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A realistic assessment of COVID-19 vaccination's effect on the Malaysian stock market's downside risk

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ABSTRACT

Numerous studies have revealed the devastating negative impact of the global-scale widespread coronavirus disease (COVID-19) pandemic on the economy, especially on the development of the stock market. Despite countries' efforts, such as implementing movement restriction orders to control the spread of the deadly virus, it has only exacerbated the economic difficulties. This research aims to provide a realistic assessment of the economic impact of vaccinations in mitigating the systemic risk that could hurt the stock market. We scrutinise the daily time series data of the Kuala Lumpur Composite Index from 19th February 2020 to 2nd March 2022 (500 trading days). We find a positive relationship between COVID-19 daily new cases, vaccination rates, investor sentiment, and the stringency index towards the Value-at-Risk in the Malaysian stock market. Statistically, with every 1% increase in COVID-19 daily new cases, Malaysia's stock market risk increases by 14.33%. Additionally, for every 1% increase in vaccine doses administered, Malaysia's stock market risk also increases by 3.42%. On the other hand, higher investor sentiment, proxied by trading volumes, and rigorous government intervention, proxied by the stringency index, are associated with higher market risk and uncertainty by 7.09% and 13.19%, respectively. The current study's findings significantly impact many aspects, including the body of knowledge, policymakers, and the institutional and individual investors community.

1. Introduction

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The coronavirus disease (COVID-19) pandemic has profoundly impacted the global economy and financial markets, causing unprecedented uncertainty and volatility. Malaysia's stock market, like many others around the world, has been affected by the pandemic. Since the first COVID-19 case was reported in Malaysia on 25th January 2020, the country has implemented various measures to control the spread of the virus, including lockdowns, social distancing, and travel restrictions. These measures have resulted in economic disruptions and fluctuations in the stock market. The impact was worsened by implementing severe containment measures and the closure of facilities, as noted by Heyden and Heyden (2021) and Zaremba et al. (2020). The rollout of COVID-19 vaccines worldwide has brought hope for economic recovery and stability. The government has implemented a national vaccination program in Malaysia to inoculate the population against COVID-19. According to the COVID-19 Immunisation Task Force, Ministry of Health Malaysia, as of 5th October 2022 over 86%, 84.2%, and 49.7% of the total population has received at least one dose, two doses and booster doses of the vaccine, respectively.

Figure 1. Malaysia’s coronavirus disease (COVID-19) vaccine tracker and daily COVID-19 cases

Source: COVID-19, Ministry of Health (MOH) Malaysia

Given the potential impact of a rapidly spreading disease on the global economy, developing a vaccine that can prevent its transmission is crucial. However, even for the world's leading pharmaceutical companies, creating a vaccine can be challenging. Developing a new vaccine typically takes 10 to 15 years to ensure its quality, safety, efficacy, and immunogenicity (Scheppler et al., 2021). To address the situation, some countries have issued emergency-use authorisation for new vaccines to prevent COVID-19. This means that the vaccine may become available to the public before it is fully licensed and without completing ongoing clinical trials.

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While vaccination programs aim to control the virus's spread and reduce the burden on healthcare systems, it is still uncertain how they will affect the stock market. This study investigates the empirical relationship between daily mass vaccinations and the downside risk of the stock market using the Value-at-Risk (VaR) model. Unlike many other studies that extensively focus on returns and volatility, they overlook the 'silent risk' that could hit the stock market in a negative way, namely the market risk. The research is divided into two stages. The first stage aims to estimate and backtest the precision of the VaR series using a parametric VaR-EWMA model and Kupiec LR-POF test. The second stage investigates the impact of vaccination on market risk, controlling for factors such as daily new COVID-19 cases, investor sentiment, and government intervention as reflected by the stringency index.

