Market liquidity of agriculture sector in Indonesia and Malaysia during COVID-19 Delta

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Abstract: This study aims to assess the influence of the COVID-19 Delta outbreak on stock market liquidity within the agricultural sectors of Indonesia and Malaysia. This study assesses the impact of the COVID-19 Delta variant by examining COVID-19 cases, mortalities, recoveries, vaccinations, and stringency datasets. The study comprised a sample of 57 agricultural firms listed on the Indonesia Stock Exchange (IDX) and Bursa Malaysia. Daily data was collected from January to December 2021, generating 8358 observations. The study utilises the panel regression weighted least square (WLS) analysis approach. This study reveals that COVID-19 Delta has adversely affected market liquidity in the agricultural sectors of Indonesia and Malaysia. The study reveals that rising daily cases, deaths, and recoveries have a negative effect on market liquidity, whereas vaccination and stringency do not demonstrate any association. Even increasing the recovery rate does not restore market liquidity due to the Delta variant's negative impact.

Keywords: COVID-19; Delta variant; stock market liquidity; market resilience; COVID-19 cases; deaths; vaccination; stringency.

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1 Introduction

This study aims to examine the influence of the COVID-19 Delta variant on market liquidity by analysing data related to confirmed cases, deaths, recoveries, vaccinations, and stringency measures. Several studies on COVID-19 and agile economics identified the COVID-19 pandemic as a source of business risk and uncertainty. It is important to reassess the critical competences of economics post-COVID-19 to make their businesses more resilient to the risks, uncertainties, and challenges posed by the COVID-19 pandemic (Wang, 2023; Wang et al., 2023). The pandemic's effect on market liquidity in the agriculture sector of the two main countries driving global agricultural production has not received enough thorough examination (Tan et al., 2023). This study distinguishes itself by investigating the impact of state policy on market liquidity. The pandemic has prompted extensive research and literature on its effects on the economy, specifically the stock market, such as previous studies by Al-Awadhi et al. (2020), Mdaghri et al. (2021), Tiwari et al. (2022), Apergis et al. (2023), Clancey-Shang (2023), and Priscilla et al. (2023). These previous studies explored stock market performance during the first period of the pandemic with confirmed cases and deaths (Al-Awadhi et al., 2020; Tiwari et al., 2022; Apergis et al., 2023), plus stringency and lockdown (Mdaghri et al., 2021; Clancey-Shang, 2023), plus vaccination (Priscilla et al., 2023). The distinctive virus-induced pandemic has impaired stock prices and the global economy (Hong et al., 2022). COVID-19 has impaired Southeast Asian stock markets, especially Indonesia and Malaysia, as shown by the stock market volatility (ASEAN, 2020). Mass vaccinations in early 2021 and more stringent regulations in many nations have helped contain the outbreak. Chan et al. (2022) show that the stock market reacts positively to vaccine efficacy and widespread immunisation, especially during the pandemic. Following the vaccination in early 2021, the stock market panic and volatility in early 2020 started to diminish, indicating a potential resumption of global stock market activity. However, the most severe phase of the epidemic was about to commence.

Initial identification of the COVID-19 Delta in Malaysia in April 2021 (Straits Times, 2021a) and Indonesia in May 2021 (Jakarta Globe, 2021) caused significant strain in the stock market. The Wealth Health Organization (WHO) stated that COVID-19 Delta has a transmission rate two times higher than other variants (WHO, 2021). In Indonesia, Delta variant cases spiked on July 15. There were 56,767 cases in the country during this peak period. The Delta variant caused over 1,000 deaths on July 11, 2021, and 2,069 on July 27, which was the highest daily amount of the pandemic. Starting July 3, the Indonesian

government implemented the Emergency Community Activity Restrictions policy (PPKM) in Java-Bali districts and cities (CNN Indonesia, 2021: Kominfo, 2021). Kompas (2021) shows that 90% of COVID transmission in Jakarta was the Delta variant. On June 26, the government in Malaysia attributed the recent rise in infections to the Delta variant (Malaymail, 2021a). Malaysia had its highest COVID cases on July 25, with 17,045 new infections. Starting on June 1, Malaysia implemented the Full Movement Control Order (FMCO) after the variant disrupted herd immunity estimates (Malaymail, 2021b). The country's policies affect market liquidity differently. The ongoing COVID-19 pandemic, particularly with the emergence of the Delta variant, has led to distinct consequences compared to the preceding year. This situation is expected to persist until the end of 2021.

The Malaysian government implemented a FMCO, or full lockdown, starting June 1, 2021, in response to the aforementioned trend. The decline in confirmed cases in Malaysia became evident in late September 2021, coinciding with the nationwide implementation of a mass vaccination program. In October 2021, the Malaysian government lifted restrictions that had been in place for a year, permitting interstate commercial travel and allowing all businesses to resume operations (Cheng et al., 2023). The Bursa Malaysia Composite experienced a substantial decline in the Malaysian stock market from early April 2021 to early 2022, as depicted in Figure 1. On December 17, 2021, the Bursa composite reached its lowest value of RM6.25 (Google Finance, 2023a)

Figure 1 Bursa Malaysia composite specific for 2021 (see online version for colours)

Source: Google Finance (2023a)

Indonesia implemented a relaxation of its stringency measures in response to a decline in cases from their highest point. The number of cases in Indonesia has decreased by 78% since July 15. According to Reuters (2021), the recovery rate surpasses the number of new positive cases. The 2021 IDX Composite, as depicted in Figure 2, illustrates the stock market recovery in Indonesia. It underwent a correction in 2021 due to the Delta variant, but exhibited an upward trend towards the end of the year. The IDX composite reached its lowest point on May 21, with a value of 5773.12 Rupiah (Google Finance, 2023b).

Figure 2 IDX composite specific for 2021 (see online version for colours)

Source: Google Finance (2023b)

The mass vaccination program in Southeast Asian countries, specifically Indonesia and Malaysia, in January and February 2021 facilitated stock market recovery. However, the arrival of the Delta variety, the most severe pandemic ever experienced in Indonesia and Malaysia, overshadowed this anticipated economic rebound. The Delta variant's emergence has validated the Black Swan Theory, highlighting the challenge of anticipating its impact on both economies. The possible implications of mass vaccination followed by the Delta variant epidemic on financial market stability in Indonesia and Malaysia, particularly market liquidity, have not been thoroughly investigated. Our research aims to address the lack of information surrounding the stock market's liquidity from the beginning of vaccination programs in early 2021 until after the COVID-19 Delta pandemic at the end of 2021.

