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The nonlinear dependence of the Vietnam stock market on the Asian stock market: Evidence from a quantile-on-quantile regression

Le Thi Thuy Van[1], Dang Thi Phuong Thao[2], Phan Thi Hang Nga[3*]

[1]*National Institute for Economics and Finance, 84, Vietnam.*
[2]*Faculty of Finance & Banking, University of Finance - Marketing (UFM), 84, Vietnam.*
[3]*Academic Affairs Department, University of Finance - Marketing (UFM), 84, Vietnam.*

Corresponding author: Phan Thi Hang Nga (*Email: phannga@ufm.edu.vn*)

Abstract

The stock market is also a flexible and attractive investment channel for organizations and individuals. It is an important medium- and long-term capital mobilization channel for businesses to promote production and business activities and create jobs and livelihoods for investors. Therefore, this study's goal employed the quantile-on-quantile regression method to study the nonlinear relationship between the Vietnam stock market and the Asian stock market. The research method also utilized the spillover index to assess the extent of spillover from the Asian stock market to the Vietnam stock market during the Covid and post-Covid periods. Moreover, the data was collected daily from January 2, 2020, to December 1, 2024, including Vietnam, South Korea, Singapore, and China. The results indicate that during the COVID period, the impact of the Asian stock market on the Vietnam stock market was more significant than in the post-COVID period. The study further reveals that in stable market conditions, the level of impact is lower compared to periods of market sensitivity. Finally, the authors proposed policy recommendations for assisting policymakers by providing evidence regarding the degree of market connectivity of each country, which can serve as a basis for developing supportive and regulatory policies for the market.

Keywords: COVID-19, Quantile-on-quantile regression, Spillover index, Stock market.

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1. Introduction

With globalization and deepening economic integration, the relationship between stock markets has become an essential and timely research topic. Stock markets reflect the economic situation of each country and demonstrate the interconnectedness of economies in the region and around the world [1, 2]. With its rapidly developing economy and financial market, Vietnam is increasingly attracting international investors' attention. As a result, significant fluctuations in major global markets will quickly and strongly impact investor sentiment and behavior in Vietnam.

In the pre-COVID-19 pandemic, the global economy was on a path of stable growth. Major stock indices such as the SP500 (USA) and NIKKEI (Japan) recorded positive growth due to factors such as accommodative monetary policies, low unemployment rates, and high corporate profits [3-5]. Meanwhile, the Vietnam stock market (VNIndex), although experiencing periods of growth, faced numerous internal challenges due to inappropriate fiscal policies and incomplete infrastructure.

When the COVID-19 pandemic broke out, it significantly shocked the global economy. Strict lockdown measures implemented to control the outbreak led to declining production and consumption activities in many countries. Stock markets worldwide underwent significant sell-offs; however, surprisingly, some markets quickly recovered after the initial shock, and the Vietnam stock market recorded a strong recovery thanks to fiscal stimulus packages from the government aimed at boosting economic growth, such as tax reductions for small and medium-sized enterprises and support for individuals facing job losses [6, 7]. This illustrates the increasing clarity of the connection between the Vietnam stock market and international indices.

This study applied quantile-on-quantile regression to assess the nonlinear dependence between the Vietnam stock market and several Asian stock markets, specifically South Korea (KOSPI), Singapore (STI), and China (SSE) [8]. The use of quantile-on-quantile regression will help us better understand how the returns of the VNIndex respond to the returns of other indices at various levels, thereby providing insights into the nonlinear dependence among markets in the context of current financial volatility. The study also presents results on the spillover index to illustrate the extent of spillover from the mentioned Asian stock markets to the Vietnam stock market.

2. Literature Review

Research on the dependence of the Vietnam stock market on international stock markets has garnered significant attention from economists both domestically and internationally in recent years. The quantile regression model investigates the relationship between the returns of the US stock market and their one-way impact on the returns of the Vietnam stock market with a one-week lag [9, 10]. The dynamic correlation coefficient between the US and Vietnam stock markets also remained positive from 2015 to 2022. The study also indicated that during periods of high market volatility (as determined by quantiles), significant price fluctuations in the US market had a strong spillover effect on the Vietnam stock market.

The study examined the spillover from the US stock market to frontier stock markets (Argentina, Croatia, Estonia, Romania, Slovenia, Kenya, Mauritius, Morocco, Nigeria, Tunisia, Bahrain, Jordan, Kuwait, Lebanon, Oman, Pakistan, Sri Lanka, and Vietnam) during the period from 2005 to 2009 to assess the dependence structure before and during the 2008 global economic crisis [11, 12]. The study investigated the spillover effects of returns at different quantiles (representing stable, booming, and recessionary market conditions) among the US stock market, the ASEAN-6 stock markets (Vietnam, Thailand, Indonesia, Malaysia, the Philippines, and Singapore), and other stock markets (India, Japan, South Korea, and China) from 2017 to 2023. Based on a quantile vector autoregression (QVAR) model, the study found more substantial spillover effects in extreme conditions (at lower quantiles), with the US, South Korean, and Singaporean stock markets exhibiting the most significant impact on other markets. This highlights the influence of stock markets in developed countries such as the US, South Korea, and Singapore.

However, the quantile regression methods employed in these studies are linear concerning the independent variable, meaning they focus solely on the impact of the independent variable's returns on the dependent variable's quantiles. The study examined the effects of Monetary Policy Uncertainty (MPU) in the US on emerging (Australia, Singapore, Hong Kong, New Zealand, Japan) and frontier markets (Bangladesh, Pakistan, Sri Lanka, Vietnam) in Asia during the period from 2006 to 2022. Based on empirical evidence from a quantile-on-quantile regression model, the authors found a negative relationship between US monetary policy uncertainty and the indices of the studied emerging and frontier stock markets [13-15]. Notably, the impact of U.S. monetary policy uncertainty was particularly pronounced at lower quantiles (representing downturn market conditions) and appeared insignificant at higher quantiles (indicating upward market conditions). Building on the approach introduced [16], this study investigates the nonlinear dependence of the Vietnam stock market on the stock markets of South Korea (KOSPI), Singapore (STI), and China (SSE). These three stock markets are selected based on their relatively high correlation with the Vietnam stock market. Additionally, the study calculates the Spillover Index proposed to illustrate the extent of influence on the Vietnam stock market due to spillovers from the South Korea, Singapore, and China stock markets.

