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COVID-19 VACCINATION, GOVERNMENT STRICT POLICY AND CAPITAL MARKET VOLATILITY: EVIDENCE FROM ASEAN COUNTRIES[3]

The COVID-19 pandemic had a negative impact on the volatility of the stock market in the ASEAN region. Mass vaccination and strictness policies are government efforts to tackle stock market losses. Hence, this study aims to examine the effect of the COVID-19 vaccination and the stringent government policies on the volatility of stock markets in ASEAN countries. We collected the daily index prices, the number of vaccines, and the stringency index from 13 January 2020 to 31 August 2021. Using the GJR-GARCH model (1, 1) and Generalized Least Square regression, this study found that the mass vaccination had a negative effect on stock market volatility, whereas the government's stringent policies had a positive effect. Mass vaccination tends to increase the confidence of economic actors, impacting investors' confidence in the stability of the stock market. Meanwhile, the government's strict policies have caused uncertainty among economic actors and investors regarding the economic prospects during the pandemic, leading to high levels of volatility. Therefore, governments must promote more aggressive vaccination policies, thereby reducing stringent policies for economic agents.
Keywords: COVID-19; mass vaccination; stringency policy; stock market volatility
JEL: G14; G15; G18; I18

1. Introduction

The COVID-19 pandemic, which emerged in late 2019 in Wuhan, China and began to spread in early 2020, caused an unprecedented shock to the global economy. Initially, world stock markets were unaffected by the pandemic. However, the stock market began to react negatively as a result of a large number of confirmed victims of this virus's nationwide spread (Khan et al., 2020). This resulted in a decline in stock prices, especially after the World Health Organization (WHO) declared COVID-19 a pandemic on 11 March 2020 (AlAli, 2020). The global stock markets have been affected by the COVID-19 pandemic, with Asia experiencing more negative abnormal returns than other regions (Shaik, 2021). This is

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because the Chinese stock market, which is representative of Asia's largest stock market, experienced a severe negative impact on their stock index returns (Liu et al., 2020).

In comparison to the effects of SARS in 2003 (Siu, Wong, 2004), the impacts of COVID-19 were much larger and lasted much longer (Mofijur et al., 2021). Previous research has demonstrated a negative relationship between stock returns and pandemic/epidemic outbreaks (Chen et al., 2009; Pendell, Cho, 2011). Prior research confirmed that stock price fluctuations due to the epidemic had brought significant economic losses to the stock market (Baker et al., 2012; Delisle, 2003; Nippani and Washer, 2004). In addition, since March 2020, when the epidemic became a global pandemic, the majority of global stock markets have experienced continued price declines and increased volatility (Li et al., 2021). Numerous studies have uncovered general evidence on the factors that influence stock market volatility, including the number of positive cases, deaths, government intervention (lockdown & stimulus packages), consumer behaviour, and investor fear (Al-Awadhi et al., 2020; Ibrahim, Kamaludin, 2020; Uddin et al., 2021; Zaremba et al., 2020).

The increasingly high spread of COVID-19 necessitates that countries implement lockdown policies to reduce the transmission rate (Reizer et al., 2022). This results in the closure of various commercial businesses, a decrease in purchasing power and consumption, and delays in investment activities (Mofijur et al., 2021). The impact of these activity restrictions has been detrimental to economic growth and even triggered a recession in several countries (Inoue et al., 2021). Negative economic growth and decreased business activity reduce investors' confidence in the stock market; consequently, investors tend to sell, resulting in a decline in stock prices (Engelhardt et al., 2021).

Vaccination is one of the good news that offers hope for mitigating the impact of COVID-19 on the global economy (Rouatbi et al., 2021). Vaccination is expected to positively affect economic activity in the community and foster investor confidence, thereby reducing stock price volatility. In addition, announcements regarding the emergence and development of new vaccines beginning at the end of 2020 have sparked optimism for the recovery of the global economy from the pandemic. Recent studies have investigated the effect of mass COVID-19 vaccination in stabilizing and reducing stock market volatility (Khalfaoui et al., 2021; Mofijur et al., 2021; Rouatbi et al., 2021). However, prior studies have only focused on the effect of vaccination rates on stock price volatility.

This study strengthens prior research by exploring the impact of vaccination and strict government policies on stock market volatility, especially in ASEAN countries. Important to consider are the tight policies from the government because they are closely related to restrictions on economic actors that have an impact on economic activity, thereby influencing stock market volatility (Bakry et al., 2021). Moreover, massive vaccination programs in various countries are currently being implemented, including in ASEAN.

Those policies are associated with the ASEAN Post-2015 Health Development Agenda (APHDA 2016-2020) initiative, which encourages regional capacity and collaboration in combating emerging threats, evaluating resilient health systems in response to infectious diseases and ensuring effective health in the ASEAN region (ASEAN, 2018). It was implemented in response to the most recent COVID-19 outbreak in Southeast Asia, which occurred in mid-January 2020. Despite the region's proximity to China, the number of cases

and deaths is significantly lower in this region than in other regions (Papageorgiou et al., 2020). This is evidenced by the fact that some countries, such as Thailand, Malaysia, and Singapore, have high scores on Global Health Security Index for health safety and capabilities (Bell, Nuzzo, 2021).

