported COVID-19 first cases in each country. Financial data were collected from Bloomberg, whilst data on COVID-19 cases, death, recoveries, vaccination and stringency index were retrieved from John Hopkins' database and referred to the Ourworldindata website.

3.2 Methodology
For the reason of variables indicated in the previous sub-chapter, the focus of this study conducts on a multiple regression approach on panel data that encompasses both time series and cross-sectional of firm financial performance data as it is more appropriate for empirical analysis (Anh and Gan, 2020). Furthermore, the panel-data regression approach is also known for its ability to discover time-variant correlations across the dependent and other explanatory variables whilst reducing the risk of biases estimation, individual variability and multicollinearity (Hsiao, 2014). Therefore, the study developed a panel regression model to investigate the influence of the COVID-19 variables upon two measurements of stock market liquidity:

$$AMIHUD_{i,t} = \beta_1 \text{CASE\_G}_{i,t} + \beta_2 \text{DEATH\_G}_{i,t} + \beta_3 \text{RECOV\_G}_{i,t} + \beta_4 \text{VAC}_{i,t} + \beta_5 \text{SGEN}_{i,t}$$
$$+ \beta_6 \text{M\_CAP}_{i,t} + \beta_7 \text{GK\_VOL}_{i,t} + \beta_8 \text{INDEX\_R}_{i,t} + \beta_9 EXC\_R_{i,t}$$
$$+ \beta_{10} INTER\_R_{i,t} + \beta_{11} \text{GOLD}_{i,t}$$

$$CPQS_{i,t} = \beta_1 \text{CASE\_G}_{i,t} + \beta_2 \text{DEATH\_G}_{i,t} + \beta_3 \text{RECOV\_G}_{i,t} + \beta_4 \text{VAC}_{i,t} + \beta_5 \text{SGEN}_{i,t}$$
$$+ \beta_6 \text{M\_CAP}_{i,t} + \beta_7 \text{GK\_VOL}_{i,t} + \beta_8 \text{INDEX\_R}_{i,t} + \beta_9 EXC\_R_{i,t} + \beta_{10} INTER\_R_{i,t}$$
$$+ \beta_{11} \text{GOLD}_{i,t}$$

3.3 Dependent variables
This study used two distinct proxies to represent both market depth and tightness since the latter is multifunctional. According to previous studies, the measurement of stock liquidity does not cover resiliency and immediacy (Alaoui Mdaghri *et al.*, 2020; Nguyen *et al.*, 2021). The first dependent variable of stock market liquidity measurement is calculated using market depth as Amihud's (2002) proposed, namely illiquidity. The price disruption caused by a one-dollar volume was measured with this indicator. This ratio is calculated by dividing the stock's daily dollar trading volume by its absolute daily return. Due to Amihud's "Illiquidity" feature, this measurement implies the reverse direction, with a higher ratio reflecting less liquid stocks. This is calculated using the following equation:

$$\text{AMIHUD}_{i,t} = \frac{|R_{i,t}|}{\text{Ln}(\text{Volume}_{i,t})}$$

$R_{i,t}$ indicates the daily stock return calculated by dividing closing price at t with the closing price at t–1; Volume$_{i,t}$ expressed by the dollar volume of stock i at day t. In this study, the illiquid measure is referred to as AMIHUD.

Effective spread is utilised as the second dependent variable in measuring market tightness, generally derived from the bid-ask spread. Chung and Zhang (2014) introduced that the CPQS is used in this study as the best approximation to convey the market tightness in estimating the bid-ask spread (Gao *et al.*, 2020). However, aligned with market depth, this measurement also has the opposite direction. Higher CPQS signify a wider spread of bid-ask, implying less liquidity.

$$\text{CPQS} = \frac{\text{Ask price}_{i,t} - \text{Bid price}_{i,t}}{\left(\text{Ask price}_{i,t} - \text{Bid price}_{i,t}\right)/2}$$

$\text{Ask}_{i,t}$ is the ask closing price of stock i on day t, whereas $B_{i,t}$, t is the bid closing price of stock i on day t.