3. Data and Methodology

3.1. Data

The data were collected daily from January 2, 2020, to December 1, 2024. The stock markets of the countries studied include Vietnam (stock index: VNI), South Korea (stock index: KOSPI), Singapore (stock index: STI), and China (stock index: SSE). All data were obtained from the website https://investing.com. Additionally, to determine the nonlinear relationship between the Vietnam stock market and the Asian stock markets during and after the COVID-19 period, the

research data are divided into two specific phases: (i) During COVID-19 (from January 2, 2020, to May 30, 2022) and (ii) After COVID-19 (from June 1, 2022, to December 1, 2024).

The return series of the stock markets is calculated using the formula:

$$r_{i,t} = \left[ln\left(P_{i,t}\right) - ln\left(P_{i,t-1}\right)\right] \times 100$$

Where: *ri*, *t* is the return of stock market *i* expressed in percentage (%); *Pi*, *t* and *Pi*, *t*−1 are the prices of market *i* at time *t* and time *t*−*1*, respectively.

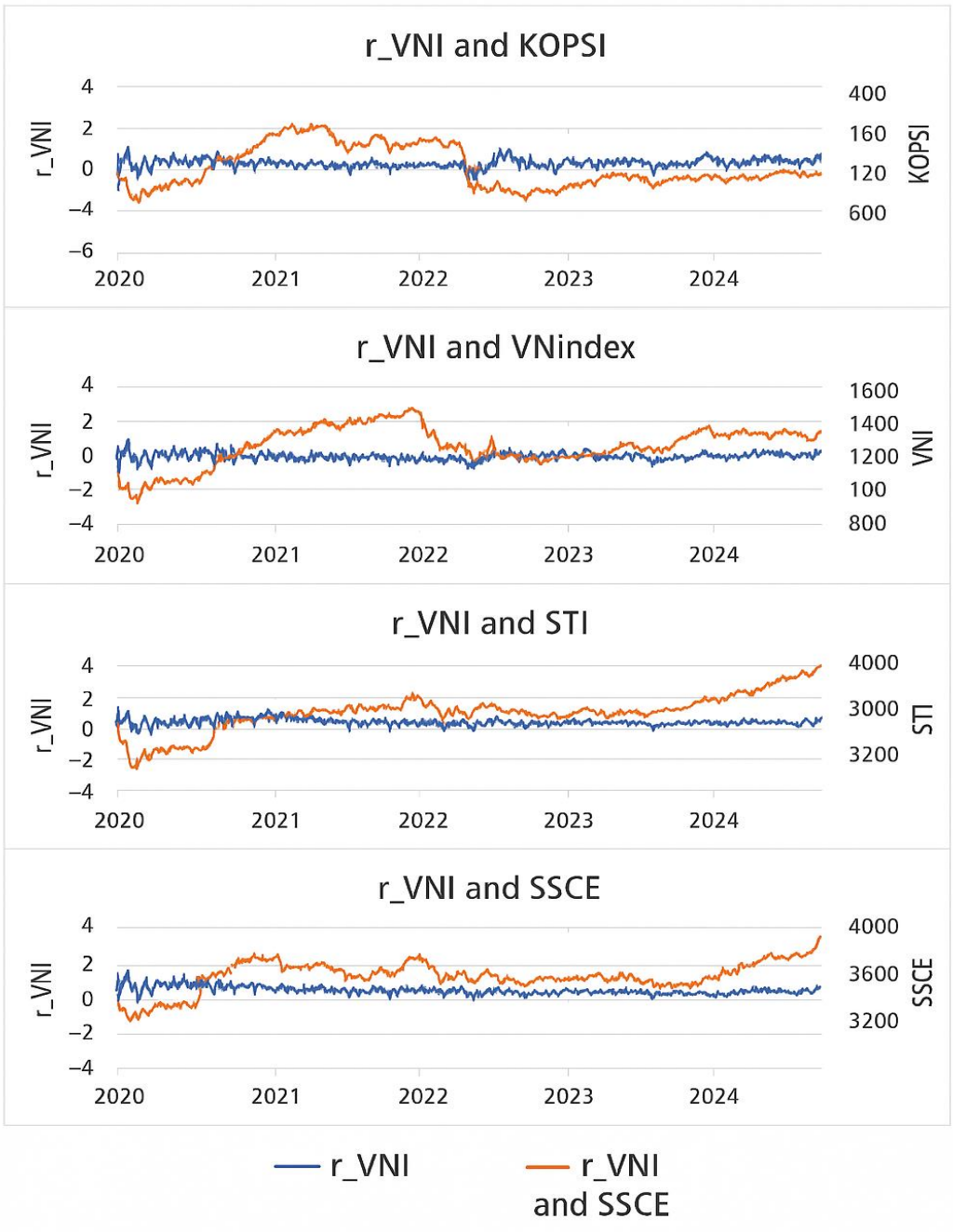

Figure 1.
The relationship between the returns of the Vietnam stock market and the stock index.

Figure 1 shows the link between Vietnamese stock market returns and the stock index, illustrating important financial dynamics. A positive correlation means that when the index rises, so do market returns, reflecting investor confidence. In contrast, a negative correlation indicates that external factors are influencing returns. Volatility patterns reflect the market's vulnerability to economic developments and regulatory changes. A greater regression slope indicates the index's significant impact on returns. Detecting anomalies aids in assessing risks and market inefficiencies. Comparing several indexes provides insight into sector-specific performance. Deviations may be influenced by external variables like inflation and global trends.

3.2. Methodology

The quantile-on-quantile regression (QQR) method, introduced [16, 17], is used to analyze the nonlinear relationship at different quantiles for independent and dependent variables. In this study, the QQR method is employed to investigate the dependence relationship between the Vietnam and Asian stock markets at various quantile levels for both markets. The following equations are presented to describe the relationship between the Vietnam stock market and the Asian stock markets as follows:

$$r\_VNI_t = \beta_0(\theta,\tau) + \beta_1(\theta,\tau)(r\_KOPSI_t - r\_KOPSI_t^{\tau}) + u_t^{\theta} \quad (1)$$

$$r\_VNI_t = \beta_2(\theta,\tau) + \beta_3(\theta,\tau)(r\_SSCE_t - r\_SSCE_t^{\tau}) + w_t^{\theta} \quad (2)$$

$$r\_VNI_t = \beta_4(\theta,\tau) + \beta_5(\theta,\tau)(r\_STI_t - r\_STI_t^{\tau}) + z_t^{\theta} \quad (1)$$

Where θ is the quantile level of *rVNI* and τ is the quantile level of the corresponding Asian stock markets.