Singapore announced early nationwide measures to enforce social distancing from 7 April to 4 May 2020, which were later extended to 1 June 2020. Singapore's limited case fatality rate of 0.8% as of 21 October 2022 demonstrates the relative success of these early strict lockdown measures, as it is the lowest among all ASEAN countries (Mathieu et al., 2022). Based on the Global Health Security in the ASEAN region, Thailand is rated as the most prepared nation to mitigate the pandemic (Purnomo et al., 2022). This is shown in Thailand's readiness to mitigate the pandemic from their 2017-2021 Twelfth National Economic and Social Development Plan to build a combined control system for mobility response to pandemic disease and improve local production capability of disease vaccines (Potempa et al., 2022). This gives Thailand high vaccine doses given in ASEAN by 199.13 points and low new cases (per 1M) by 5.82 points as of 14 October 2022 (Mathieu et al., 2022).

This study contributes to the literature on capital markets by examining the effect of vaccination and tightening policies on stock index volatility during the COVID-19 pandemic. The results of this study may also be considered by the government in its effort to expedite the vaccination program and achieve immunity in the society. Thus, the purpose of this study is to examine the effect of COVID-19 vaccination and stringent government policies on the volatility of the capital markets in ASEAN countries.

2. Literature Review

The COVID-19 pandemic that has spread since December 2019 has affected all facets of life and created a great deal of interest among researchers to conduct academic research on the pandemic. Since the beginning of 2020, there have been more studies examining the impact of the pandemic on financial markets. At the onset of the pandemic, researchers reported the medical pandemic's impact on financial markets, where the increase in the confirmed positive cases and the high COVID-19 death rate had a positive effect on the volatility in world capital markets (Baker et al., 2020; Chatjuthamard et al., 2021; Cheng et al., 2021). As the number of COVID-19-positive victims outside of China began to rise, global financial market volatility was also rising (Albulescu, 2020). Volatility is the rate at which stock prices rise or fall over a given time period (Kyröläinen, 2008). Volatility is used as a barometer to measure uncertainty risk (Endri et al., 2021) and is the main influential factor in investment portfolio decision-making (Suryadi et al., 2021).

Since the COVID-19 case was made public, stock returns have declined in eleven stock market indexes in countries impacted by the virus (Khatatbeh et al., 2020). COVID-19 has also been found to influence markets for cryptocurrencies (Umar, Gubareva, 2020), exchange rates (Liu et al., 2022), gold (Yousef, Shehadeh, 2020), property and real estate (Milcheva, 2022), bonds (Liu et al., 2022) and oil prices (Mhalla, 2020). Several studies have also reported the effects of the pandemic that harmed various industrial sectors, such as transportation, mining, electricity, environment (He et al., 2020), construction

(Pamidimukkala, Kermanshachi, 2021), aviation (Maneenop, Kotcharin, 2020) and tourism (Hao et al., 2020).

Long before the COVID-19 pandemic, other infectious diseases such as swine flu, MERS, SARS, Ebola, and Zika had substantial economic and financial implications, negatively affecting Gross Domestic Product (GDP) growth rates and stock market returns (Ma et al., 2020). Others found a negative impact of the 1918 Great Influenza Pandemic on GDP, consumption, and stock returns (Bai et al., 2020). Besides impacting the stock market, a pandemic can affect a company's financial fundamentals, including profitability, employment, and debt (Ma et al., 2020). Thus, an epidemic is always detrimental to the development of the capital market.

The COVID-19 virus naturally mutates and generates new variants over time. Some of these more recent variants are more infectious and lethal than their predecessors (Islam et al., 2022). The emergence of new variants of COVID-19, such as Gamma, Delta, and Omicron has posed a threat to global efforts in dealing with the pandemic (WHO, 2022). Therefore, government intervention becomes more expensive and less effective in returning the world economy to its pre-pandemic state (To et al., 2021). Thus, mass vaccination plays a role in creating immunity, allowing the global economic activity to return to normal (Rouatbi et al., 2021). However, the literature regarding the impact of vaccine development and mass vaccination on financial markets is still minimal. The financial markets literature explore only the impact of successful clinical trial drug development (Sumadi, 2016), approval of new drugs (Donovan, 2018), and potential development of new drugs for cancer (Huberman, Regev, 2001) on the stock market.

Research on the impact of vaccine development on the stock market did not exist until the COVID-19 pandemic hit. The world has never experienced a widespread health crisis like this before; hence, herd immunity can only be achieved through mass vaccination (MacIntyre et al., 2022). With a vaccine efficacy of at least 90% against all infections, herd immunity can be achieved by vaccinating 66% of the population (MacIntyre et al., 2022). (Rouatbi et al., 2021) reported the positive impact of the COVID-19 vaccination program in 66 countries in reducing the volatility of stock returns, where vaccination was measured by the number of daily vaccines administered, the duration of vaccination, and the increase in the number of daily vaccines.