2. Literature review

Since the outbreak of COVID-19, many researchers are becoming more interested in finding out its impact on the financial markets. Some studies focused on financial factors in companies before the pandemic that could be used to mitigate the pandemic's impact, such as a solid financial background and an appropriate capital structure (Ding *et al.,* 2021; Ramelli & Wagner, 2020; Fahlenbrach *et al.,* 2020). While some researchers discovered that remarkable stock price resilience during the pandemic was associated with high environmental evaluations and ESG scores (Broadstock *et al.*, 2021; Albuquerque *et al.*, 2020; Ding *et al., 2021*), other researchers discovered the exact opposite (Bae et al. (2021) and Takahashi and Yamada (2021).

According to Ramelli and Wagner (2020), a company's performance during the pandemic was influenced by family ownership, corporate culture, work-from-home viability, market power, and engagement in international trade. Hyun *et al.* (2020) confirmed their findings by revealing that a company's market power improved its performance throughout the pandemic. Moreover, Bai *et al.* (2021) discovered that work-from-home viability increased an organisation's performance during a pandemic. Additionally, family ownership was found to have an impact on the company's success during the pandemic by Ding *et al.* (2021). Along with firm-level factors, the study also explores factors at the national level. The same study questions are investigated at the country and firm-level factors. Previous studies have shown that various variables can affect a market's immunity at the national level. These factors include the national culture of the nation, which is highlighted by Ashraf (2021), Fernandez-Perez *et al.* (2021), and Kaczmarek *et al.* (2021), as well as the level of economic freedom that is emphasised by Erdem (2020). Zaremba *et al.* (2021) looked at the pre-pandemic economic conditions as the factor affecting market immunity, while Narayan *et al.* (2021) emphasised the government responses to the pandemic.

The impact of COVID-19 on the financial market has been the subject of numerous research in the past (Ngwakwe, 2020). Investors ' emotions significantly influence equity and other capital markets, particularly greed and fear (Mishra *et al*., 2022). For instance, markets frequently respond irrationally to unanticipated catastrophes or "black swan" events, like the Spanish Flu in 1918 and the H1N1 pandemic in 2009. Investors also frequently exaggerate the negative impacts of government actions and interventions, which causes market overreactions during pandemics. However, Phan and Narayan (2021) assert that the market tends to self-correct as more knowledge becomes available.

Additionally, Dzator *et al.* (2021) advocate that public health policies should be implemented rather than employing stringent lockdown measures to raise awareness and encourage full involvement from every member of society. A full-blown pandemic on a large scale is uncommon, although there have been numerous localised epidemics around the globe. As a result, investors' worries about future income and economic ruin can cause pessimism to linger over the stock market (Liu *et al*.,2020).

In reaction to the COVID-19 pandemic, several nations have started mass vaccination campaigns, progressively easing restrictions. Researchers are becoming more interested in the effects of these

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vaccination campaigns on the economy and financial markets. The amount of research on this subject still needs to be increased, in any case. From January 1st, 2020, to April 30th, 2021, Rouatbi *et al.* (2021) looked into how the COVID-19 vaccination affected stock market volatility in 66 different nations. The research discovered proof that widespread immunisation campaigns are connected to stabilising international stock markets using Pooled Ordinary Least Squares (POLS) estimation.

Additionally, it was discovered that established markets were more strongly affected by vaccination than emerging markets. Similarly, from December 20, 2020, to April 9, 2021, Khalfaoui *et al.* (2021) used multiple wavelet coherence to investigate the effect of COVID-19 immunisation on US financial markets. The study found that immunisation benefits the S&P 500 index, suggesting that implementing government interventions in immunisation strategies could support stock market recovery and overall economies. In a different research, To *et al.* (2021) looked into the possibility that vaccine initiation rates could lessen the volatility of the world stock market during the COVID-19 pandemic. The authors proved that vaccination start rates favour stabilising the global stock market using the asymmetric GJR-GARCH model. This effect was more pronounced in developed markets and nations with excellent vaccination initiation rates than the global average. Demir *et al.* (2021) investigated the function of widespread immunisation in the energy sector. On a dataset of 58 countries from January 1st, 2020, to April 30th, 2021, the authors verified that vaccination programmes help lower volatility in the stocks of energy companies on the global market. They did this using pooled OLS and Random Effects Model (REM) estimations.