3.3. Spillover Index Method

This study employs the Spillover Index proposed based on the variance of forecast errors derived from the VAR model to determine the spillover effects between markets.

The VAR model estimated with lag *p* for a vector *Xt* consisting of *N* variables is given by:

$$X_t = \sum_{i=1}^{p} \phi_i X_{t-i} + \varepsilon_t \quad (3)$$

Where: *Xt* is the vector of endogenous variables, ϕ_i is the *N*×*N* matrix of autoregressive coefficients, and ϵ_t is the residual distributed as $N(0,\sigma^2)$.

The VAR(p) representation from equation (3) can be expressed in a moving average form of order *Q* (MA(Q)):

$$X_t = \sum_{i=0}^{Q} A_i \varepsilon_{t-i} \quad (4)$$

Where: $A_i = \phi_1 A_{i-1} + \phi_2 A_{i-2} + \cdots + \phi_Q A_{i-Q}$ và A_i is a matrix of coefficients measuring the magnitude of each unit shock to ε_{t-i}.

To measure the impact of a shock from variable *j* on the shock of variable *i* based on the general VAR introduced [17], the generalized forecast-error variance decomposition (H-step-ahead forecast-error variance decomposition) is defined as:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)} \quad (5)$$

Where: Σ is the variance matrix of the error ϵ, σ_{jj} is the standard deviation of $\epsilon\epsilon$ for the *j*-th equation, and ei, *ei* is a vector with ones for the *i*-th element and zeros elsewhere.

Subsequently, $\theta_{ij}(H)$ is normalized to $\bar{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)}$ Satisfying the conditions $\sum_{i=1}^{N} \theta_{ij}(H) = 1$ and $\sum_{j=1}^{N} \theta_{ij}(H) = N$.

Based on the research of Diebold and Yilmaz (2012), the total spillover index (TS) is defined by the formula:

$$TS(H) = \frac{\sum_{i,j=1, i\neq j}^{N} \bar{\theta}_{ij}(H)}{N} \cdot 100 \quad (6)$$

The directional spillover that market *i* receives from all other markets is defined as:

$$DS_{i\leftarrow \mathrm{j}} = \frac{\sum_{j=1, j\neq i}^{N} \bar{\theta}_{ij}(H)}{N} \cdot 100 \quad (7)$$

The directional spillover that market *i* transmits to all other markets is defined as:

$$DS_{i\rightarrow \mathrm{j}} = \frac{\sum_{j=1, j\neq i}^{N} \bar{\theta}_{ji}(H)}{N} \cdot 100 \quad (8)$$

4. Empirical Results

4.1. Descriptive Statistics

During the COVID period, despite witnessing a rare event that occurs once every 100 years, the average returns of the stock markets were all positive, indicating that the stock markets were thriving during this time, with the Vietnam stock market experiencing the most significant growth. The market's strong growth can be attributed to economic stimulus policies: Governments and central banks worldwide implemented numerous robust economic stimulus measures to support businesses and individuals amid the crisis caused by COVID-19, such as lowering interest rates and increasing the money supply. However, due to the impact of the COVID pandemic, production faced difficulties, leading to a substantial influx of capital into the stock market, which caused the market to grow exponentially, albeit with significant risks of financial bubbles, as evidenced by the standard deviation of stock indices during this period being more substantial than the standard deviation of stock indices in the remaining period.

Table 1.
Descriptive Statistics.

The during Covid -19 periods (January 2020 - June 2022)				
	VNI	**SSCE**	**KOPSI**	**STI**
Mean	0.0696	0.0291	0.0344	0.0015
Maximum Value	6.3781	7.9213	8.2513	6.0947
Minimum Value	-8.5295	-5.5391	-8.7670	-7.0712
Standard Deviation	1.7997	1.3036	1.6151	1.3064
Jarque-Bera	531.2068***	492.664***	545.7736***	771.1373***
ADF	-18.6709***	-19.8018***	-18.0929***	-17.7396***
ARCH (2)	11.0035***	20.9186***	45.9182***	46.2553***
Number of Observations	423	423	423	423
The post-COVID-19 period (June 2022 - present)				
Mean	0.0091	-0.0037	0.0051	0.0409
Maximum Value	5.3902	7.7551	6.0033	3.1052
Minimum Value	-11.7902	-4.1368	-12.6463	-6.3389
Standard Deviation	1.4087	1.1432	1.3810	0.8197
Jarque-Bera	3003.979***	686.138***	5401.375***	1513.5011***
ADF	-21.8890***	-19.4167***	-23.5470***	-19.6392***
ARCH (2)	3.4595***	19.8559***	3.1218***	17.0441***
Number of Observations	429	429	429	429

Note: *** indicates a statistical significance level of 1%.

Table 1 shows that the JB (Jarque-Bera) test is used to assess the normality of the data distribution; the ADF (Augmented Dickey-Fuller) test is used to check the stationarity of the return series; the ARCH(2) test is used to assess the second-order ARCH effect of the return series. Additionally, the descriptive statistics table shows that the return series does not follow a normal distribution at a 1% statistical significance level based on the JB test, indicating that traditional regression analysis methods are no longer suitable. Furthermore, all series are stationary at a 1% statistical significance level according to the ADF and PP tests. Finally, a second-order ARCH effect exists at a 1% statistical significance level across all markets.

In the post-COVID period, it can be observed that the returns of the Vietnam stock market continued to grow positively, although there was a decline compared to the previous period. This can be explained by the government's tightening monetary measures to curb inflation and stabilize the macroeconomy. On the other hand, the Singapore market witnessed more substantial growth than in the COVID period, indicating that businesses in these countries have adapted better to the new context, particularly in the technology and services sectors. However, it is surprising that the Chinese stock market experienced a significant decline with negative returns due to the Zero-COVID policy. This can be explained by China's continued strict adherence to the "Zero-COVID" policy, leading to prolonged lockdown measures in many major cities. This negatively impacted economic activity and investor sentiment. The Chinese real estate sector is also facing a crisis, with major companies like Evergrande encountering financial difficulties. This affects the real estate sector and spreads to other areas of the economy.