Previous research by (Chan et al., 2021) analyzed the stock market's reaction to the initiation of COVID-19 vaccine clinical trials in humans. The average abnormal return in 49 countries increased by 15.2 basis points (bps) on the first day of clinical trials of the vaccine. Afterwards, abnormal returns increased by 30.0 bps and 51.7 bps, respectively, on the first day of phase 2 and phase 3 clinical trials. The increase in abnormal returns indicates a favourable reaction of the stock market to vaccine development, which continues into the next phase of the vaccine test.

In both developed and developing countries, post-clinical trial mass vaccination significantly reduced stock market volatility (To et al., 2021), so an increase in the vaccinated population contributed to stabilizing stock markets. Several other studies have also reported on the impact of vaccine development on the economy and the stock market that has been carried out in a short time (Bakry et al., 2021; Chan et al., 2021; Gräb et al., 2021). The study by

(Bakry et al., 2021) in analyzing the impact of vaccination was limited to data until February 2021, whereas (Rouatbi et al., 2021) extended the study period to April 2021, when the immunization program was still in its infancy, with 20.5 million doses administered compared to August 2021 of 41.18 million doses. Thus, this study extends the research period from 13 January 2020 to 31 August 2021.

In addition to vaccination, the number of victims of positive cases, deaths, and government intervention also contribute to volatility in the capital market (Ibrahim, Kamaludin, 2020; Khan et al., 2020; Zaremba et al., 2020). During the COVID-19 period, (Zaremba et al., 2020) pioneered research on the impact of government-imposed social restrictions on stock market volatility. They explore the impact of the aggregate stringency index and the individual impact of seven government policy actions on stock market volatility. The results show that non-pharmaceutical intervention (tightness policy) significantly increases the volatility of the stock market.

Strict government policies such as lockdowns, workplace closures, or restrictions on people's movement are effective in reducing the spread of infection, but they have serious economic impacts (Atalan, 2020; Zaremba et al., 2020). Strict policies stop production and all other economic activities (Wagner, 2020). The government's strict policy in handling COVID-19 is also stricter, broader, and of a longer duration than the policy response to the handling of the Spanish Flu and the 1957-1958 influenza pandemic (Baker et al., 2012).

Government policies in dealing with pandemics are always dynamic and change according to the conditions of COVID-19 itself. This intervention changes lead to increased uncertainty, which makes the stock market more volatile (Fauzi, Paiman, 2021; Zhang et al., 2020). One of the main sources of market volatility is the uncertainty and potential economic loss due to a pandemic (Ashraf, 2020; Zhang et al., 2020). Higher stock market volatility can lead to investor pessimism regarding future economic developments (Razak et al., 2020). In addition, the decline in investor confidence also causes uncertainty about the company's growth opportunities which then increases the risk of falling stock prices (Hong, Stein, 2003). Thus, the hypothesis of this study are as follows:

H_1: There is a negative effect of COVID-19 vaccination on stock index return volatility in ASEAN countrie

H_2: There is a positive effect of the government's tightness policy on the volatility of stock index returns of the six ASEAN countries

3. Research Methodology

This study uses stock price indexes from six ASEAN countries (Indonesia, Philippines, Malaysia, Thailand, Singapore, and Vietnam) over a period of 427 days (13 January 2020 – 31 August 2021), yielding a total of 2,562 observations. ASEAN is the seventh largest economic superpower in the world and the fourth in Asia, with a combined GDP of US$3.0 trillion (International Monetary Fund, 2022). Among ASEAN countries, ASEAN-5 (Singapore, Indonesia, Malaysia, Thailand and Vietnam) are the countries with the strongest GDP growth and stable economic activity (Munir et al., 2020). The impact of COVID-19 in

one of China's neighbouring regions has had a direct effect on its economy (Fauzi, Paiman, 2021).

Table 1 shows the six ASEAN member countries included in this study, where the stock price index is obtained from the *Eikon Refinitive Database*. This study uses only six ASEAN member countries because the other four do not have a capital market (Brunei Darussalam) or have a very small number of listing firms (Laos, Cambodia, and Myanmar)[4] (Naufa et al., 2019). The research period begins on 13 January 2020 as that is when the first time a COVID-19 case entered Southeast Asia in Thailand (Sim et al., 2021). The study period concludes on 31 August 2021, taking into account the number of vaccinated populations (at least the first dose) in Southeast Asia, which has reached 91% (WHO Southeast Asia Regional Office, 2021) and extends the previous study period (Rouatbi et al., 2021; To et al., 2021).

Table 1. Research

No	Country	Major Stock Indices
1	Philippines	PSEi Composite
2	Indonesia	IDX Composite
3	Malaysia	FTSE Malaysia KLCI
4	Thailand	SET Index
5	Singapore	Straits Times Index
6	Vietnam	Vietnam Ho Chi Minh Stock Index

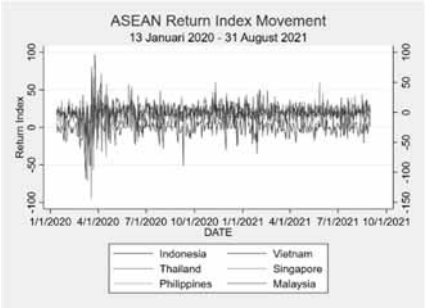
Daily vaccination data is obtained through Our World in Data (*ourworldindata.org/coronavirus*), which collects the most recent data from the government and the Ministry of Health of each country. The government's stringent policy response is based on the Oxford COVID-19 Government Response Tracker (*covidtracker.bsg.ox.ac.uk*). The stringency index is a composite measurement of nine government response metrics: school closures; workplace closures; event cancellation; meeting restrictions; closure of public transportation; stay-at-home requirements; information campaigns; internal restrictions; and international travel (Hale et al., 2020). On a given day, the index is calculated as the average score of these nine metrics, each of which ranges from 0 to 100 (Worldometer, 2022).