Value-at-Risk (VaR), a single measure with little complexity that aids in identifying downside risk, is incredibly popular and extensively used even though different market risk measures are described in the literature. VaR is the commonly used metric to calculate market risk (Figurelli et al., 2021). VaR was successfully launched by JP Morgan and Reuters through RiskMetric in 1994. Following that, many other industries started using VaR to calculate market risk. The creation of VaR as a risk measure was sparked by the high volatility of key economic indicators and the growing use of derivatives, according to Linsmeier and Pearson (2000). "VaR can summarise the effects of leverage, diversification, and probabilities of adverse price movements in a single dollar amount that is simple to convey," claims Jorion (2002). It is the optimal risk measure for a sizable class of continuous distributions, according to Gaglianone et al. (2011). After the Basel Committee on Banking Supervision made it mandatory to assess risk using VaR in April 1995, VaR gained more traction in the banking industry as a risk measure. It was used as a base to calculate the capital adequacy ratio. Estimating the risk of the banking industry, methodological advancements, and model backtesting are significant areas of study using VaR.

3. Methods

To investigate the impact of COVID-19 vaccinations on stock market risk in Malaysia, we computed a series of predicted VaR using daily time series data of Kuala Lumpur Composite Index (KLCI) returns from 19th February 2020 to 2nd March 2022 (500 trading days). This period was selected to cover the period before the vaccination rollout in Malaysia (19th February 2020 to 24th February 2021) and the vaccination period (25th February to 2nd March 2022). Each period comprised 250 daily trading series, following the common practice outlined by the Basel Committee, in computing a robust 99% confidence level of VaR. The KLCI data series included the trading volume as a sentiment proxy collected from Investing.com data on COVID-19 new daily cases, recent daily vaccinations, and the stringency index. These data were obtained from open-source databases via www.ourworldindata.org (Mathieu *et al.*, 2021).

To achieve the study's first objective, we estimated the predicted VaR using a parametric approach, assuming that the returns were time-varying and not constant. Therefore, we employed the EWMA model, as recommended by several studies, including Abdul Hamit *et al.* (2022), Shaik and Padmakumari (2022), Karlsson, Zakrisson, and Nilsson (2016), Brooks (2014), and Pattarathammas, Mokkhavesa, and Nilla-Or

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(2008). These studies suggest that EWMA-VaR estimates better measure market risk exposure, particularly during volatile market conditions. The equation of the EWMA model is written as follows:

$$\sigma_t^2 = 500 \sum_{i=0}^{\infty} (1-\lambda)\lambda^i (r_{t-1-i} - \mu_t)^2 \qquad (1)$$

We used the equation $VaR_t = \mu_t - z^{-1}(h)$ to calculate the daily VaR. Here, λ represents the exponential factor or lambda, which is 0.94, following the RiskMetrics model introduced by JP Morgan. Meanwhile, μ denotes the mean value of the distribution, which is typically assumed to be zero for daily VaR. The standard normal cumulative distribution's inverse, z^{-1}, is multiplied by the standard deviation of returns σ_t calculated using the EWMA model. The probability (h) is set to 99%. Figure 2 illustrates the calculations for market volatility using the EWMA model and market risk or VaR from 2019 to 2022. The volatility of KLCI spiked explosively after the Malaysian government implemented the first nationwide lockdown on 18th March 2020. The EWMA model assigns the heaviest weight to the most recent data and thus provides an immediate reaction to market crashes or massive changes. We found that market risk was the highest during the early days of the pandemic, with maximum possible losses amounting to -7.48%, while volatility appears to have stabilised around the period of vaccination rollout that started on 25th February 2021. With the vaccination campaign, the market risks dropped drastically to -3.47% and -3.09% in 2021 and 2022, respectively.