This study's contribution can be summarised into several key points. First, this study provides novel insights by examining the Delta variant's impact on the predicted economic recovery in Indonesia and Malaysia. The Delta variant, the most severe pandemic ever seen in these countries, has confirmed the Black Swan theory. Second, although both countries began vaccination practically simultaneously, the travel restriction regulations enacted during the COVID-19 Delta were substantially different. This study is unique because it examines how state policy affects market liquidity. Third, there is a lack of comprehensive analysis regarding the impact of the pandemic on market liquidity in the agricultural sector of the two primary countries responsible for global agricultural production (Tan et al., 2023). The pandemic has had repercussions on the labour markets in Indonesia and Malaysia, particularly in the agricultural sector. Putra et al. (2023) show that the agricultural sector in Indonesia has the highest prevalence of informal labour. The onset of COVID-19 resulted in significant job losses, reduced working hours, decreased wages, and a transition from formal to informal employment. Conversely, the implementation of lockdown in Malaysia during the COVID-19 Delta had resulted in a downturn in the agricultural industry due to the inability of numerous foreign workers employed in the Malaysian agricultural sector to enter the country (Straits Times, 2021b). This study's findings can help agricultural firms and policymakers navigate the pandemic.

The paper's sections follow this order. The literature review and development of hypotheses are briefly explained in Section 2. Section 3 describes data sources and

research methodology. Section 4 presents and discusses the study's outcomes. Section 5 concludes the paper by summarising the findings and underscoring the implications.

2 Literature review and hypotheses development

2.1 The black Swan theory and the COVID-19 delta pandemic

The Black Swan hypothesis was developed and popularised by Taleb (2007, 2010). He outlined the characteristics of Black Swan events. First, these events are rare, obscure, and unpredictable, resulting in significant consequences that surpass typical expectations. Second, the probability of this event is extremely low, making its calculation challenging. The Economic Times (2024) defines the Black Swan Theory as those occurrences that are hard to foresee in the regular course of business. These are sporadic, unanticipated, but highly significant occurrences. These are regarded as anomalies since there is no historical evidence that suggests they may happen anytime soon. Another critical feature of black swan events is that they are difficult to model because they never reoccur. Farley and Voinov (2016) note that although the Black Swans are unpredictably unexpected, the likelihood of crossing them appears to be rising quickly. Farley and Voinov (2016) suggest that we should work to lower the possibility of catastrophic thresholds and increase the possibility of breakthroughs. Mishra (2020) characterised the COVID-19 event as a Black Swan event. The pandemic has highlighted the challenges of predicting and preparing for unforeseen and unpredictable events, such as Black Swan events, despite the global health community's focus on pandemic preparedness. The emergence of new COVID-19 variants, like Delta, aligns with the attributes of a Black Swan Event due to the unpredictable nature of the effects resulting from the development of these variants. Malaysia had enforced a full lockdown, while Indonesia had implemented community activity restrictions. Despite the implementation of stringent policies, the adverse effects of the unexpected event were evident in the stock markets of Indonesia and Malaysia on May 21, 2021, and December 17, 2021, respectively, coinciding with the COVID-19 Delta epidemic in both countries (Google Finance, 2023; Google Finance, 2023b). The divergent stringency policies implemented by the two countries have significantly affected the liquidity of their respective stock markets.

2.2 Stock market liquidity

Market liquidity is widely discussed and analysed by investors due to its significant implications. Chordia et al. (2004) define market liquidity as the efficient purchase or sale of large quantities of assets at low prices. Sarr and Lybek (2002) and von Wyss (2004) identified four major attributes of market liquidity using considerable research. These include tightness, depth, breadth, and resilience. Tightness refers to transaction costs, such as the bid-ask spread, whereas depth refers to the availability of buy and sell orders at different prices. Breadth covers a wide range of orders, yet it has little effect on cost. The market's resilience is its ability to quickly correct order imbalances.

Market liquidity is essential for financial stability and economic prosperity. Decision makers use liquidity to stabilise the stock market by showing that prices accurately reflect relevant information (El Bannan and Farooq, 2019). The ease of purchasing and selling assets without price swings shows the market's depth and efficiency. Market liquidity is a

significant indicator of economic health and resilience. It reflects the availability of funding for businesses, promotes investment opportunities, and encourages capital formation. Monitoring and comprehending market liquidity trends is crucial for investors, policymakers, and analysts to navigate the intricacies of the financial landscape and promote sustainable economic development. Highly liquid markets are typically profitable due to their numerous advantages, including improved resource allocation and enhanced information quality (El Bannan and Farooq, 2019).

2.3 COVID-19 confirmed cases, deaths, and market liquidity

There is a correlation between the growth in confirmed cases and the impact on market liquidity (Haroon and Rizvi, 2020). Previous studies have examined the impact of COVID-19 on stock market returns and liquidity (Al-Awadhi et al., 2020; Mdaghri et al., 2021; Haroon and Rizvi, 2020; Shehzad et al., 2020; Priscilla et al., 2023; Tiwari et al., 2022). The epidemic has raised investor concerns about stock trading safety and the risk of large losses, particularly in market liquidity. Mdaghri et al. (2021) examined how the pandemic affected market liquidity in the Middle East and North Africa (MENA) countries, concentrating on market depth and stringency. Moreover, an analysis of industry-level and country-level data suggests a substantial and adverse correlation between the pandemic and market liquidity (Haroon and Rizvi, 2020). Apergis et al. (2023) present findings indicating that elevated confirmed cases substantially influence implied volatility during periods of heightened uncertainty. The authors suggest that financial markets primarily respond to extreme levels of fear. Al-Awadhi et al. (2020) and Ftiti et al. (2021) demonstrate that confirmed cases and deaths negatively influence stock market returns and liquidity, increasing overall risk. Baig et al. (2021) discovered that the number of reported confirmed cases and deaths had a negative impact on market liquidity and volatility at the individual investor level. During COVID-19, market volatility appears to have a substantial influence on market liquidity over the short-to-middle term (Tissaoui et al., 2021). On the contrary, Shehzad et al. (2020) discovered that COVID-19 does not affect Asian stock markets. Agriculture research in Indonesia and Malaysia is still limited, although both countries heavily rely on the agriculture industry as the main driving force behind their economies (FAO, 2023; Tan et al., 2023). This study builds on prior research to investigate how COVID-19 affects Indonesian and Malaysian agricultural enterprises. Based on the explanation, the hypotheses are

H1: The COVID-19 confirmed cases are negatively associated with an increase in market liquidity.