4.2. Correlation Matrix

The Pearson linear correlation coefficients between the stock markets are presented in Table 2. Notably, the Vietnam stock market positively correlates with the other markets in the range of (0.18 – 0.35). However, the Pearson correlation coefficient between the Vietnam stock market and other markets during the COVID period is higher than in the post-COVID period, indicating that during this phase, the Vietnam stock market is sensitive to fluctuations in the stock markets of Asian countries.

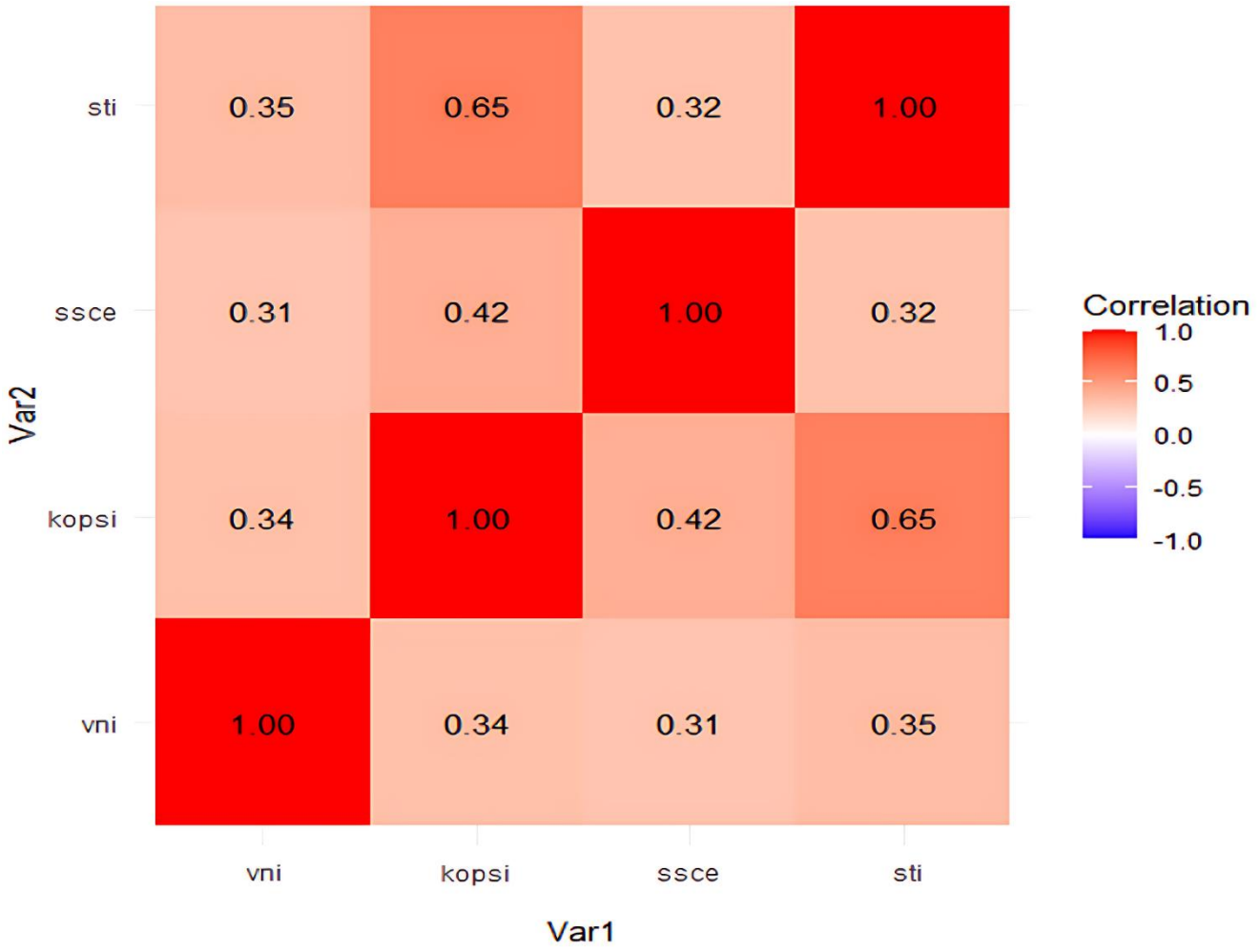

Figure 2.
Heat map of pairwise correlations during the COVID period.

Figure 2 shows the Pearson correlation index in the post-COVID period, which shows a decline compared to the COVID period; however, it remains relatively high, demonstrating that the Vietnam stock market still has a strong connection with international stock markets. Nevertheless, the Pearson linear correlation coefficient is highly dependent on the normal distribution of the data. As presented in Table 1, the return series does not follow a normal distribution in any of the study periods, thus making the quantile-on-quantile regression method appropriate.