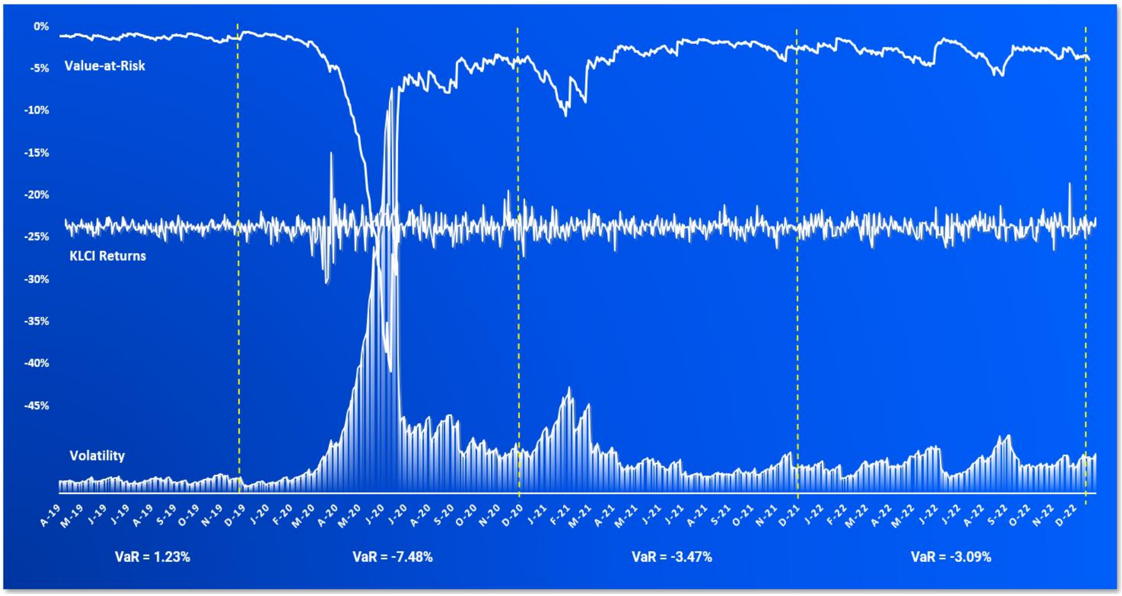

Figure 2: Market returns, market risk, and volatility of the KLCI from 2019 to 2022

Source: Author's Computations; KLCI returns series computed from price series obtained from Investing.com using the formula, $KLCI_t = LN(P_1/P_{t-1}) \times 100$

It is worth noting that the estimated VaR could vary depending on the method and parameters used. The estimation could be misleading and inaccurate. Therefore, it is crucial to backtest the predicted VaR to ensure its accuracy before proceeding to the next stage of regression analysis. Kupiec's Proportion of Failures (POF-test) is the most common backtesting method. Escanciano and Olmo (2010) defined backtesting as comparing out-of-sample trading results with model-generated risk measures. Kupiec's test checks the frequency of losses exceeding VaR. As Abdul Hamit *et al.* (2022) mentioned, the method is done by calculating the number of times the observed returns fall below the VaR estimate at the confidence level and comparing the corresponding failure rates to the confidence level, α. The null hypothesis is that the estimated proportion of violations equals α. According to Nieppola (2009), the POF test should produce meaningful results, even with limited observations of one year, especially with lower confidence levels.