H2: The COVID-19 deaths are negatively associated with an increase in market liquidity.

2.4 COVID-19 recovery, vaccination, and market liquidity

According to Yu and Xiao (2023), negative information related to COVID-19 is expected to have a more pronounced effect on stock price volatility compared to positive news. Therefore, as the number of recovery cases rises and negative news diminishes, it is anticipated that volatility will decrease. Market volatility can also arise from positive sentiment and improving global growth prospects, resulting in a more predictable investment climate. Despite ongoing challenges and uncertainties, widespread

vaccination efforts hold promise for increasing the number of recovered cases, restoring financial stability, and fostering a resilient global economy. Global financial markets play a crucial role in providing valuable insights into the expected progress of vaccination. This study examines the impact of recovery cases on market liquidity in Indonesia and Malaysia.

The year 2021 has provided a ray of hope amid the pandemic, as vaccinations have emerged to enhance immunity against the virus. Multiple studies indicate that the vaccination has a beneficial effect on stock market performance (Chan et al., 2022). The research findings underscore the importance of prioritising vaccination programs to boost economics. Researchers have found that vaccination contributes to the stability and decreased volatility of global financial markets (Zheng et al., 2021; Rouatbi et al., 2021). (Zheng et al., 2021; Rouatbi et al., 2021). Effective vaccine dissemination and implementation offer potential for economic recovery by mitigating pandemic health risks. The increasing vaccination rates will reduce the likelihood of widespread outbreaks and associated fatalities. Considering all of these factors, the resulting hypothesis is:

H3: COVID-19 recovery is positively associated with an increase in market liquidity.

H4: COVID-19 vaccination is positively associated with an increase in market liquidity.

2.5 COVID-19 stringency and market liquidity

The devastating COVID-19 outbreak prompts governments to impose stringent measures like travel bans and mandatory isolation. The authorities took these steps to combat the widespread and deadly effects of the viral outbreak. Previous research evaluated government stringency policies (Rosemary et al., 2022; Yu and Xiao, 2023; Cheng et al., 2023). These actions slowed the virus's spread and protected public health. Governments restrict travel across regions, countries, and continents to keep the virus from spreading and prevent future outbreaks. People who have been exposed to the virus or exhibit symptoms are quarantined. The goal is to limit the infection and reduce healthcare system strain. The Indonesian government has Community Activity Restrictions (PPKM), while the Malaysian government has a movement control order (MCO) and other policies (Cheng et al., 2023; Rosemary et al., 2022).

COVID-19 could have wide-ranging effects on the financial sector across different countries, impacting banking institutions, investment companies, insurance companies, and stock markets (Goodell, 2020). The pandemic's ripple effects have the potential to disrupt global supply chains, leading to an economic downturn and destabilising financial systems. The government implemented several preventive measures, including lockdowns, to prevent the virus's spread, which also had an impact on the stock market. As a result, their economies have been disrupted, resulting in the closure of many industries and increased unemployment (Jena et al., 2021). Multiple studies have examined the government's implementation of stringent policies in response to the pandemic (Rosemary et al., 2022; Yu and Xiao, 2023; Cheng et al., 2023).

Mdaghri et al. (2021), Baig et al. (2021) and Priscilla et al. (2023) have examined the influence of government-imposed stringency measures on the stock market in the context of the pandemic. Baig et al. (2021) explained that the pandemic includes government strategies, including social isolation and confinement. The country's economic recovery depends on balancing government intervention with investor-friendly conditions.

Baig et al. (2021) found that COVID-19 lockdowns impacted US stock market stability and liquidity. The study found that stringency policies have disrupted trade, increasing volatility and lowering investor confidence. These findings show the link between the pandemic's impact on public health and financial markets, underlining the need for a comprehensive approach to mitigate harsh measures' economic effects. Haroon and Rizvi (2020) show that government involvement in restricting movement has enhanced market liquidity. According to Priscilla et al. (2023), the imposition of restrictions and the promotion of lockdown measures are the primary factors influencing market liquidity. This study investigates the impact on the capital markets of Indonesia and Malaysia. These findings suggest a hypothesis for analysing the situation.

H5: COVID-19 stringency is associated with market liquidity.

3 Research method

3.1 Data and sample

The research sample consists of observations from 57 agriculture sector firms listed on the Indonesia Stock Exchange (IDX) and Bursa Malaysia. The observation spans the period from January 2021 to December 2021. It covers the influence of vaccination, the stringency of restriction or lockdown due to the COVID-19 Delta variant, and the end of restriction in both countries. This study examined 8358 daily firms' panel sample units. Variables data are obtained from the Bloomberg, Yahoo Finance, and John Hopkins databases and referred to the OurworldIndata website. There are only 4910 COVID-19's recovery observations.

3.2 Dependent variable

This study employs Amihud's (2002) concept of market depth, specifically illiquidity, to assess stock market liquidity. This proxy quantifies the impact on prices caused by a one-dollar change in volume (Priscilla et al., 2023). Amihud's illiquidity proxy suggests a higher ratio may indicate less liquid stock. The calculation is performed using the following equation:

$$AMIHUD_{i,t} = \frac{\left|R_{i,t}\right|}{Ln\left(Volume_{i,t}\right)}$$

$R_{i,t}$ is the daily stock return computed by dividing the closing price at t with the closing price at t–1. Volume i, t is the dollar volume of stock i at day t.