It has been widely explained in the literature that the volatility of stock returns fluctuates from time to time (Teräsvirta, 2009). In other words, there are fluctuations or alternating increases and decreases in the data (Soedewi, Purqon, 2015). Research in capital markets, that use time series data, usually has a high level of volatility. This is also the case in our study, as shown in Figure 1 and Figure 2, whereby price and return fluctuation exist in the majority of the six indexes during the pandemic. The high volatility of financial data results in volatility clustering, often referred to as heteroscedasticity symptoms (Hafizah et al., 2020), whereas homoscedasticity is required for time series data modelling (Ghozali, Imam, 2016). To overcome heteroscedasticity, the time series model that can be used is the Autoregressive *Conditionally Heteroscedastic-Generalized Autoregressive Conditionally Heteroscedastic* (ARCH-GARCH) model (Dutta, 2014), which is widely used in studies examining the volatility of financial assets (Miswan et al., 2014).

[4] Laos has 11 registered companies (Lao Securities Exchange (LSX), 2022), Cambodia has 9 registered companies (Cambodia Securities Exchange (CSX), 2022), while Myanmar has only 7 registered companies (Myanmar Securities Exchange Centre, 2022).

Figure 1. ASEAN Price Index Movement

Figure 2. ASEAN Return Index Movement



The traditional GARCH model can capture the clustering of volatility and leptokurtosis[5], but the model assumes that the financial data come from an asymmetric distribution (Bakry et al., 2021). Thus, the GARCH model cannot capture the asymmetric response of volatility to market shocks caused by both good and bad news (Dutta, 2014). The *Glosten Jaganathan Runkle-Generalized Autoregressive Conditionally Heteroscedastic* (GJR-GARCH) model (Glosten et al., 1993) overcomes this limitation and captures the asymmetric response to volatility by examining negative shocks that have a greater impact on return volatility than positive shocks.

(Glosten et al., 1993) and (Nelson, 1991) have developed *Glosten-Jagannathan-Runkle-GARCH* (GJR-GARCH) and exponential GARCH (EGARCH) models. In this study, the GJR-GARCH asymmetric model (*p, q*) is used to obtain the conditional variance of stock market index returns during COVID-19 or referred to as stock market volatility. This study uses *p*=1 and *q*=1 because they are the most appropriate options for the financial time series (Glosten et al., 1993). The use of the GARCH (1,1) model is considered sufficient for most of the financial data (Engle, 2001). The formula for the GJR-GARCH (1,1) model specifically is as follows:

$$r_t = \mu + \varepsilon_t \quad (1)$$

$$VOL_t = \omega + \alpha\gamma(\varepsilon_{t-1}^2) + \beta_j h_{t-1} \quad (2)$$

Where r_t is the stock index return of each country which is calculated by *ln(Pt/Pt-1). P_t* is the closing price of the stock index in period *t*, while *Pt-1* is the closing price of the stock index in period *t-1*. VOL_t is the volatility at time *t*; denotes the asymmetric parameter. The equation of panel data analysis used to calculate the effect of vaccination and government strictness on stock market volatility during COVID-19 is the following formula:

$$lnVOL_{i,t} = \beta_o + \beta_1 lnSI_{i,t} + \beta_2 lnNVAC_{i,t} + \varphi X_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where *i* and *t* refer to country and time, respectively. β_o is a constant variable. The dependent variable $lnVOL_{i,t}$ is the natural logarithm of the daily stock index return volatility as measured from equation 2. The independent variable is the natural logarithm of the number

[5] *Leptokurtosis is a condition when the volatility of securities is not volatile, where the volatility of a security changes at a relatively low level* (Pati et al., 2017).

of daily vaccinations ($lnNVAC_{i,t}$) and the natural logarithm of government policy tightness index value ($lnSI_{i,t}$). In addition, $\varphi X_{i,t}$ was added as a country-level control variable as suggested by previous studies (Bakry et al., 2021; Rouatbi et al., 2021; Uddin et al., 2021). The control variables are the natural logarithm of daily exchange rate changes in the country's currency value to USD (*lnER*) for country *i* at time *t*, the natural logarithm of the number of daily positive confirmed cases (*lnNC*), and the natural logarithm of the number of daily death cases (*lnND*) measured for the country *i* at time *t*.

PfizerAnn was the dummy variable when Pfizer-BioNTech announced vaccine development on 9 November 2020. Meanwhile, *PfizerVAC* was the dummy variable when the Pfizer-BioNTech vaccine was first administered by the US Food and Drug Administration on 23 August 2021. Table 2 explains in more detail the variables, definitions, and research data sources used.