The test statistics are calculated by plugging the data (number of observations, number of exceptions, and confidence level) into the corresponding LR-statistic function as follows:

$$LR_{POF} = -2\ ln\ ln\ [(1-p)(T-x)p^{x}] + 2ln\ [(1-x/T)^{(T-x)}(T-x)^{x} \quad (2)$$

$$LR_{POF} = -2\ln\ [(1-0.01)\ (500-8)\ 0.01] + 2\ln\ [(1-8/500)\ (500-8)\ (8/500)8] = 1.53828 \quad (3)$$

The POF test statistic, as depicted above (1.53828), is much lower than the critical value of X^2 for a 1-day trading interval at a 99% confidence level which is 3.842 X^2 (Chi-Square), indicating that the model is accurate in providing good market risk precision (Abdul Hamit *et al.*, 2022).

The next stage is to regress the estimated daily VaR series as the dependent factor with explanatory factors such as the daily vaccination rolled out (natural logarithm), the daily new cases of COVID-19 (natural logarithm), the investor sentiment (natural logarithm of trading volume daily changes), and the stringency index (natural logarithm). The empirical regression model is expressed as follows:

$$VaR_t = \alpha_0 + \beta_1 lnVACC_t + \beta_2 lnCASES_t + \beta_3 lnSENT_t + \beta_4 lnSTRINGENYC_t + \varepsilon_t \quad (4)$$

VaR_t	=	Value-at-Risk on a daily time basis (based on EWMA Model)
$LNVACC_t$	=	Natural logarithm of daily vaccinations
$LNCASES_t$	=	Natural logarithm of daily new cases of COVID-19
$LNSENT_t$	=	Natural Logarithm of KLCI daily trading volume changes
$LNSTRINGENCY_t$	=	Natural logarithm of daily stringency index
$\alpha_0, \beta_1, \varepsilon_t$	=	Constant, Beta coefficient, and residual error terms, respectively

To account for the heteroskedasticity and serial correlation in the data series, we employ a time series linear regression model with robust alternative standard error, *vce (hc2)*. This ensured the model was free from econometric bias and remained the best linear unbiased estimation. Additionally, the model option modifies the robust variance calculation. In the context of linear regression without clustering, the idea behind the robust estimation is somehow to measure σ_j^2 , the variance of the residual associated with the j^{th} observation, and then to use that estimate to improve the estimated variance of δ. Because residuals have (theoretically and practically) mean 0, one estimate of σ_j^2 is the observation's squared residual v_j^2. A finite-sample correction could improve that by multiplying v_j^2 by $n/(n-k)$.

We utilise Microsoft Excel for VaR calculation and STATA statistical software. Version 14 is used to conduct the regression analysis.

4. Result and Discussions

Table 1 shows the descriptive statistics and the normality traits of the datasets. The data series for all variables except for VaR is transformed into natural logarithms. The mean VaR value is -1.86, with a standard deviation of 0.42. This suggests that the VaR variable has a relatively narrow distribution, with most values close to the mean. Skewness measures the degree of asymmetry in the distribution, while kurtosis measures the degree of peakedness or flatness. Normal distributions have a skewness of 0 and a

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kurtosis of 3. The table also includes the results of a skewness and kurtosis normality test for each variable, with the probability (Prob>chi2) that the distribution of the variable is normal. The table shows that all variables have a p-value less than 0.05, indicating that the distributions significantly differ from normal at the 5% level. For example, the VaR variable has a skewness of 0.0049 and a kurtosis of 0.0000, indicating a relatively symmetrical and flat distribution. However, the distribution probability is normal (0.0001) ***, which suggests that the distribution is significantly different from normal.

Table 1: Descriptive statistics

Variables	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	Prob>chi2
VaR_t	-1.860	.4225	-3.16	0.53	.0049	.0000	(.0001) ***
ln$VACC_t$	5.7849	5.881	.000	13.28	.4604	.0000	(.0001) ***
ln$Cases_t$	5.1868	1.120	.000	6.21	.0000	.0000	(.0001) ***
ln$Stringency_t$	4.1629	.3868	2.97	4.52	.0000	.0000	(.0001) ***
ln$Sent_t$	18.869	.4043	17.76	20.34	.0000	.0149	(.0001) ***

Table 2 demonstrates a pairwise correlation matrix between each variable. It is important to note that correlation does not imply causation, and other factors may not be captured in this analysis. Nevertheless, the pairwise correlation matrix provides a useful starting point for understanding the relationships between the variables in the dataset.