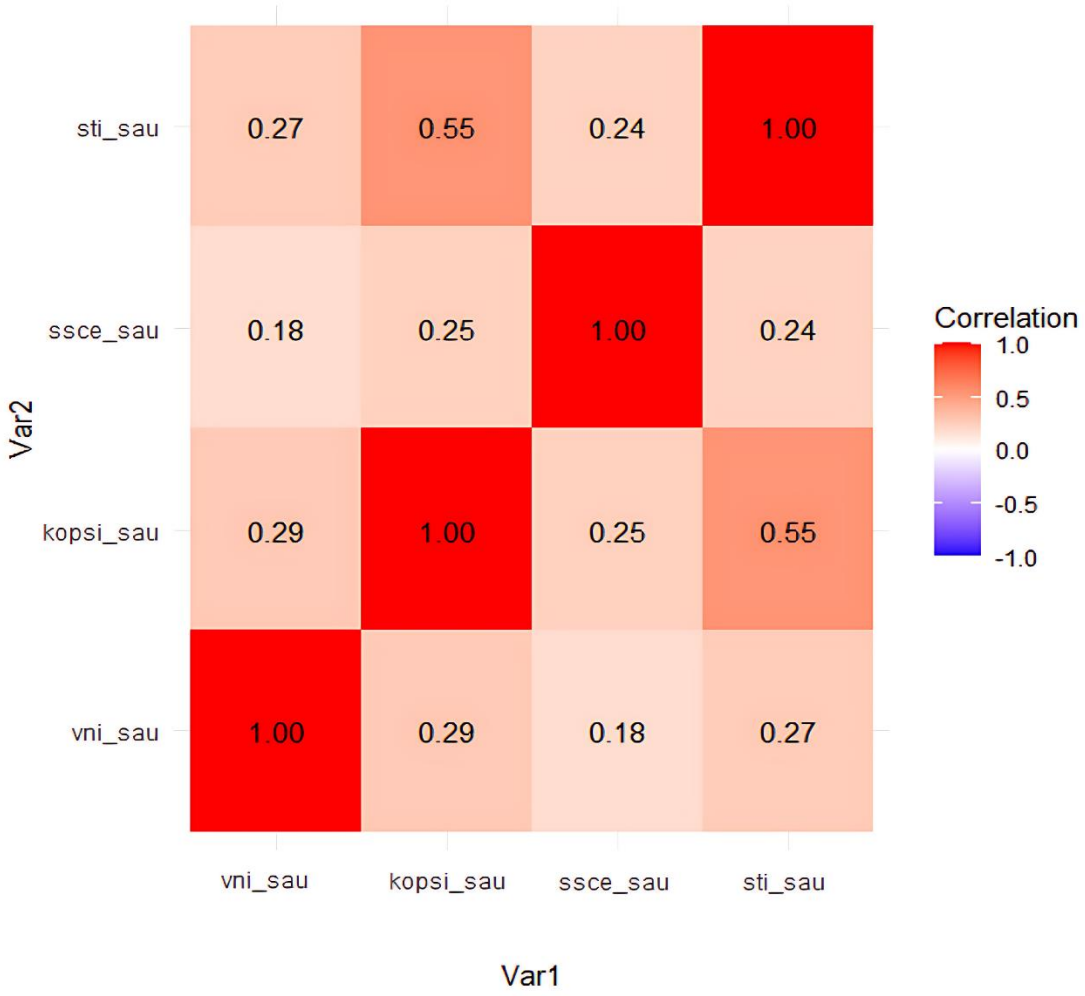

Figure 3.
Heat map of pairwise correlations during the post-Covid period.

Figure 3 shows the heat map of pairwise correlations depicting changing financial relationships in the post-COVID era. Strong positive correlations indicate that sectors are moving together, which is typically impacted by economic policies. In contrast, negative correlations reveal possible hedging assets such as gold versus stocks. Understanding these relationships enables investors to diversify their portfolios and control risk. Changes in correlations imply systemic shifts in market behavior following the pandemic. Interest rate policies may cause financial stocks to have a high correlation. Divergence in asset performance reflects shifting investor sentiments. Comparing pre- and post-COVID trends provides information about resilience and vulnerability. Government actions play a significant influence in shaping market trends. Analysis of these trends improves strategic investment and risk management.

4.3. Quantile on Quantile estimates

In this section, the study presents the main empirical results of the QQR analysis regarding the impact of the returns of various stock markets on the returns of the Vietnam stock market. By using a three-dimensional chart, where the height axis represents the QQR coefficients, this coefficient provides a more detailed presentation of the research results with the regression coefficients between the variable pairs at each quantile. The strength of the impact of the independent variable on the dependent variable is illustrated through the color scale on the right. The low quantile (0.00-0.4), medium quantile (0.41-0.7), and high quantile (0.71-1), respectively, represent the market during periods of low returns, stable returns, and high returns. Overall, the empirical results of the QQR estimates indicate that the relationship between the selected variables is heterogeneous in each state, suggesting that the interconnection between the two indices is asymmetric across quantiles for the pair VNIndex and KOSPI index.

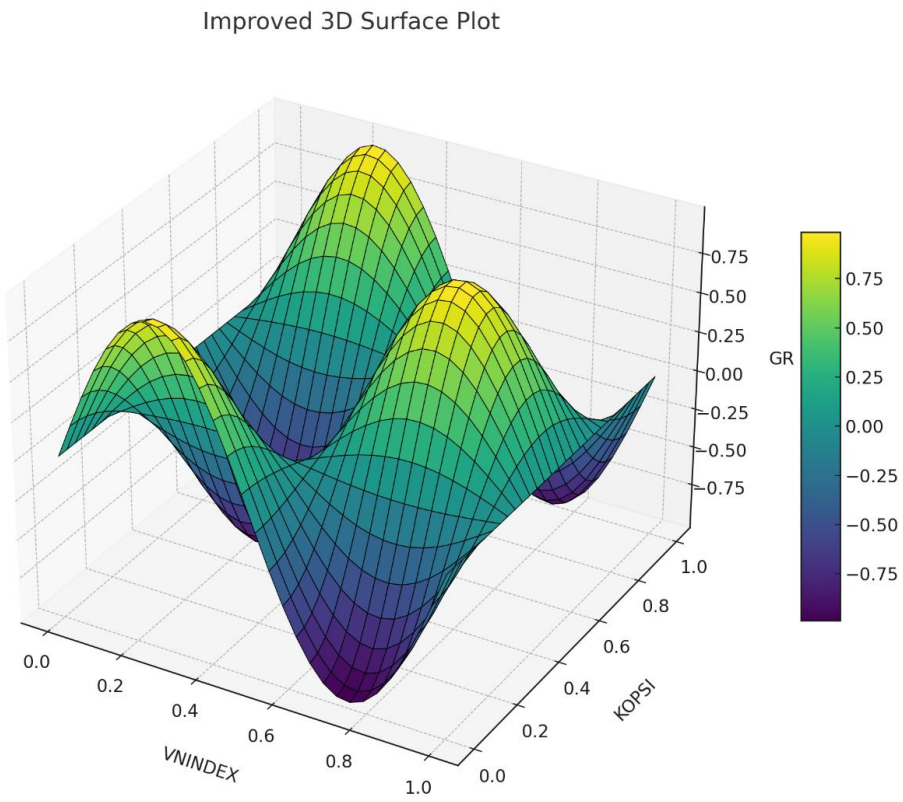

Figure 4.
During the COVID-19 period.