Equation 3 can be estimated using ordinary static panel regression, such as pooled ordinary least squares (OLS) or panel random effects regression, which is in line with previous studies (Bakry et al., 2021; To et al., 2021). However, to decide which model is the most efficient and reliable, this study uses the *Breusch-Pagan Lagrange Multiplier* (LM) test to select the best estimation model. The LM test is an analysis carried out with the aim of determining the best method between common effects or random effects (Abbas & Eksandy, 2018). The LM test shows $p>0.05$. Thus, the pooled ordinary least squares (OLS) model is used to test eq 3.

Table 2. Definition of operational variables

Variables	Definition	Data Sources
Dependent Variables		
lnVOL	Natural logarithm of daily stock index return volatility measured by conditional variance extracted from asymmetric GJR-GARCH (1,1) for country *i* at time *t*	*Eikon Refinitive Database* (stock index price data*)*
Independent Variables		
lnNVAC	Natural logarithm measured as daily new COVID-19 vaccination for country *i* at time *t*	*ourworldindata.org/coronavirus*
lnSI	Natural logarithm measured as the daily strictness policy index from the Oxford Covid-19 Government Response Tracker (OxCGRT) for country *i* at time *t*	*github.com/OxCGRT/covid-policy-tracker*
Control Variables		
lnNC	Natural logarithm measured as the daily number of positive cases for country *i* at time *t*	*ourworldindata.org/coronavirus*
lnND	Natural logarithm measured as the number of cases of death for country *i* at time *t*	*ourworldindata.org/coronavirus*
lnER	Natural logarithm measured as the change in the exchange rate for country *i* at time *t* against the US Dollar	*investing.com/currencies/single-currency-crosses*
PfizerAnn	Dummy variable taking 1 on the day Pfizer-BioNTech announced the development of a COVID-19 vaccination that is 90 percent effective in stopping the virus and 0 otherwise	*google.com*
PfizerVAC	Dummy variable taking 1 on the day of Pfizer-BioNTech COVID-19 vaccine administered first by the US Food and Drug Administration and 0 otherwise	*google.com*

The results of the volatility test using the GJR-GARCH (1.1) model in Table 3 show the significant coefficient of 0.877, indicating changes in volatility that fluctuate and cause stock index movements to experience an unstable tendency.

Table 3. GARCH volatility test

lnip	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
garch(1,1)	0.877	0.035	24.980	0.000	0.809	0.946	***
constant	0.000	0.000	-5.060	0.000	0.000	0.000	***

*Note: *** p<0.01*

Table 4 shows a low correlation between the primary variables *lnSI*, *lnNVAC*, and *lnVOL*. Other control variables, such as *lnNC*, *lnND*, and *lnER* had a low correlation with *lnVOL*, indicating no multicollinearity in the research data. *lnNC* and *lnND* are positively correlated, but this is reasonable given that number of COVID-19-positive cases and daily deaths are always in line (Rouatbi et al., 2021). The results of the classical assumption test on the data, however, found heteroscedasticity through the *Breusch-Pagan* test and autocorrelation through the *Wooldridge* test. Generalized Least Square (GLS) is used instead of OLS to test equation 3. GLS can overcome time series autocorrelation and correlation (cross-section) among observed values (Musau et al., 2015; Winarno, 2017). GLS is also more effective than the OLS in estimating data with autocorrelation and heteroscedasticity model errors (Iswati et al., 2014).

Table 4. Pairwise correlation test

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) lnVOL	1.000							
(2) lnSI	0.021	1.000						
(3) lnNVAC	-0.177****	0.178****	1.000					
(4) lnNC	-0.072****	0.459****	0.435****	1.000				
(5) lnND	-0.087****	0.294****	0.426****	0.840****	1.000			
(6) lnER	-0.085****	-0.021	0.012	-0.025	-0.280****	1.000		
(7) PfizerAnn	0.059**	0.015	-0.079****	-0.013	-0.016	0.001	1.000	
(8) PfizerVAC	0.004	0.042**	0.183****	0.152****	0.178****	0.000	-0.017	1.000

*Note: **** p<0.001, ** *p<0.01, ** p<0.05, *p<0.1*

4. Results and Discussions

Table 5 shows the descriptive statistics of the study in the combined period (Panel A), the period before vaccination (Panel B), and the period after vaccination (Panel C). The average value of daily vaccination (*lnNVAC*) in Table 5 Panel C is 7.667, indicating that the number of daily vaccinations in ASEAN countries is not yet maximized (i.e. around 150,000 vaccinations per day). This is because the vaccinations supplies are still limited. However, governments in ASEAN countries continue to strive to increase the number of COVID-19 vaccinations because with more and more citizens being vaccinated, the potential for herd immunity is greater (Rodrigues et al., 2020).

Even though the number of daily vaccinations is still limited, the government strives for routine vaccinations. The minimum value of *lnNVAC* is 0 due to differences in countries in ASEAN in initiating COVID-19 vaccination. For example, Vietnam was not vaccinated until 9 March 2021, whereas Singapore administered the vaccine earlier than other countries, on 31 December 2020. The highest *lnNVAC* value was 14.846 on 13 August 2021, when Indonesia carried out the most vaccinations in ASEAN, 2.8 million doses.