3.4 Independent variables
Taking into account the COVID-19 outbreak, this study used five independent variables performing daily COVID-19 confirmed cases, deaths, recoveries, vaccination and the stringency index in the four major ASEAN capital markets.

The first variable is the daily growth of the total number of confirmed cases and was denoted as CASE. It is measured by the additional COVID-19 confirmed cases daily.

The second variable is designed as the daily growth of the number of confirmed deaths and denoted as DEATH.

Regarding assessing further gaps, daily growth recovery of COVID-19 cases is also implied as to the third independent variable and denoted with RECOV. It is derived from the additional COVID-19 recovery cases daily.

With the introduction of vaccination in early 2021, the fourth independent variable is the fully vaccinated cases denoted as VAC. It is counted by the total fully vaccinated COVID-19 citizen daily.

The last variable was computed with the daily stringency index and was denoted as SGEN. It should be emphasised that the latter is an index rescaled ranging between 0 and 100 and demonstrates the governments' actions in dealing with the COVID-19 pandemic. A metric that comprises a greater stringency index would annotate that the government is taking more stringent preventative actions.

3.5 Control variables
Control variables are implemented that are presumed to influence stock market liquidity for each company respectively. In terms of corporate level, daily market capitalisation is incorporated by the logarithm of daily closing price multiplied by outstanding shares of each firm to assess the impact of different company sizes. This variable is denoted as M_CAP. Unexpected fluctuations in market volatility substantially influence stock liquidity (Cheriyan and Lazar, 2019). In a precursor to a reduction in stock liquidity, the volatility shock increases (Lee *et al.*, 2017). In regard to that, volatility is regarded as controls by inducing daily volatility using Garman and Klass (1980) to estimate the volatility denoted as GK_VOL. The formula for this measurement is as follows:

$$GK_{vol} = \sqrt{\frac{1}{2}\left(log\left(\frac{HPi_{i,t}}{LP_{i,t}}\right)^2 - (2.log(2)-1).log\left(\frac{CP_{i,t}}{OP_{i,t}}\right)\right)}$$

where $HP_{i,t}$, $LP_{i,t}$, $Cp_{i,t}$, and $OP_{i,t}$ represent the highest, lowest, closing and opening prices of company i on day t, correspondingly.

This study further incorporated the daily stock market return each of the four ASEAN capital market indexes, notably, Indonesia Stock Exchange, the Stock Exchange of Thailand, Bursa Malaysia and the Singapore Exchange depicted by INDEX_R. On a macroeconomic scale, daily exchange rates against the US dollar of each respected country are opted as envisaging the impact of the FX market towards the stock liquidity during the COVID-19 period, denoted as EXC_R. The measure is essential as outstanding stock market performance attracts foreign capital to the economy, boost the stock market and, in response, increase the currency (Gokmenoglu *et al.*, 2021). The foundation of liquidity in the stock market comes from monetary policy, expressed in interest rates as the most used instrument in various nations (Keister, 2019; Sun and Yuan, 2021). In regard to that, daily interest rate is used as a control variable as it is essential towards stock market liquidity, denoted as INTER_R.

Last but not least, an additional control variable on the daily gold price is also accounted for denoted as GOLD. The current pandemic boosts the demand for gold as a "safe haven" during economic turbulence, thus implying the surge to add as the control variable in this research (Yousef and Shehadeh, 2020).

4. Empirical findings

4.1 Descriptive statistics and statistical test

Table 2 depicts the descriptive statistics of the variables conducted in the developed panel regression model on 50,268 observations. Market depth is denoted with AMIHUD, which shows a mean average of 0.14%. The measurement had the highest value with 0.325 and a minimum of 0. The second method of calculating the market liquidity is market tightness, which refers to CPQS. The average is higher than the overall market depth, which accounts for 3.7%. As observed, the CPQS accounts for a maximum value of 1, with the minimum at negative 1.06. Going through the COVID-19 variables, confirmed cases and deaths of the disease accounted for an average of 1278.51 cases and 2040.45, respectively. Daily growth cases have reached 21,807 cases and over 44,270 death cases.