- There is a strong positive correlation between lnVACC and lnCases (coefficient = 0.7480***). This suggests that as the number of cases increases, so does the vaccination rate.
- There is also a strong positive correlation between VaR and lnVACC (coefficient = 0.7527***) and between VaR and lnCases (coefficient = 0.7480***). This suggests that higher VaR values are associated with higher vaccination rates and case numbers.
- There is a moderate positive correlation between lnCases and lnStringency (coefficient = 0.6774***). This suggests that the number of cases increases as the stringency of COVID-19 measures increases.
- There is a weak positive correlation between lnStringency and lnVACC (coefficient = 0.4120***). This suggests that as the stringency of COVID-19 measures increases, so does the vaccination rate, but the correlation is not as strong as the correlation between lnVACC and lnCases.
- There is a weak negative correlation between lnSent and lnVACC (coefficient = -0.1541***) and between lnSent and lnStringency (coefficient = -0.2181***). This suggests that as the sentiment towards COVID-19 decreases, the vaccination rate and the stringency of COVID-19 measures tend to increase, but again the correlations are not very strong.

Table 2: Pairwise correlation matrix and testing results for stationary

Variables	VaR_t	*ln*$VACC_t$	*ln*$Cases_t$	*ln*$Stringency_t$	*ln*$Sent_t$	DF-Test	PP-Test	Order
VaR_t	*1.000*					*(-5.845) ****	*(-4.67) ****	I (0)
ln$VACC_t$	*.7527****	*1.000*				*(-20.74) ****	*(-20.7) ****	I (1)
ln$Cases_t$	*.7480****	*.6522****	*1.000*			*(-4.716) ****	*(-6.06) ****	I (0)
ln$Stringency_t$	*.5343****	*.4120****	*.6774****	*1.000*		*(-3.974) ****	*(-11.5) ****	I (0)
ln$Sent_t$	*-.0664*	*-.154****	*-.1053*	*-.2181****	*1.000*	*(-11.35) ****	*(-3.92) ****	I (0)

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Notes: DF-test is the Dickey-Fuller test for the unit root, and PP-test is the Phillips-Perron test for the unit root. I (0) denotes the level order of stationary while I (1) means the data series stationary at the first-order difference.

The results of the ADF-test and PP-test reveal that all variables are stationary at levels except for lnVACC, which is stationary at first-order differences. Therefore, to analyse the dynamics between the research variables, we first transformed the nonstationary variable (lnVACC) into the first difference form so that all analysed variables are stationary.

Table 3: Multiple linear regressions

Value-at-Risk	Robust Std. Errors (hc2)
$ln\text{VACC}_t$	.0342
	(12.09) ***
$ln\text{CASES}_t$	.1433
	(8.80) ***
$ln\text{SENT}_t$	.0709
	(1.75) ***
$ln\text{STRINGENCY}_t$	.1318
	(3.50) ***
Constant	-4.687
	(-6.10) ***
Model Fitness	
R-Squared	0.6890
F-Statistics	*(609.9)* ***
Diagnostics Testing	
VIF Test	Mean VIF = 1.87 *(No Multicollinearity)*
BPCW Test	$p > \|z\|$ = (0.42) *(No heteroskedasticity presence)*
BGLM Test	$p > \|z\|$ = (99.005) *** *(serial correlation presence)*
No. of Observations	500

Notes: Variance Inflation Factor test for multicollinearity; Breusch-Pagan / Cook-Weisberg test for heteroskedasticity; Breusch-Godfrey LM test for autocorrelation

The current study's regression analysis, as depicted in Table 3, shows a positive relationship between COVID-19 daily new cases, Vaccination rate, Investor Sentiment, and Stringency Index towards Value-at-Risk in Malaysia Stock Market. Statistically, with every 1% increase in COVID-19 daily new cases, Malaysia's Stock Market Risk heightens by 14.33%. Additionally, for every 1% increase in vaccine doses administered, Malaysia's Stock Market Risk also increases by 3.42%. On the other hand, higher investor sentiment proxied by trading volumes and rigorous government intervention proxied by the stringency index is associated with higher market risk and uncertainty by 7.09% and 13.19%, respectively.