Table 3. Descriptive statistics

Variables	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Panel A: Before and After Vaccination Period (13/Jan/2020 – 31/Agu/2021)					
lnVOL	2562	-8.821	0.605	-10.213	-5.033
lnNVAC	2562	3.124	5.136	0.000	14.846
lnSI	2562	3.912	0.899	0.000	4.605
lnNC	2562	4.888	3.269	0.000	10.947
lnND	2562	1.713	2.154	0.000	7.635
lnER	2562	-4.785	3.756	-10.055	-0.276
PfizerAnn	2562	0.016	0.127	0.000	1.000
PfizerVAC	2562	0.016	0.127	0.000	1.000
Panel B: Period Before Vaccination (13/Jan/2020 – 30/Des/2020)					
lnVOL	1518	-8.730	0.665	-10.197	-5.033
lnSI	1518	3.738	1.127	0.000	4.605
lnNC	1518	3.576	2.927	0.000	9.032
lnND	1518	1.019	1.637	0.000	5.557
lnER	1518	-4.790	3.754	-10.055	-0.280
PfizerAnn	1518	0.028	0.164	0.000	1.000
PfizerVAC	1518	0.000	0.000	0.000	0.000
Panel C: Period After Vaccination (31/Des/2020 – 31/Agu/2021)					
lnVOL	1044	-8.953	0.477	-10.213	-6.392
lnNVAC	1044	7.667	5.469	0.000	14.846
lnSI	1044	4.166	0.169	3.707	4.445
lnNC	1044	6.796	2.762	0.000	10.947
lnND	1044	2.722	2.403	0.000	7.635
lnER	1044	-4.776	3.760	-10.054	-0.276
PfizerAnn	1044	0.000	0.000	0.000	0.000
PfizerVAC	1044	0.040	0.197	0.000	1.000

The government's response to COVID-19 is measured by the logarithm of the natural stringency index (*lnSI*). Table 5 Panel B shows the number 0 for *lnSI* because when COVID-19 first hit ASEAN on 13 January 2020, there were no countries that had responded to the pandemic. Vietnam was the first ASEAN country to implement a strict policy on 27 January 2020, followed by the Philippines on 30 January 2020. The average *InSI* across all time periods (Panels A, B, C) was relatively high, indicating that the average ASEAN country has implemented strict government policies in dealing with COVID-19. For example, Indonesia in the Implementation of Emergency Community Activity Restrictions, mandated that all non-essential sector employees work from home, shopping centres and malls were closed, and school activities were conducted online from 3 to 20 July 2021. Then, on 7 June 2021, Malaysia implemented the Movement Control Order policy, which imposed a total national lockdown across all social and economic sectors.

In the pre-vaccination period (Table 5, Panel B), the highest *lnSI* value was 4.605, indicating a stringency index of 100. This policy was implemented by the Philippines on 25 March 2020, when President Rodrigo Duterte signed the "*Bayanihan to Heal as One Act*", which granted him full authority to combat the COVID-19 pandemic. The highest *lnSI* value in the vaccination period (Panel C) was lower than in the pre-vaccination period (Panel B). The existence of vaccination can be a tool to achieve immunity in society, allowing the government to loosen restrictions.

Statistical data revealed that *lnNC* and *lnND* increased during the vaccination period (Panel C), but *lnVOL* decreased by an average of -8.953 from the pre-vaccination period. *lnNVAC* as a vaccination variable can be an antidote to market volatility when the rising number of positive cases and deaths causes investors to become increasingly alarmed. This is our initial evidence of the negative effect of vaccination on stock market volatility in ASEAN. The high *lnNC* and *lnND* during the vaccination period were caused by the *Delta* variant, which was more virulent than the previous variant (*Alpha, Beta, & Gamma*). In addition, *lnNC* and *lnND* both show a minimum of 0, because, on certain days, a number of countries do not report any additional COVID-19-positive cases or death.

The results of the regression model of equation 3 for all countries from 13 January 2020 to 31 August 2021 are presented in Table 6. The government's health policy that aims to achieve immunity in the society through mass vaccination (*lnNVAC*) has a negative effect on volatility (*lnVOL*) in the ASEAN stock market. During the COVID-19 period, the number of daily vaccinations injected into the community may play a role in reducing volatility in the stock market. This may be due to the massive vaccination campaign carried out by the government, which can boost investor confidence, thereby encouraging a bull market and tends to help reduce volatility in the ASEAN stock market (Rouatbi et al., 2021). This finding is consistent with previous research that there is a negative effect of COVID-19 vaccination on international stock market volatility (Apergis et al., 2022; Bakry et al., 2021; Chan et al., 2021; Gräb et al., 2021; Rouatbi et al., 2021; To et al., 2021).