The growth rate of COVID-19 recoveries presents a high mean of 3972.81 cases, reaching a maximum of 44,270 and a minimum of 0 recoveries. In terms of the breakthrough vaccination a year after the outbreak rise, the average of the total vaccination accounts for 294,708. Record is maximum total vaccination accounts for 13,465,499 with a zero minimum vaccination is depicted. With four countries observed, stringency in regard to the COVID-19

	Mean	Sd	Min	Max
AMIHUD	0.0015	0.01973	0	0.325
CPQS	0.0376	0.0836	−1.0568	1
CASE_G	1278.51	2157.51	0	21,807
DEATH_G	2040.45	4188.46	0	44,270
RECOV_G	3972.81	6422.99	0	44,270
VAC	294708.90	1130569.24	0	13,465,499
SGEN	61.3274	13.9601	0	80.56
M_CAP	7.7347	0.6514	5.9644	10.4908
GK_VOL	0.1491	0.0872	0	0.7157
INDEX_R	0.0003	0.0143	−0.1112	0.1019
EXC_R	0.2656	0.2353	6.04E-05	0.759
INTER_R	2.553431	1.4276	0.697	8.322
GOLD	1682.87	460.2157	14.7146	2062.75

Table 2.
Descriptive statistics

Source(s): Authors' calculation

preventive measures has 61.33 on average, with the highest index reaching 80.56 and a minimum of 0 stringencies. The standard deviation illustrated in Table 2 diversely occurs by virtue of some variables that use absolute numbers.

Table 3 portrays the Pearson correlation matrix across all variables observed. Findings imply that there is no multicollinearity issue since no strong relationship amongst the variables is found. This is supported by variance inflation factors (VIF) of each variable which is less than 10.

Earlier studies incorporated random effects on the panel data regression model on stock market liquidity measurement and panel data regression models (Alaoui Mdaghri *et al.*, 2020; Nguyen *et al.*, 2021). Given data variability and the results from Table 4, the market depth – AMIHUD – is examined using random-effects, whilst the market tightness – CPQS – is examined using weighted least squares (WLS) as the best approach to address the presence of the common data issue, heteroskedasticity in fixed effect model (Usman *et al.*, 2019).

Table 5 portrays the regression results between each stock market liquidity towards the independent and control variables. The AMIHUD metric is strongly correlated with the COVID-19 vaccination cases and hence the stringency index. The growth rate of the recovery cases has also proven to influence the AMIHUD, but only at 5% level. Research signifies that the stock market's depth measure is favourably impacted by the COVID-19 daily recovery rate and vaccination cases by 1 and 10%, respectively, through implying higher liquidity by the inoculation. Further to that, the stock market depth appears to be substantially influenced by the restrictions applied by the governments on the technology industry of four major ASEAN countries to forestall and prevent the contagion. However, the market depth is not significantly influenced by the daily rise of confirmed and death cases of the novel virus.

The presented table further revealed that market tightness, as measured by CPQS, is significantly integrated into the increase in daily confirmed cases, death, recovery and stringency. In terms of death cases by the virus, the transaction cost to trade stocks increases, and so does the death cases. Conversely, rise in COVID-19 daily confirmed cases, recoveries and stringency index significantly enhance the stock market to be more liquid. At last, vaccination of the COVID-19 featured to have no significant impact towards the spread measurement.

Regarding firm-related characteristics, firms' market capitalisation significantly influenced the market tightness in a negative correlation. The volatility index as measured by GK_VOL also has a significant positive correlation towards the tightness of stock market liquidity. Both AMIHUD and CPQS are affected by the four respected indexed market returns, exhibiting higher index returns to increase stock market liquidity. The exchange rate is found to significantly influence the CPQS, as a higher rate of exchange hinders the stock market liquidity. On the other side, the interest rate is found to have different significant results on both market liquidity measurements. In AMIHUD, a higher interest rate increases the liquidity at 10% level, while in CPQS, the increase of interest rate at 5% level triggers illiquidity. Last but not least, the role of gold price towards the stock market liquidity is found to have a high influence indicating that the rise of gold price decrease of the two stock market liquidity measures.