3.3 Independent variables

Based on the COVID-19 pandemic, this research employs five independent variables that demonstrate daily confirmed cases, deaths, recovery, vaccination, and stringency in Indonesia and Malaysia. The first independent variable is the daily growth of confirmed cases, denoted as confirmed cases (CASES). The second independent variable represents the daily growth in the number of deaths due to confirmed cases, denoted as deaths. The third independent variable, denoted as RECOV, shows the daily growth in recoveries. As

the first vaccinations were introduced worldwide in 2021, this research employs the fourth independent variable, vaccination, denoted as VACC. It is calculated based on the growth of residents in both countries who receive vaccinations each day. The fifth independent variable is stringency (SGC). The stringency index is a comprehensive assessment that takes into account nine response indicators, such as school closures, employment closures, and travel bans. It is then scaled to a value ranging from 0 to 100, with 100 representing the harshest measures (OWID, 2021).

3.4 Control variables

This study use these control variables because they may impact the liquidity of the agribusiness market. Low stock liquidity increases volatility shocks (Lee and Chung, 2017). Thus, this volatility is used as a control variable to promote daily volatility estimation (Garman and Klass, 1980) (GK_VOL). This measuring formula is:

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

$HP_{i,t}$, $LP_{i,t}$, $CP_{i,t}$, and $OP_{i,t}$ are the highest, lowest, closing, and opening prices of firm i on day t, respectively.

This research also incorporates the stock market return in the agricultural sector in Indonesia and Malaysia, denoted by Index_R. Additionally, this study includes daily interest rates as a control variable because this variable has a significant impact on market liquidity, denoted as Inter_R. The pandemic itself led to an increase in the demand for gold during economic shocks (Priscilla et al., 2023). Therefore, this research also adds the last control variable, the daily gold price, denoted as Gold_LN. For a more detailed and comprehensive explanation of all variables, please refer to Table 1 in the study.

Table 1 Variables specification

Variable	*Abbreviation*	*Description*
	Dependent variable	
Amihud Illiquidity	AMIHUD	Market illiquidity
	Independent variables	
Confirmed cases	CASES	Daily growth COVID case
Deaths	DEATHS	Daily growth COVID death
Recovery	RECOV	Daily growth COVID recovery
Vaccination	VACC	Daily growth COVID vaccinations
Stringency index	SGC	Daily stringency index ranging between 0 to 100
	Control variables	
Garman and Klass Volatility	GK_Vol	Daily market volatility
Index return	Index_R	Daily stock return
Interest rate	Inter_R	Daily nationwide interest rate
Gold price	Gold_LN	Daily gold price

3.5 Empirical model

This study employed panel data weighted least squares (WLSs) with the Gretl software. Anh and Gan (2021) argue that panel regression data is preferable for empirical analysis due to its suitability. In addition, this regression method can be used to identify time-varying correlations between dependent variables and explanatory variables while mitigating estimation bias, individual variability, and multicollinearity (Hsiao, 2014). This study employs a panel regression model to examine the impact of the COVID-19 variable on market liquidity measurement.

$$AMIHUD_{i,t} = \beta_1 CASES_{i,t} + \beta_2 DEATHS_{i,t} + \beta_3 RECOV_{i,t} + \beta_4 VACC_{i,t} + \beta_5 SGC_{i,t} + \beta_6 GK\_Vol_{i,t} + \beta_7 Index\_R_{i,t} + \beta_8 Inter\_R_{i,t} + \beta_9 Gold\_LN_{i,t}$$

4 Result and discussion

4.1 Descriptive statistic

Descriptive statistical analysis is employed to describe or depict the main characteristics within a dataset as it is and applied in a general or generalised context. The descriptive statistical analysis used in this research includes measures such as the mean (average), median, standard deviation, minimum value, and maximum value. The aim is to describe the dependent, independent, and control variables. This study conducted this analysis on 8,358 observations, and Table 2 displays the results.

Table 2 Descriptive statistics of Indonesia and Malaysia

Variable	*N*	*Mean*	*Median*	*S.D*	*Min*	*Max*
AMIHUD	8358	0.003	0.002	0.005	0.00008	0.262
CASES	8358	0.019	0.009	0.038	0.00003	1.834
DEATHS	8358	0.024	0.011	0.053	0	2.543
RECOV	4910	0.024	0.013	0.039	0	0.944
VACC	8358	0.177	0.018	2.285	0	92.800
SGC	8358	68.510	68.070	8.489	49.040	85.190
GK_VOL	8358	0.417	0.112	1.972	0	13.400
Index_R	8358	0.000	0	0.008	–0.022	0.035
Inter_R	8358	0.024	0.018	0.009	0.017	0.038
Gold_LN	8358	7.492	7.490	0.026	7.425	7.556

The Amihud measure, represented as market depth, indicates an average of 0.25%. The highest value for this measurement reaches 26.21%, and the lowest value is 0.0076%. Confirmed cases have an average daily growth of 1.86%, while death cases have an average of 2.42%. The daily growth in confirmed cases and deaths reaches 3.82% and 5.30%, respectively. The recoveries have an average of 2.36%, with a maximum of 94.44%. Regarding vaccination, the test results indicate an average of 17.71% within a year, with the highest breakthrough reaching 9280% and a minimum of 0 vaccinations.

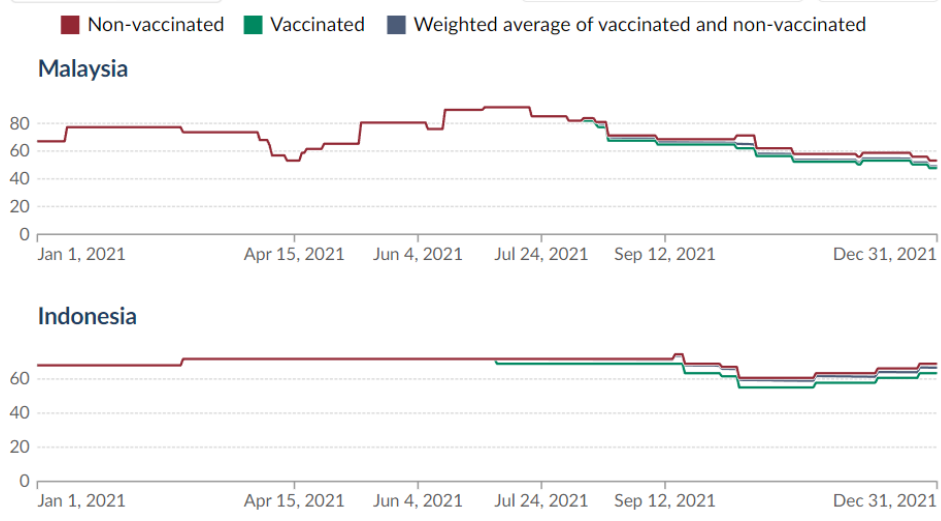
For Indonesia and Malaysia, the average stringency index reached 68.51, with the highest index at 85.19 and a minimum of 49.04 for stringency.