Table 6. GLS regression results for all countries and all periods

Variables	Coef.	St.Err.	t-value	p-value
lnNVAC	-0.020	0.003	-7.570	0.000****
lnSI	0.029	0.015	1.950	0.051*
lnNC	0.021	0.008	2.490	0.013**
lnND	-0.046	0.012	-3.850	0.000****
lnER	-0.020	0.004	-5.610	0.000****
PfizerAnn	0.217	0.092	2.360	0.018**
PfizerVAC	0.220	0.094	2.340	0.019**
Constant	-8.996	0.055	-163.520	0.000****

*Note: **** p<0.001, ***p<0.01, ** p<0.05, *p<0.1*

Vaccination can improve immunity and public health (Biggs, Littlejohn, 2022), leading to higher life expectancy (Chudasama et al., 2020). Higher life expectancy can increase the incentives for households to smooth consumption over time and save a greater proportion of their income (Heaton, Lucas, 2017). This share of income allows them to invest more money in the future, for example, to further their education or purchase stocks (Jit et al., 2015). Macroeconomically, the health of good economic actors, is critical to broader economic performance (Bloom, Canning, 2003), in both business and the public economy. Therefore, vaccinations that affect public health are an important factor in the stock market performance (Ngwakwe, 2021).

Using the same model as in equation 3, this study also investigates the effect of vaccination, strict government policies, and other COVID-19 variables on stock market volatility in each country prior to and after vaccination (see Table 7). Each country starts vaccination at a

different time. Indonesia and Malaysia began vaccinations on 25 January 2021, while Vietnam did not begin until 6 March 2021.

Table 7. Regression results per country and per period

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	All Countries
Panel A: Period Before Vaccination							
lnSI	0.315****	-0.083	0.123**	-0.009	-0.104***	0.051	0.023
lnNC	-0.186***	0.052**	0.022	-0.068*	0.128****	0.181****	0.041***
lnND	0.040	-0.035	-0.061***	0.000	-0.014	-0.234	-0.080***
lnER	-2.049**	-7.030****	-11.344****	-18.705****	-11.445****	-64.535**	-0.018***
PfizerAnn	0.230	0.366*	0.626***	0.698**	0.881***	-0.183	0.181*
PfizerVAC	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Constant	-2.846***	-18.840****	-53.362****	-14.548****	-47.958****	-657.79*	-8.968***
Panel B: Period After Vaccination							
lnSI	-2.394	0.360	0.006	0.201	-0.134	0.342	0.365***
lnNVAC	0.001	-0.013	0.000	0.013	-0.002	0.015	-0.008***
lnNC	-0.121	-0.488****	0.019	-0.010	0.112*	0.076**	0.006
lnND	0.046	0.197***	-0.082***	-0.054	-0.094	-0.107***	-0.038***
lnER	-0.779	-6.318	-6.433****	-3.367	0.714	-79.966**	-0.026***
PfizerAnn	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PfizerVAC	0.102	0.630***	-0.011	0.037	0.348**	0.358	0.233***
Constant	-5.382	-16.053**	-33.687****	-10.956***	-6.620	-814.382**	-10.482***

*Note: **** p<0.001, ***p<0.01, ** p<0.05, *p<0.1*

Table 7 Panel A shows the pre-vaccination period beginning on 13 January 2020, the date of the first positive case in ASEAN, and ending on 30 December 2020, the day before the first vaccination in Singapore (Worldometer, 2022). The vaccination period (Panel B) starts on 31 December 2020, when the first vaccination was administered in Singapore, and ends on 31 August 2021. In Panel B, *lnNVAC* shows consistent results with Table 6, indicating that vaccination can reduce the volatility of the ASEAN stock market when the vaccination program is implemented in ASEAN. Thus, this study provides evidence to support the first hypothesis (H_1) that COVID-19 vaccination has a negative effect on stock return volatility.

Table 6 shows a marginally positive relationship between the government's stringency policy (*LnSI*) and the stock market volatility. These results support earlier findings that non-health interventions, such as the closure of schools, workplaces, internal movement restrictions, and international travel, as well as the cancellation of public events during the COVID-19 outbreak, significantly increased stock market volatility (Bakry et al., 2021; Engelhardt et al., 2021; Rouatbi et al., 2021; Zaremba et al., 2020).

The government's stringent policies lead to low levels of public trust due to the lack of public awareness in complying with policies, especially in developing countries (Engelhardt et al., 2021). People's disobedience to the government's stringent policies could exacerbate the impact of the pandemic and trigger further tightening policies, which ultimately inhibited economic activity (Zaremba et al., 2020). Thus, investors responded negatively to this government policy and generated negative signals of economic and financial instability in ASEAN countries. This initial response made investors react negatively to changes in government conservatism in anticipation of uncertainty in the pandemic situation (Zaremba et al., 2020).

The government's stringent policy gave different results during the pre-vaccination period, whereas in Table 7 Panel A, *lnSI* had no significant impact on stock market volatility. This is evidenced by the absence of a positive response to the strict policy on stock market volatility in the majority of ASEAN countries. Before and after vaccination, Malaysia, Singapore, and Vietnam did not respond significantly to the effect of *lnSI*. However, the three countries responded more to the confirmation of positive cases as an indicator of market fear and uncertainty than to the government's strict policy preceding vaccination. These results support the previous study, indicating that the stringency index has no effect on the volatility of the stock market in the absence of the vaccination variable (Yiu, Tsang, 2021).