4.2 Country analysis
In order to create a comprehensive point of view on the impact of COVID-19 catastrophes towards the capital market, this study conducted extensive panel regression research on four ASEAN capital markets namely: Indonesia, Thailand, Malaysia, and Singapore. This further had been taken into account as it may be presumed that each country responds differently towards the outbreak variables. Below, the regression findings for each respected country's market liquidity in terms of depth (AMIHUD) and tightness (CPQS) are presented in Tables 6 and 7.

Table 3.
Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) AMIHUD	1												
(2) CPQS	-0.015**	1											
(3) CASE_R	-0.040**	-0.124**	1										
(4) DEATH_R	-0.037**	-0.086**	0.739**	1									
(5) RECOV_R	-0.045**	-0.074**	0.452**	0.662**	1								
(6) VAC	-0.005	-0.094**	0.543**	0.364**	0.105**	1							
(7) SGEN	-0.051**	-0.035**	0.376**	0.310**	0.373**	0.106**	1						
(8) M_CAP	0.111**	-0.356**	0.039**	0.026**	0.005	0.046**	-0.057**	1					
(9) G_VOL	-0.019**	0.357**	0.004	0.003	0.049**	-0.016**	0.080**	-0.196**	1				
(10) INDEX_R	-0.001	-0.011*	-0.024**	-0.020**	-0.050**	-0.017**	0.130**	0.006	-0.022**	1			
(11) EXC_R	0.150**	0.178**	-0.233**	-0.190**	-0.107**	-0.087**	-0.150**	-0.093**	-0.083**	-0.008	1		
(12) INTER_R	-0.076**	-0.078**	0.489**	0.386**	0.252**	0.287**	0.317**	-0.099**	0.075**	0.001	-0.424**	1	
(13) GOLD	0.020**	0.083**	-0.388**	-0.262**	0.032**	-0.339**	-0.033**	0.041**	0.044**	0.008	0.300**	-0.806**	1
VIF mean	–	–	3.124	3.25	2.329	1.518	1.494	1.091	1.082	1.034	1.275	4.944	4.336

Note(s): **Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Model and p-value	Heteroskedasticity test	Fixed effect estimator (Chow Test)	Random effects estimator (Breusch–Pagan test)	Fixed vs random effects estimator (Hausman Test)
AMIHUD	TR^2 = 5598.669009, with p-value = P(Chi-square(77) > 5598.669009) = 0.000000	F(176, 50,080) = 32422.7 with p-value 0.000	LM = 6.96289e+006 with p-value = prob(chi-square(1) > 6.96289e+006) = 0.000	H = 7.77139 with p-value = prob(chi-square(8) > 7.77139) = 0.456114 *Result: Random Effect Model*
CPQS	TR^2 = 13170.329199, with p-value = P(Chi-square(77) > 13170.329199) = 0.0000	F(176, 50,080) = 301.932 with p-value 0.000	LM = 1.40365e+006 with p-value = prob(chi-square(1) > 1.40365e+006) = 0.000	H = 500.008 with p-value = prob(chi-square(8) > 500.008) = 7.00606e-103 *Result: Fixed Effect Model*