Table 3 displays the descriptive data for each sample, specifically for Indonesia and Malaysia. Within panels A and B, the minimum values for confirmed cases, deaths, and recoveries reflect a value of zero, signifying that there has been no change in data from one day to the next. Minimum vaccination values of zero indicate that no citizens have obtained the vaccine since vaccination in both countries began around the end of January for Indonesia and late March for Malaysia. Based on the vaccination and stringency data of the two countries, there are significant policy differences. Indonesia's standard deviation of VACC is 0.527, compared to Malaysia's 2.831. This shows the volatility of the growth of citizens who obtain vaccines higher and faster in Malaysia than in Indonesia, meaning that vaccinations in Indonesia are gradually carried out over a longer period than in Malaysia. The second stringency deviation standard is also different, with Indonesia showing 4.314 and Malaysia showing 10.12. This means that the stringency policy in Malaysia is changing faster in the short term than in Indonesia. Figure 3 provides this explanation.

Table 3 Descriptive statistics of each sample

	Panel A – Indonesia sample					
	N	*Mean*	*Median*	*S.D.*	*Min*	*Max*
AMIHUD	3023	0.002371	0.001431	0.006291	0.0001272	0.2621
CASES	3023	0.01051	0.004737	0.03653	0.00003192	1.834
DEATHS	3023	0.01149	0.005357	0.04885	0	2.543
RECOV	1797	0.01498	0.01053	0.01837	0	0.457
VACC	3023	0.07783	0.02072	0.527	0	26.39
SGC	3023	68.33	71.37	4.314	59	73.66
GK_VOL	3023	0.9698	0.1302	3.204	0	13.4
Index_R	3023	0.0001811	0.0003	0.008534	–0.0212	0.035
Inter_R	3023	0.0352	0.035	0.0006773	0.035	0.0375
Gold_LN	3023	7.493	7.491	0.02626	7.425	7.556
	Panel B – Malaysia sample					
AMIHUD	5335	0.00263	0.001688	0.003106	0.000076	0.05186
CASES	5335	0.02325	0.01126	0.03837	0.001154	0.879
DEATHS	5335	0.03148	0.0161	0.054	0.0005802	1.448
RECOV	3113	0.0289	0.01605	0.04175	0.003257	0.9444
VACC	5335	0.2334	0.01193	2.831	0	92.8
SGC	5335	68.61	68.06	10.12	49.04	85.19
GK_VOL	5335	0.1034	0.09885	0.05848	0	0.4766
Index_R	5335	–0.00009014	–0.0004	0.006913	–0.0222	0.0203
Inter_R	5335	0.01736	0.0175	0.0001845	0.017	0.0175
Gold_LN	5335	7.492	7.489	0.026	7.425	7.556

Figure 3 Government stringency index 2021 Malaysia and Indonesia (see online version for colours)



Source: Our World in Data (OWID, 2021)

Table 4 displays the correlation matrix for all variables in this study. The coefficient between variables indicates that a value below 0.8 indicates the absence of multicollinearity between the independent and control variables. The variables of confirmed cases, deaths, and recovery exhibit a strong coefficient association among them, necessitating the testing of each independent variable independently. The result shows that there is no issue of multicollinearity since there is no strong relationship between each independent variable and the controls. The validity of this statement is corroborated by the variance inflation factor (VIF) value for each variable, which falls within the range of 1.000 to 1.804.

Table 4 Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) AMIHUD	1									
(2) CASES	0.0494	1								
(3) DEATHS	0.0437	0.9269	1							
(4) RECOV	0.0575	0.8669	0.7333	1						
(5) VACC	–0.0022	0.0788	0.0704	–0.0047	1					
(6) SGC	–0.0007	0.2695	0.2905	0.1712	0.0009	1				
(7) GK_VOL	–0.0413	–0.0405	–0.0448	–0.0399	–0.0080	–0.0048	1			
(8) Index_R	–0.0185	–0.0182	–0.0150	–0.0251	–0.0278	–0.0109	0.0050	1		
(9) Inter_R	–0.0221	–0.1593	–0.1853	–0.1765	–0.0343	–0.0180	0.2114	0.0183	1	
(10) Gold_LN	0.0019	0.1484	0.1651	0.1566	–0.0766	0.0665	0.0111	0.0007	0.0327	1

4.2 Panel estimation

As shown in Table 5, this research conducted a number of tests in an effort to identify the optimal model. The first test used combined data from Indonesia and Malaysia, and the second assessed robustness for subsamples in Indonesia and Malaysia. In each test, there were five models: the first model included the variable CASES, the second model included DEATHS, the third model included RECOV, the fourth model included VACC, and the fifth model included SGC. These independent variables were tested against all the control variables in each model. This research employed three levels of testing to choose the pooled, fixed effect, or random effect model that is suitable for the model.

Given that the data is in panel format, it is crucial to carefully select the estimation method for evaluating the data. The optimal estimating model is developed by a tripartite process of testing. The Chow or F-test, is used to determine the appropriate model between pooled ordinary least squares (OLS) and fixed effect (FE). The Breusch-Pagan Test is used to find the most suitable panel model, either a pooled OLS or random effect. The Hausman Test is used to select the optimal model, either random effect or fixed effect, for estimating the data. The test conducted in Tables 5.1–5.3 demonstrates that the panel data estimation method yields a more accurate estimation model when utilising the fixed effects (FE) model. The heteroscedasticity test conducted on the fixed effects (FE) model using the Groupwise test indicates the presence of heteroscedasticity. This study employed a WLS panel to address the issue of heteroscedasticity.