Figure 4 shows that the COVID-19 pandemic substantially impacted financial markets, creating volatility and uncertainty. Stock market performance was likely characterized by rapid falls followed by recovery periods. Healthcare and technology may have performed well, but tourism and retail failed. Government initiatives, such as stimulus packages and monetary policies, impacted market patterns. Investors' increased risk aversion prompted them to seek out safe-haven assets such as gold and bonds. Market liquidity fluctuated as uncertainty impacted trading volumes. Economic upheavals impacted the correlation patterns between assets. Investor sentiment has a significant impact on market movements. Comparing pre-, during-, and post-pandemic trends can provide insights into economic resiliency. Understanding these trends helps you make wise investment decisions.

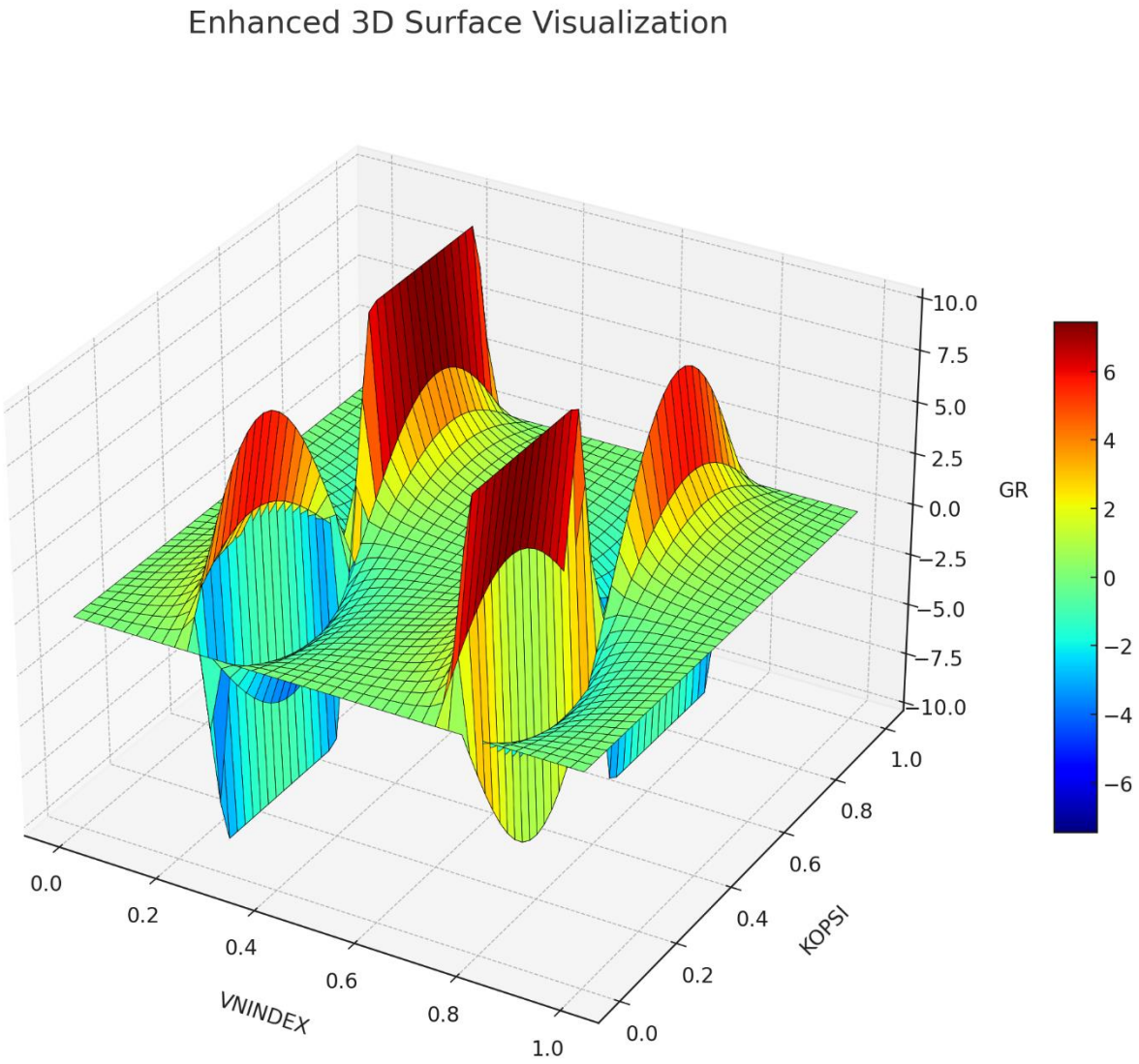

Figure 5.
The post-COVID-19 period.

Figure 5 shows that during the COVID period, at the medium quantile of VNI (from 0.4 to 0.6), the KOPSI index predominantly has a positive and weak impact across most quantile levels. In the quantile range from (0.55 – 0.75) of VNI, the KOPSI index has a positive and weak effect at the lower quantile (0.00 – 0.35) but negatively impacts the remaining quantile levels. In the lower quantile of VNI (from 0.00 to 0.4) and the high quantile (from 0.71 to 1), the impact of the KOPSI index on VNI is higher and negatively affects most quantiles.