Table 4.
Heteroskedasticity test
and panel effects
model test

	AMIHUD	CPQS
Constant	0.0005 (0.0015)	0.1639 (0.002)
CASES_R	5.4137e-09 (6.7775e-09)	−5.6175e-07*** (1.0053e-07)
DEATH_R	3.1258e-09 (3.5213e-09)	3.742e-07*** (5.3149e-08)
RECOV_R	−3.6415e-09* (2.021e-09)	−2.9814e-07*** (2.5939e-08)
VAC	−2.8248e-011*** (8.8294e-012)	1.2023e-011 (1.6731e-010)
SGEN	−2.3083e-06*** (7.1267e-07)	−4.0085e-05*** (8.3677e-06)
M_CAP	5.114e-05 (5.2166e-05)	−0.0211*** (0.0002)
GK_VOL	−5.1602e-05 (0.0001)	0.092*** (0.0017)
INDEX_R	−0.0013** (0.0006)	−0.0234*** (0.0067)
EXC_R	0.0006 (0.0011)	0.0256*** (0.0005)
INTER_R	−0.0001*** (3.177e-05)	0.0003** (0.0002)
GOLD	5.1137e-07*** (1.0394e-07)	3.9614e-06*** (5.305e-07)
p-value	2.2583e-019	0.000
R-squared	0.0086	0.282072

Table 5.
Regression results

Note(s): Robust standard errors are stated in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Variables	Indonesia	Thailand	Malaysia	Singapore
Constant	−4.83075e-06	2.56314e-05***	6.06225e-06**	−0.0123391*
CASES_R	7.27195e-011	9.92641e-011	1.07110e-011	−2.98346e-07
DEATH_R	−1.35541e-011	3.70743e-011	7.66503e-012	−1.49933e-05
RECOV_R	−2.83755e-010	4.98446e-011	−3.20559e-012	−7.22412e-08
VAC	−1.65575e-013**	−3.12060e-013	0.000000	−2.12529e-011
SGEN	−1.66729e-07***	−4.05901e-08***	−6.37981e-09**	−5.10187e-08
M_CAP	6.19444e-09	−2.16692e-07	−1.24189e-07***	0.00318838***
GK_VOL	−4.28986e-06	−1.37606e-05***	−1.31551e-06***	0.00304941***
INDEX_R	−5.22651e-06	5.15216e-06	2.08368e-06	0.00157897
EXC_R	−0.142198	−0.000466080***	−1.01395e-05	−0.0152682
INTER_R	2.46884e-06*	−1.38416e-06**	−1.77414e-07	−9.18309e-05
GOLD	7.73575e-07*	−1.55410e-09	−7.47792e-010*	3.56966e-07
p-value (F)	1.43e-08	1.48e-13	0.001239	2.91e-27
Adjusted R Square	0.014013	0.006852	0.000722	0.016066

Table 6.
Regression results for AMIHUD in each respected country

Note(s): Robust standard errors are stated in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Variables	Indonesia	Thailand	Malaysia	Singapore
Constant	0.315417***	0.0678757***	0.454686***	0.446556***
CASES_R	−2.71643e-06***	−2.39863e-08	6.18696e-07***	3.52328e-06
DEATH_R	−1.91573e-08	9.77234e-09	2.09733e-07**	0.00161199
RECOV_R	1.83247e-07	1.05024e-07	−8.89326e-08**	−1.79617e-06
VAC	−8.93081e-010***	−2.23336e-010	−9.07204e-010	1.84513e-09
SGEN	0.000134816	−6.35327e-05***	−9.14472e-05***	−0.000328495***
M_CAP	0.000513429	−0.00640476***	−0.0068***	−0.0330997***
GK_VOL	−0.0227482	0.107652***	0.0417***	−0.0341131***
INDEX_R	0.0881983	−0.00945534	−0.276872	0.0566556
EXC_R	−2277.44***	−0.181758	−0.561836***	−0.148200***
INTER_R	−0.0147672***	−0.000595616	−0.00715114***	−0.00641641*
GOLD	−0.00252718**	−4.36910e-06*	−3.44216e-05***	−9.68324e-06
p-value (F)	1.26e-07	1.1e-183	0.000000	3.0e-243
Adjusted R Square	0.012521	0.078229	0.211116	0.123074

Table 7.
Regression results for CPQS in each respected country

Note(s): Robust standard errors are stated in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

In contemplation of market depth findings, the COVID-19 stringency had a detrimental impact on all countries except in Singapore. This result was consistent with the findings in aggregate with a favourable result, as stricter regulations on imposing lockdowns and social distancing would increases the market liquidity significantly. The effect of vaccination case was found to have a beneficial impact, however, only towards the liquidity in Indonesia Stock Exchange.