Table 5.1 Panel estimation – Indonesia and Malaysia

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
F Test	2.49E-266	4.79E-267	6.60E-118	3.32E-270	3.44E-270
Result	Fixed	Fixed	Fixed	Fixed	Fixed
Breush-Pagan test	0	0	0	0	0
Result	Random	Random	Random	Random	Random
Hausmann test	7.48E-59	1.30E-59	2.33E-23	3.32E-56	9.21E-56
Result	Fixed	Fixed	Fixed	Fixed	Fixed
Heteroscedasticity	0	0	0	0	0
Summary	WLS	WLS	WLS	WLS	WLS

Table 5.2 Panel estimation – Indonesia subsample

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
F Test	4.03E-36	4.12E-36	1.03E-22	4.64E-36	3.40E-36
Result	Fixed	Fixed	Fixed	Fixed	Fixed
Breush-Pagan test	5.40E-211	5.60E-211	1.38E-90	6.37E-211	1.47E-211
Result	Random	Random	Random	Random	Random
Hausmann test	4.78E-04	5.15E-04	2.65E-02	1.19E-03	3.56E-03
Result	Fixed	Fixed	Fixed	Fixed	Fixed
Heteroscedasticity	0	0	0	0	0
Summary	WLS	WLS	WLS	WLS	WLS

Table 5.3 Panel estimation – Malaysia subsample

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
F Test	2.31E-295	3.12E-297	5.40E-155	0	0
Result	Fixed	Fixed	Fixed	Fixed	Fixed
Breush-Pagan test	0	0	0	0	0
Result	Random	Random	Random	Random	Random
Hausmann test	8.08E-09	2.93E-10	1.73E-04	6.78E-01	5.98E-01
Result	Fixed	Fixed	Fixed	Random	Random
Heteroscedasticity	0	0	0	0	0
Summary	WLS	WLS	WLS	Random	Random

4.3 Hypotheses testing

Table 6 shows that confirmed cases, deaths, and recoveries have a positive association with market illiquidity, meaning that it has an impact on decreasing market liquidity in the agricultural sector in Indonesia and Malaysia. The test results show that confirmed cases (CASES), deaths (DEATHS), and recovery (RECOV) show coefficients of 0.003, 0.002, and 0.003, respectively, at a significant level of 0.01 (H1 and H2 accepted, H3 rejected). The COVID-19 recovery has an impact on decreasing market liquidity. The reason underlying this result is that recovery is very strongly associated with confirmed cases. This argument is supported by the correlation matrix (Table 4), which shows a very strong correlation coefficient ($\beta = 0.9269$) between recovery (RECOV) and confirmed cases (CASES). As the number of confirmed cases increases, so do recoveries. As expected, the impact of increasing recoveries on increasing market liquidity will require a longer period. The other findings show that vaccination (VACC) and stringency (SGC) have no association with market liquidity (H4 and H5 rejected).

4.4 Robustness test

Robustness tests in Tables 7.1 and 7.2 show that the results of the hypotheses are robust for the Malaysian sample but not robust for Indonesia. In the Indonesian sample (Table 7.1), confirmed cases, deaths, and recoveries are not associated with market liquidity. This means that the COVID-19 Delta does not impact market liquidity in Indonesia's agricultural sector. In contrast, in the Malaysian sample (Table 7.2), confirmed cases (CASES), deaths (DEATHS), and recoveries (RECOV) were proven to be positively associated with market illiquidity in the agricultural sector or caused a decrease in market liquidity.

4.5 Endogeneity test

According to the endogeneity tests conducted in Table 6, there is no issue with omitted variable bias in the model. Incorporating control factors into the study model results in an adjusted R-square increase from less than 1% to over 2% in models 1 to 3. This indicates that the model has incorporated control variables linked to the dependent variable.

Table 6 Hypotheses result – Indonesia and Malaysia

	Model 1A	*Model 1B*	*Model 2A*	*Model 2B*	*Model 3A*	*Model 3B*	*Model 4A*	*Model 4B*	*Model 5A*	*Model 5B*
	Dependent variable = AMIHUD									
CASES	0.006***	0.003***								
DEATHS			0.0027***	0.002***						
RECOV					0.0057***	0.003***				
VACC							−0.000009	0.00001		
SGC									0.000000007	0.0000003
GK_VOL		−0.00004***		−0.00004***		−0.00005***		−0.00004***		−0.00005***
Index_R		−0.002		−0.002		−0.008***		−0.002		−0.002
Inter_R		−0.011***		−0.011***		−0.004		−0.013***		−0.013***
Gold_LN		0.0001		0.0001		0.002**		0.0007		0.0007
Const	0.0024***	0.0009	0.0018***	0.0007	0.0018***	−0.0120**	0.0018***	−0.0034	0.0018***	−0.0037
N	8358	8358	8358	8358	4910	4910	8358	8358	8358	8358
Adj R-squared	0.26%	2.1%	0.39%	2%	0.95%	2.2%	0.0031%	1.8%	.	1.9%
ρ-value (F)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 7.1 Robustness result – Indonesia subsample

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
CASES	0.0002				
DEATHS		0.00006			
RECOV			−0.0003		
VACC				0.00007	
SGC					0.00001*
GK_VOL	−0.00005***	−0.00005***	−0.00005***	−0.00005***	−0.00005***
Index_R	−0.004	−0.004	−0.008**	−0.0045	−0.004
Inter_R	0.307***	0.308***	0.250***	0.309***	0.313***
Gold_LN	−0.0017	−0.0017	0.0009	−0.0018	−0.002
Const	0.004	0.004	−0.014	0.000065	0.0014
N	3023	3023	1797	3023	3023
Adj R-squared	0.039	0.039	0.045	0.019	0.040
ρ-value(F)	0.000	0.000	0.000	0.000	0.000