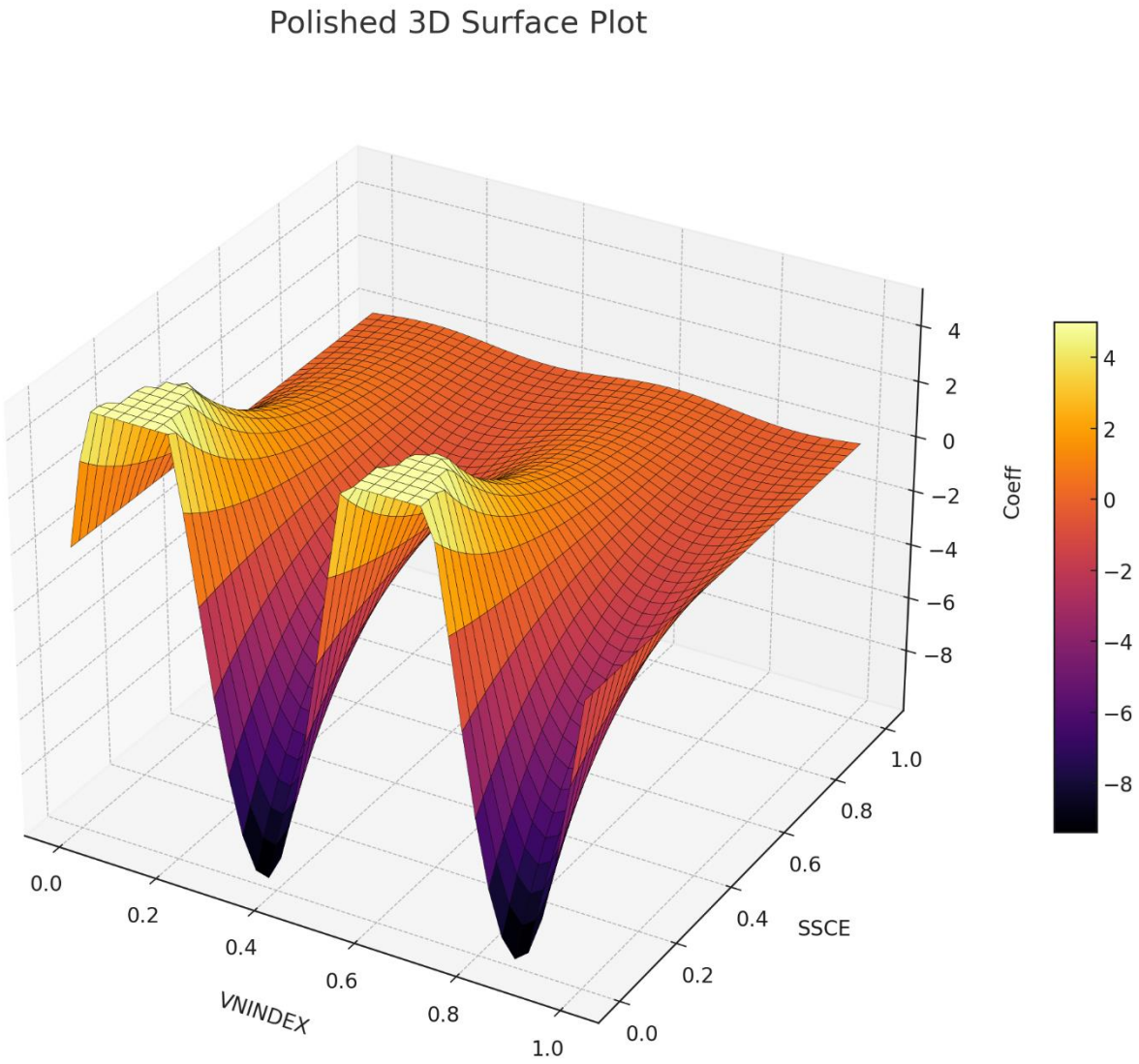

Figure 6.
During the COVID-19 period.

Figure 6 shows that the post-COVID index's overall impact of the KOPSI index on VNI is lower than during the post-COVID period, and the level of impact is also more stable across specific quantiles. In the lower quantile range of VNI (0.00-0.45), KOPSI has a small and equal impact across most quantiles. In the medium quantile of VNI (0.46 – 0.75), the effects of KOPSI decrease significantly; however, they remain relatively even across each quantile. In the high quantile range of VNI, the impact of KOPSI increases compared to the medium quantile range, but it is still not as high as in the lower quantile of VNI for the pair VNIndex and SSCE index.