In terms of market tightness, the results were a substantial for Indonesia and Malaysia on daily confirmed cases in a different direction. Transaction costs in Indonesia stock market markets decrease as the COVID-19 cases escalate. Meanwhile, investors in Malaysia stock exchange are burden with a higher transaction cost as the confirmed cases of COVID-19 rise. This also applies to the confirmed deaths in Malaysia as it also increases the transaction cost. On the bright side, recovery cases due to the outbreak were found to affect the market tightness in Malaysia, as higher recovery cases would narrow the gap within the spread. The vaccination of COVID-19 was found to have a considerable effect towards the market tightness in Indonesia imposing increase in vaccinations would increase the market liquidity in tightness. Respecting the stringency index, Thailand, Malaysia and Singapore all have significant oppose direction, as higher index would decrease the transaction cost in trading stocks.

4.3 Discussion and managerial implication

4.3.1 Discussion of empirical results. Based on the findings of the four major ASEAN capital market technology industries, stock market liquidity is significantly influenced due to the COVID-19 phenomenon. Market uncertainty emerges during the pandemic, reflecting the EMH theory on how stock prices are reflected from available COVID-19 related information (Fama, 1970). Observed in the growth of COVID-19 death cases captured by CPQS, the increase inhibits the stock market's liquidity. Investors induced more outstanding transactions in order to trade in the fragile market. The finding confirms the study examined by Chebbi *et al.* (2021) and Baig *et al.* (2021) in the S&P500 index and the US equity market respectably. Just from the other aspect, the emergence of COVID-19 confirmed cases accelerated the stock market's liquidity in terms of market tightness. The discovery contradicts study findings, which show that the alarming incidence of COVID-19 confirmed cases widens the gap within CPQS, diminishing stock liquidity (Alaoui Mdaghri *et al.*, 2020; Nguyen *et al.*, 2021; Chebbi *et al.*, 2021).

The uncertainty of the COVID-19 cure remains undiscovered, and this has sparked the need for information by investors regarding the treatment of the virus. Nonetheless, as the number of COVID-19 recovery cases rises, it has attracted the attention of investors, promoting higher stock market liquidity. Proven through this finding, the growth of recovery cases enhances both the stock market liquidity measurement, AMIHUD and CPQS. Furthermore, the emergence of the vaccination program of the virus is also found to be a promising act on increasing liquidity in the capital market. This is captured by the measurement of AMIHUD, as the vaccination of the virus has a strong negative correlation, reducing the illiquidity. The finding is consistent with the research conducted by Rouatbi *et al.* (2021), which revealed how the COVID-19 vaccine brought stability to light while also decreasing the volatility in financial markets worldwide. The result also confirms the study of DTP vaccination role in strengthening the economic performance by Masia *et al.* (2018), as a higher record of COVID-19 vaccination augments the capital market liquidity.

Stock market liquidity is also discovered to be associated with restrictions imposed by the government. Likewise, as portrayed in Table 5, market depth and tightness are positively affected significantly in the four major ASEAN stock markets. Moreover, higher stringency indexes increase liquidity in the stock market and decrease the cost of trading stocks.

Therefore, the research outcome invalidates the observation conducted by Zaremba *et al.* (2021), Baig *et al.* (2021) and Alaoui Mdaghri *et al.* (2020). Nevertheless, the study confirms the findings in the Vietnam Stock Exchange financial services industry, as the government intervention in ASEAN nations is shown to increase rather than decrease stock market liquidity (Nguyen *et al.*, 2021).