Table 7.2 Robustness result – Malaysia subsample

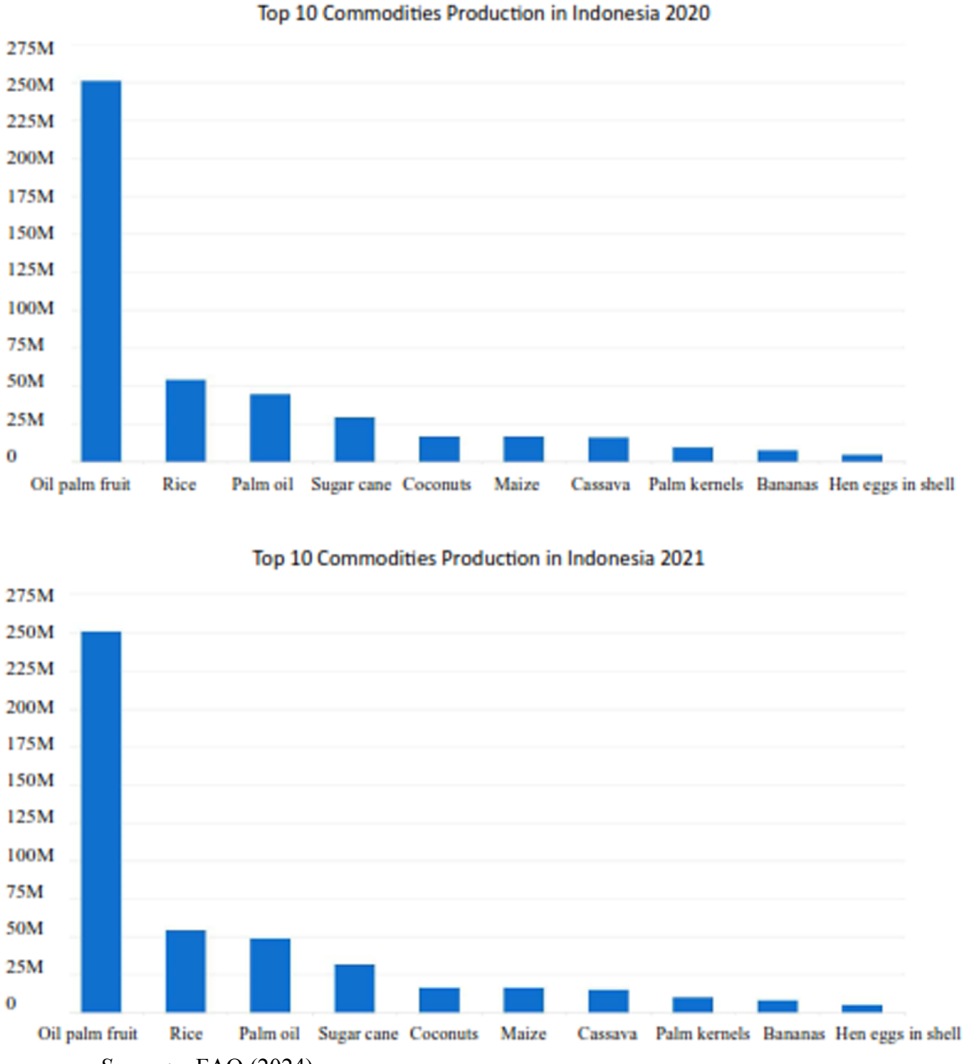
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
CASES	0.0046***				
DEATHS		0.0032***			
RECOV			0.0055***		
VACC				−0.000009	
SGC					−0.0000
GK_VOL	0.0210***	0.0211***	0.0208***	0.0180***	0.0181***
Index_R	−0.0007	−0.0010	−0.0053	0.0015	0.0015
Inter_R	−0.1385	−0.1078	−0.2484**	0.0795	0.1170
Gold_LN	−0.0014*	−0.0016*	−0.0011	0.0001	0.0006
Const	0.0129**	0.0135**	0.0127*	−0.00157	−0.0051
N	5335	5335	3113	5335	5335
Adj R-squared	0.2784	0.2793	0.3104	0.1537	0.1543
ρ-value(F)	0.000	0.000	0.000	0.000	0.000

4.6 Discussion

This study, based on the Black Swan theory, is one of a small number of studies that explain the role of the COVID-19 Delta in market liquidity in the Indonesian and Malaysian stock markets. Using combined confirmed cases, deaths, and recoveries data from both countries, this study contributes to the literature showing that confirmed cases, deaths, and recoveries are positively associated with market liquidity. During the COVID-19 Delta pandemic, financial markets were largely responsive to severe levels of fear. Al-Awadhi et al. (2020) and Ftiti et al. (2021) show that confirmed cases and deaths

reduce stock market returns and liquidity, raising total risk. Baig et al. (2021) discovered that the number of reported confirmed cases and deaths reduced market liquidity and volatility at the individual investor level. Consistent with Haroon and Rizvi (2020) and Apergis et al. (2023), there is a significant and negative link between the epidemic and market liquidity at times of increased uncertainty. A positive attitude and better global growth prospects can also cause market volatility, which would make the investment environment more predictable. The results agree with Priscilla et al.'s (2023) findings that the increase in COVID-19 daily confirmed cases and recoveries greatly increases the liquidity of the stock market.

Figure 4 Production levels in Indonesia's agriculture industry between 2020 and 2021 (see online version for colours)