The positive relationship between the vaccination program and the KLCI market risk means the vaccinations trigger uncertainty, consequently heightening the market risk. Investors' anxiety and mistrust towards the newly developed COVID-19 vaccine are some of the factors that have contributed to the poor response of stock markets to immunisations. Even though a vaccine against COVID-19 has been made available, and countries have started mass vaccination campaigns, people still have a feeling of fear and lack of confidence in the effectiveness of vaccines in preventing disease. However, countries have begun mass vaccination campaigns.

Besides that, the lengthy and deliberate process of producing vaccines, which can take many years before receiving final clearance, contributes to people's trust in vaccinations, as stated by Fadda et al. (2020). People may be reluctant to get the vaccine because they believe it was rushed to market before being

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adequately tested for both its safety and its efficacy, which is one of the factors that could contribute to the backlash. The public's reluctance to get vaccinated is exacerbated by false information. The aggressive activity of anti-vaccination campaigns through social media also causes misinformation regarding vaccination, increasing public hesitance and mistrust about the efficacy of COVID-19 vaccinations and the probable side effects they may cause.

The trust of shareholders in the stock market has not been restored at this time. For instance, in Malaysia, infection and death rates from COVID-19 have grown, although the vaccination rate has also increased. This has led investors to conclude that despite the availability of a vaccine, the pandemic is not yet under total control. In this situation, people tend to invest in other assets as a haven for stocks, decreasing the stock market (Robiyanto et al., 2017; Wen & Cheng, 2018).

5. Conclusion

The current research findings suggest that the COVID-19 pandemic's impact on the Malaysia stock market's downside risk is significant and that vaccinations alone may not be sufficient to mitigate the market risk. In designing policies to stabilise the stock market, considering other factors, such as investor sentiment and government intervention, is crucial. Policymakers should also monitor the COVID-19 situation closely and provide timely interventions to prevent further negative impacts on the stock market.

It is important to note that the positive relationship between vaccination and market risk does not imply that the vaccination program is ineffective or detrimental to the economy. Instead, the relationship suggests that the market is responding to the uncertainties and anxieties brought about by the pandemic and the vaccine rollout. The positive effect of vaccination on the economy may only manifest in the long run as more people get vaccinated and the pandemic is controlled. In the short term, however, the stock market may remain volatile and uncertain due to various factors, including investor sentiment and government policies.

To mitigate the negative impact of the pandemic on the economy, governments worldwide have implemented various measures, including fiscal stimulus and monetary policy. These measures aim to boost consumer spending, support businesses, and provide liquidity to financial markets. In Malaysia, for example, the government has launched several economic stimulus packages to relieve individuals and businesses affected by the pandemic. However, these measures' effectiveness in mitigating the pandemic's economic impact is still uncertain. It depends on various factors, including the pandemic's duration and severity and the vaccine's effectiveness.

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Conflict of interest statement

The authors agree that this research was conducted without any self-benefits or commercial or financial conflicts and declare the absence of conflicting interests with the funders.

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Authors' contributions

Ahmad Fauze carried out the research, which included the technical computations, wrote, and designed the research. Maryam assisted in preparing the manuscript formatting and critically contributed to the introduction, particularly the motive and the research direction. Ninalyn Fridrict drafted the manuscript and added recent studies to the literature review list. Abdul Aziz Lai (PhD) helped in reviewing and revising the manuscript. All authors discussed the results and contributed to the final manuscript.

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