4.3.2 Robustness test. In order to validate the robustness of this research, this study incorporated development measures using the quantile regression based on the COVID-19 independent variables towards the respected dependent variables, the AMIHUD and CPQS. The implementation of quantile regression allows the research to estimate a variety of conditional distribution functions, with each quantile representing a different point in the conditional distribution (Polemis, 2020). The quantile regression also robust to outliers; therefore, it can enhance the analysis in which segmentation of the companies best represent the significance of the variables' relationship. The result of the five-level quantile regression is presented as follows:

Tables 8 and 9 portrayed the five quantiles of each independent variable towards both stock market liquidity measurements. As preserved in the regression results, the daily growth of COVID-19 confirmed cases only linked with CPQS, which further is confirmed to increase the liquidity of the lowest liquid firms significantly. COVID-19 death cases growth, as examined against the AMIHUD and CPQS, present a significant positive correlation where higher death resulted in lower liquidity. The increase of confirmed COVID-19 deaths significantly decreases the highest and lowest companies' stock market liquidity, shown in quantile 0.05 and 0.95.

Regarding confirmed recoveries of the Coronavirus, both AMIHUD and CPQS confirm the findings implying higher recoveries rate also increases the stock market liquidity. The lowest liquid firms are highly affected in the measurement of AMIHUD as proven in high T-ratio in quantile 0.75. At the same time, CPQS confirms that each liquidity performance is highly affected with the findings with the most affected on lowest liquid stocks. AMIHUD confirms that the vaccination has a favourable impact on the market depth as higher total vaccinated throughout nations boosts the liquidity, increasing investors' confidence. The findings apply to the highest liquid companies, as presented in the −50.1619 T-ratio. As the government imposes restrictions to decrease the spread of COVID-19, AMIHUD and CPQS both confirm higher liquidity on the stock market performance. All the liquidity measurement significantly applies to the companies with the lowest liquid performance.

4.4 Managerial implication

The study has various findings of the impact of COVID-19 towards the stock market liquidity. First, COVID-19's repercussions are felt across countries, limiting the access of movements as the airborne strike. Second, the migration to the digital world brought new opportunities for the technology industry and resulted in the stock market's performance skyrocketing. The increased investors' interest in technological firms is due to the stock performance has implied a promising target (Schaefer *et al.*, 2020). Third, as stricter preventive measures are implemented, it surges many activities to be remoted from home or from any places, and thus increase in demand in the technology sector such as hardware/software, IT services, semiconductors and network equipment (Deloitte, 2020). The technology industry has consistently outperformed exceptionally in the stock market, but the degree of divergence differs in comparison during the COVID-19 pandemic, as observed in the S&P500 index (Borrett, 2021).

The importance of the technology industry rises worldwide, and this applies as well to the capital markets as observed in the four major ASEAN capital markets. The four ASEAN countries – Indonesia, Malaysia, Singapore and Thailand – imposed strict regulations that stimulate the usage of the technology advancement. For example, Indonesia implemented 'large-scale social restrictions' which are highly dependent on teleworking. Malaysia tightened

Variables	0.05		0.25		Quantile (AMIHUD) 0.5		0.75		0.95	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
CASE_G	-1.96E-16	-0.0109	-2.21E-14	-1.5833	-3.38E-13	-5.1181	-2.32E-12	-8.6176	-8.69E-10	-0.3166
DEATH_G	4.59E-17	4.90E-03	3.95E-15	5.40E-01	1.35E-13	3.88 E+00	2.17E-12	15.3768	8.05E-10	0.5579
RECOV_G	3.86E-17	0.0074	3.90E-15	0.966	-3.15E-14	-1.642	-1.07E-12	-13.7703	-7.32E-10	-0.9189
VAC	-3.11E-19	-0.013	-2.32E-18	-0.1251	-7.36E-17	-0.8373	-1.71E-15	-4.7701	-4.55E-12	-1.2469
SGEN	1.94E-14	0.0101	1.31E-12	0.8795	1.07E-12	0.1508	-1.28E-10	-4.4518	-4.25E-08	-0.145