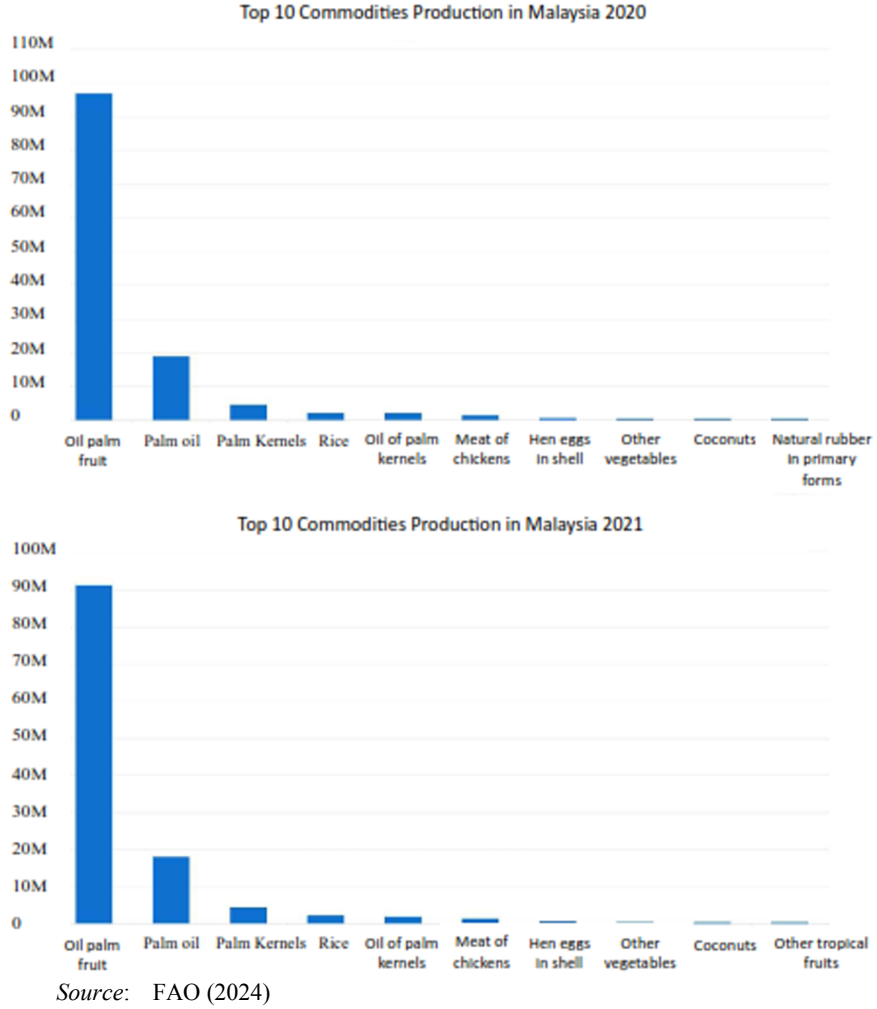
Source: FAO (2024)

The robustness test results also show that confirmed cases, deaths, and recoveries are highly positively linked with market liquidity in Malaysia. However, the robustness does not support the test results for Indonesian samples. The robustness test findings varied between the two countries for a variety of reasons. In Indonesia, confirmed cases, deaths, and recoveries are not associated with the market liquidity of agricultural firms for the following reasons: First, the Food and Agriculture Organization of the United Nations (FAO) report shows that the agricultural sector in Indonesia has demonstrated resilience in the face of the pandemic, as seen in Figure 4. The Indonesian agriculture sector experienced steady positive year-on-year economic growth for eight consecutive quarters, spanning from the first quarter of 2020 to the fourth quarter of 2021 (Figure 4). This occurred despite the overall negative GDP growth in 2020 (FAO, 2023). Government policy related to the sufficiency of food consumption and food security in Indonesia through 'Social Safety Net' programs is considered successful in overcoming the supply chain in Indonesia's agriculture during the pandemic, including the Delta variant (FAO, 2023). Second, since the first outbreak in 2020 to the period of the Delta variant, the restriction movement (PPKM) implemented by the Indonesian government does not apply to critical sectors, specifically agriculture, logistics and transportation, food and beverage, health, and energy industries. These sectors were allowed to operate at 100%, while others were required to work from home at 50 to 100% (Kemendagri, 2021). This causes market liquidity in the agricultural sector in Indonesia to not experience a sharp decline.

In Malaysia, confirmed cases, deaths, and recoveries are associated with the market liquidity of agricultural firms for the following reasons: First, the Malaysian paddy industry, in particular, relies heavily on imports, as the country sources 30% of its total consumption from other global regions. The cost of rice has tripled for customers, causing concern for nations during this pandemic emergency (Adnan and Nordin, 2021). Second, Malaysia has implemented a lockdown since the first outbreak in March 2020 (Tan et al., 2023). The sudden implementation of the MCO caused significant disruption to food production and supply lines, as seen in Figure 5. There has been an inconsistent supply of agricultural and food products to the market (Tan et al., 2023). The influence of the COVID-19 Delta on market liquidity in Malaysia's agriculture confirms the Black Swan theory (Taleb, 2007; Mishra, 2020) that these events are rare, obscure, and unpredictable, resulting in significant consequences that surpass typical expectations.

This study finds no association between the growth of vaccination, the stringency index, and market liquidity in the agriculture industry of both countries. The explanation is that COVID-19 vaccination does not show immunity to the COVID-19 Delta virus, so increasing vaccination does not have a direct impact on reducing the pandemic and increasing market liquidity. According to Figure 3, Malaysia's stringency index in 2021 will range from 45 to 90 (out of 100), while Indonesia's stringency index will range from 50 to 70 (out of 100). The difference in stringency index between the two countries does not appear to be significant enough to cause a big difference in market liquidity. The mean stringency data for Malaysia and Indonesia, 68.61 and 68.63, respectively, as shown in Table 3, further supports this argument.

Figure 5 Production levels in Malaysia's agriculture industry between 2020 and 2021 (see online version for colours)



Source: FAO (2024)

5 Conclusion and implications

This research aims to investigate the influence of the COVID-19 Delta variant in 2021 through analysis of confirmed cases, deaths, recoveries, vaccinations, and stringency on stock market liquidity in the agricultural sector of Indonesia and Malaysia. The findings demonstrate that confirmed cases, deaths, and recoveries are positively associated with market liquidity. The increase in confirmed cases, deaths, and recoveries tends to impede market liquidity. This result is because the growth of recoveries is very strongly associated with confirmed cases in the short term. This study finds no association between the growth of vaccination and the stringency index and market liquidity in the agriculture industry of both countries. The robustness results are strong and reliable for Malaysia but have not been confirmed for Indonesia. Further findings reveal insights into

evaluating the impact of government interventions in response to tightening measures during the COVID-19 Delta variant.

A thorough understanding of the mechanics of market liquidity is critical for investors and regulators. First, it enables traders to optimise their trading strategies by controlling liquidity risks, resulting in an optimal allocation of funds and increasing their return in the future. Based on the provided data, it is crucial for investors to first understand the impact of the COVID-19 Delta variant on the stock market. Investors can take action by understanding the effects of COVID-19 on the stock market and anticipating what lies ahead. Second, regulators can promote laws to protect the stock market against liquidity declines, specifically during the pandemic. This is necessary because COVID-19 significantly influences the stock market in both Indonesia and Malaysia.

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