The government's stringency policy has a positive effect on *lnVOL* in the post-vaccination period (see Table 7 Panel B), which is consistent with the findings in Table 6 for the period and the entire country. This result differs from the pre-vaccination period (Table 7 Panel A) because in the post-vaccination period (Panel B), starting on 31 December 2020, there was the first wave and the second wave of COVID-19, which resulted in significantly tighter government policies to control case transmission (Song et al., 2021). The emergence of a new and more contagious *Delta* variant, migrant workers, and international tourists in the ASEAN region who transmit COVID-19 caused these major waves (Fauzi, Paiman, 2021). Therefore, this study provides empirical evidence to support the second hypothesis (H_2) that government stringency policies have a positive effect on stock return volatility.

This study also examines the impact of the control variables, namely daily positive cases (*lnNC*) and daily death cases (*lnND*) due to COVID-19, as well as the daily currency exchange rate (*lnER*) of each ASEAN country relative to the US dollar. Table 6 shows that the increase in positive cases contributes to the volatility in the ASEAN stock markets. These results support the previous research, that demonstrated an increase in COVID-19 positive cases as a negative reaction of investors to triggers of increased stock market uncertainty during the pandemic (Bakry et al., 2021; Rouatbi et al., 2021; To et al., 2021; Zaremba et al., 2020).

The results in Table 6 are consistent with the period before vaccination (Table 7 Panel A), but different from the period following vaccination (Panel B). *lnNC* continues to have a positive effect on the volatility of the stock market, but this effect becomes insignificant after vaccination. This is because the market captures vaccination information as an important tool for governments and health institutions to contain and reduce positive cases of COVID-19 (Mertens et al., 2022), resulting in a positive investor sentiment that drives stock market performance (Hartono, 2021).

Mortality cases have a negative effect on the volatility of the ASEAN stock markets, as shown consistently in Tables 6 and 7. These results contradict those of studies (Rouatbi et al., 2021) and (To et al., 2021), but are in line with studies (Bakry et al., 2021) and (Zaremba et al., 2020). When assessing economic and business prospects, it appears that investors are more concerned with positive cases data than with mortality rates (Bakry et al., 2021). These diverse results show that numerous factors affect the movement of the stock market. In addition to demand and supply, there are additional market-disrupting factors, such as government intervention, news sentiment, and abnormal trading (Herlina et al., 2022).

5. Conclusions and Recommendations

This study aims to determine the effect of mass vaccination and the government's stringency COVID-19 policy on the volatility of stock market returns in six ASEAN countries. This study uses daily data on major stock indices, stringency index, vaccinations, positive cases, deaths, and the exchange rate relative to the US Dollar. The results of this study indicate that mass vaccination reduces stock market volatility, with increased vaccination helping to stabilize stock markets in six ASEAN countries. This study also demonstrates that government intervention in non-health matters, such as tightening policies, has a positive effect on volatility.

Mass vaccinations carried out by the state can boost investor confidence, thereby encouraging a bull market and reducing volatility in the ASEAN stock markets. Vaccination also improves health and tends to increase life expectancy, allowing individuals to increase consumption and invest more in the stock market. In contrast, market volatility increases as a function of the stringency index as a proxy for government policies, and vice versa. Stringent policies implemented by the government caused uncertainty from economic actors and investors regarding the economic outlook during a pandemic situation, thereby increasing volatility.

This study provides recommendations for governments in the ASEAN region to encourage more aggressive vaccination policies. Based on the findings of this study, in order to minimize stock market volatility during pandemics, it is crucial that policymakers respond quickly to implement a strong vaccination program. In addition, the government is expected to implement policies that are beneficial to economic actors. The government needs to loosen tight policies to reduce stock market volatility by promoting vaccination to create herd immunity as soon as possible. Governments should carefully consider adapting their regulatory response to the pandemic in the light of the need to strike a balance between public health and the economy.

This recommendation is supported by the recent data on *OurWorldInData.org* which indicates that high vaccination rates in the majority of the sample countries result in a reduction in stringent policies, which ultimately stabilizes the stock market. For example, as of 9 October 2022, Singapore, with a population vaccination rate of 93.91%, has an impact on reducing the level of strictness rate by 17.59%, thereby impacting the stabilization of the Straits Time Index above 3,000 levels.

Mass vaccination is a topic that requires further attention from researchers employing a variety of approaches to determine the role of vaccines in international financial markets. This study uses a volatility estimation model (GJR-GARCH). Further studies can test the selection of the best model to determine the appropriate model using GARCH-X, GARCH-M, or TGARCH.

The research data also exhibited signs of heteroscedasticity; future studies can remedy this condition by employing alternative methods such as Weighted Least Squares. In addition, the ASEAN stock market is the sole focus of this study. Future research is expected to explore the impact of vaccinations on other financial assets, such as corporate bonds or cryptocurrencies, and in other regions. By considering geographical factors, culture, population, and varying levels of education in each country, further research can also conduct

different tests for each country. This research has the opportunity to have confounding effects from variables outside the study. For example, there is the emergence of negative sentiments for the first & second waves of COVID-19 and the latest variant of Delta. Therefore, further research can consider incorporating these variables to compare the results.

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