Note(s): *t*-ratio > ±1.96

| Variables | Quantile (CPQS) | | | | | | | | | |
| | 0.05 | | 0.25 | | 0.5 | | 0.75 | | 0.95 | |
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
CASE_G	−1.87E-07	−2.7017	−8.42E-08	−2.735	−2.27E-07	−3.6599	−5.38E-07	−3.6907	−4.29E-06	−8.3771
DEATH_G	4.12E-07	11.3058	2.40E-08	1.4826	1.79E-07	5.4979	3.73E-07	4.8729	2.60E-06	9.6646
RECOV_G	−1.66E-07	−8.2329	−3.30E-08	−3.7007	−1.52E-07	−8.491	−4.10E-07	−9.6882	−1.99E-06	−13.3681
VAC	−4.63E-09	−50.1619	2.34E-11	0.5729	−5.18E-11	−0.629	2.19E-10	1.1272	−6.76E-10	−0.9908
SGEN	−5.49E-06	−0.7405	−1.15E-05	−3.4988	−4.32E-05	−6.5233	−0.00011	−6.96114	−0.00038	−6.9911

Note(s): t-ratio > ±1.96

Table 9.
Robustness test of quantile in CPQS

their restriction to closing borders and lockdowns, which was also imposed in Thailand (OECD, 2020). In addition, technologies are heavily used to trace the COVID-19 cases and verify home-quarantine orders by Singapore, indicating the prominent role of the technology industry during the COVID-19 (McKinsey, 2021). The led to the background of this research on assessing the impact of COVID-19 towards stock market liquidity, specifically the technology industry.

As observed, new COVID-19 confirmed cases had triggered countries to be more careful in combating the severity of the virus's transmission. Many cases that rose affect many workplace closures to inhibit the spread, leading to dependence on technology. The increase of confirmed cases is found to escalate the stock market liquidity, but only significant to the market tightness gap (CPQS). In terms of growth COVID-19 deaths, it significantly influences the stock market's liquidity examined both in AMIHUD and CPQS measures. It reflects the EMH theory, where the rise of confirmed deaths would spread investors' fear of investing, resulting in illiquidity. On the other side, the rise of recovery cases infected by the COVID-19 increases investors' confidence in the stock market, thus resulting in higher liquidity both captured by the market depth and market tightness. Vaccination has also been found to influence the stock market liquidity as measured in AMIHUD but is insignificant on CPQS. Liquid stock indicates that prices are informative, and this is proven by how the stock market liquidity reacts to the good news of the virus treatment.

In contrast, the impulsive stringency index escalates the liquidity of the stock market. Although not all the observed countries implemented the lockdown, restrictions are still considerably high. High stringency affects citizens' activities, resulting in a work-from-home and online school to be implemented, indicating how the technology is utilised the most during this condition. Most investors take opportunities to invest in the technology industry into account, which is reflected in this finding as higher stringency increases the stock market liquidity through the market depth (AMIHUD). This finding is also seen from the CPQS, as the bid-ask spread is tighter during more stringent measures.

5. Conclusion and limitation

The study conducted the influence of the most significant health catastrophes to date, COVID-19, towards the stock market liquidity in 177 technology industries in four major ASEAN capital markets from March 2, 2020, to June 30, 2021. By taking all COVID-19 into account, this study included additional variables: the recoveries and vaccination of COVID-19 to enhance previous studies further. Results of the study vary within each of the virus-related variables as measured using the two-stock market liquidity measure: AMIHUD and CPQS. COVID-19 confirmed cases are positively correlated with liquidity, as the rise of confirmed cases increases the stock market liquidity. However, recorded confirmed deaths were found to inhibit the liquidity as observed in the stock markets. On a positive remark, recovery and vaccination cases of COVID-19 positively impacted the capital market, as higher recoveries and vaccination improve the liquidity as captured in AMIHUD. The finding further assessed the stringency impact as the government responded to intervene with the outbreak and discovered that higher stringency resulted in higher stock market liquidity.

All in all, this research has limitations to be considered in future studies. First, the observation covers four ASEAN major capital markets, specifically the technology sector. Future studies can enrich the scope of the observation to other regions and industries. Second, the study only covers March 2020 to June 2021, but the COVID-19 has appeared to have grown and extended with new variants and conditions that shall be considered. Third, further research shall implement various indicators on the COVID-19 variables relevant to the later COVID-19 period.

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