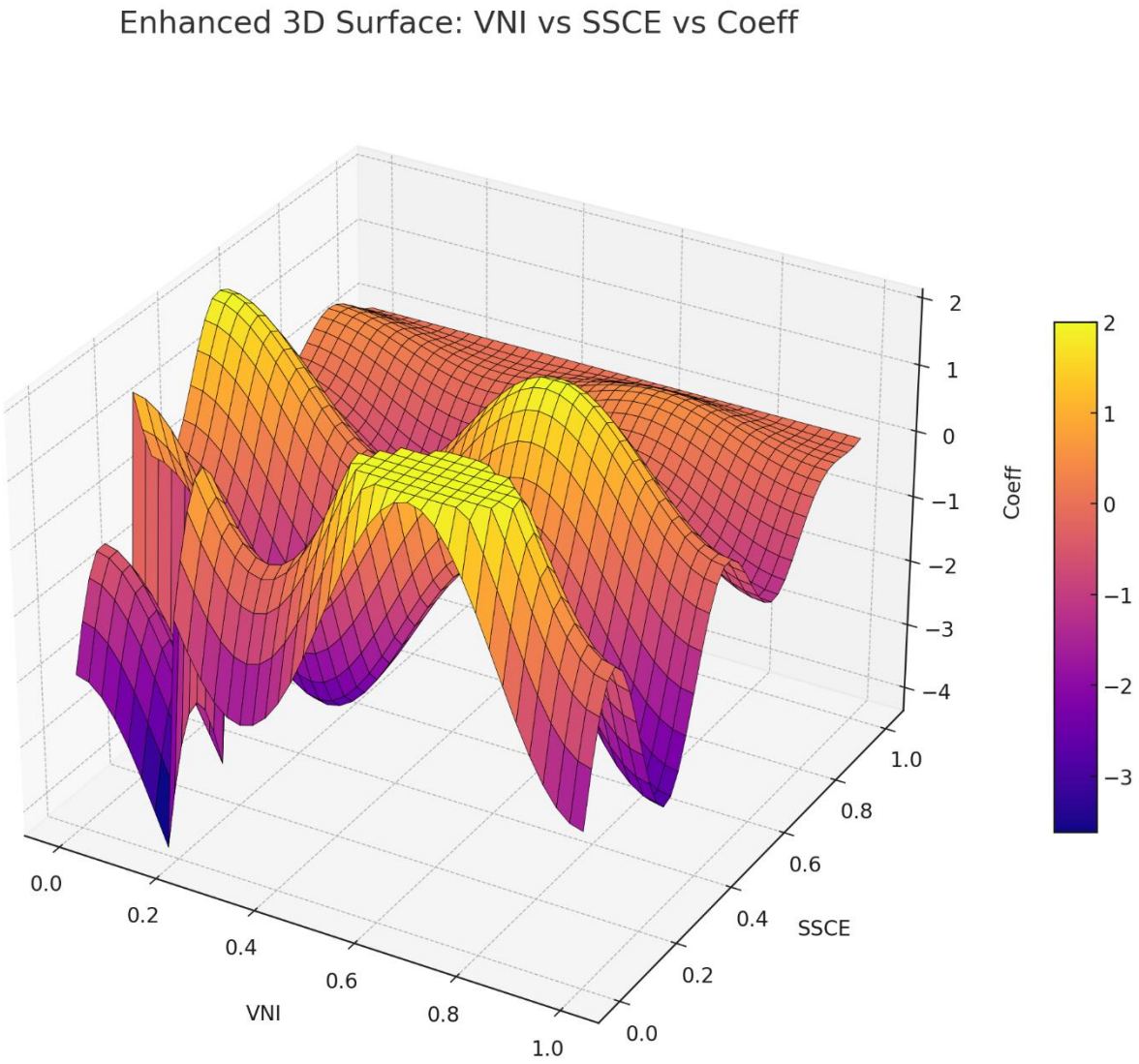

Figure 7.
The post-COVID-19 period.

Figure 7 shows that during the COVID period, in the lower quantile of VNI (from 0.00 to 0.1), the SSCE index has a negative and relatively significant impact in its lower quantile range (0.00 – 0.25), and this impact gradually decreases in the quantile range (0.35-0.55). In the remaining quantiles of SSCE, the effect is positive but relatively small. In the remaining lower quantile range of VNI (0.11 – 0.4), SSCE generally harms VNI in the lower quantile and has a positive impact in the higher quantile; however, the level of impact is not strong. In the medium quantile range of VNI (0.41-0.74), SSCE generally positively impacts VNI across most quantiles, but the effect is insignificant. However, in the high quantile range of VNI (0.75-1), SSCE harms VNI in most quantiles.

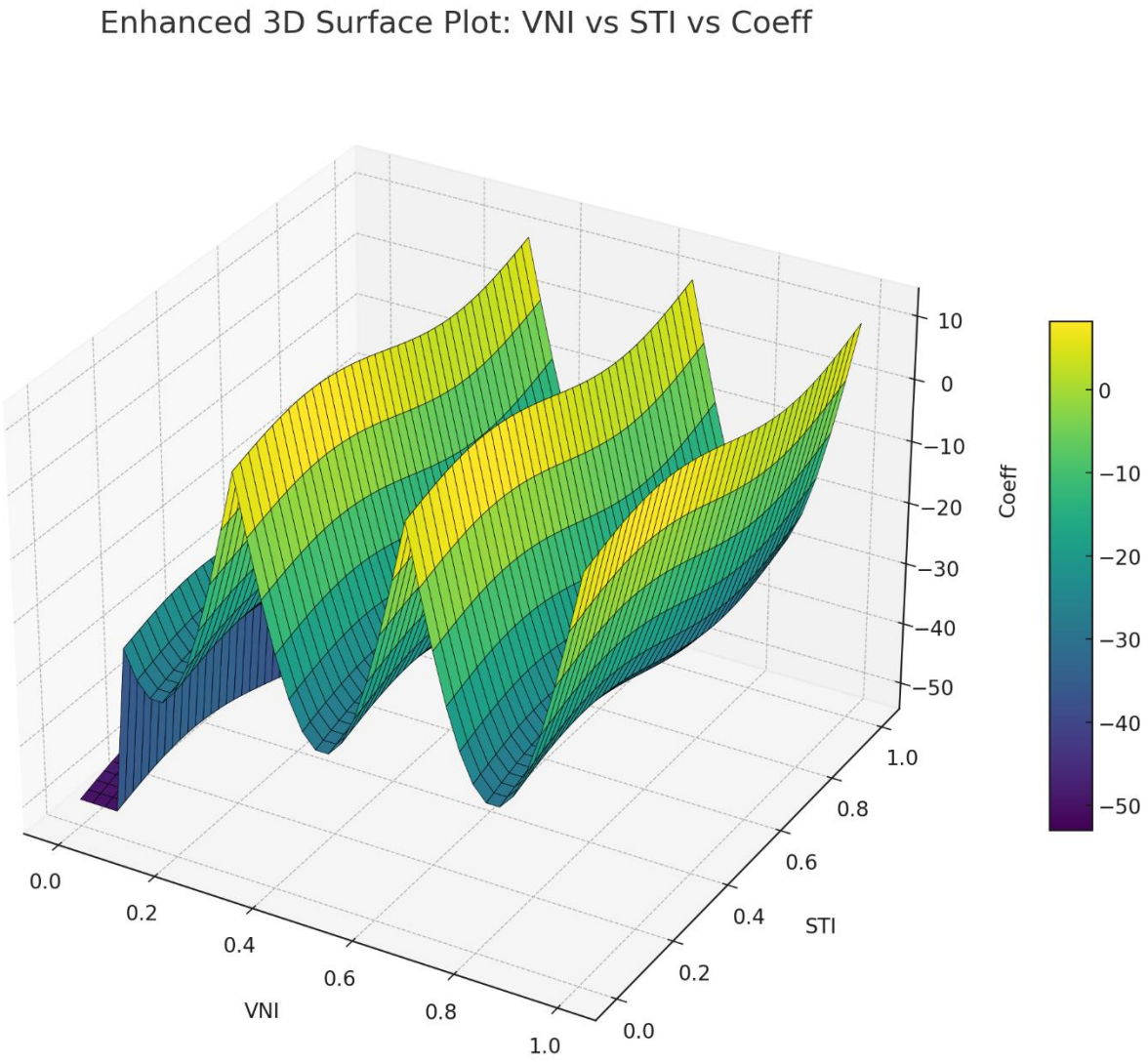

Figure 8.
During the COVID-19 period.

Figure 8 shows that in the post-COVID period, the overall impact of the SSCE index on VNI is lower than during the COVID period, and the level of impact is also more stable across the quantiles. Specifically, in the lower quantile range of VNI (0.00-0.4), SSCE has a small and equal impact across all quantiles. In the medium and high quantile ranges of VNI, the effect of SSCE decreases, but it remains relatively even across each quantile. In the high quantile range, SSCE harms VNI, but the level is not high for the pair VNIndex and STI index.

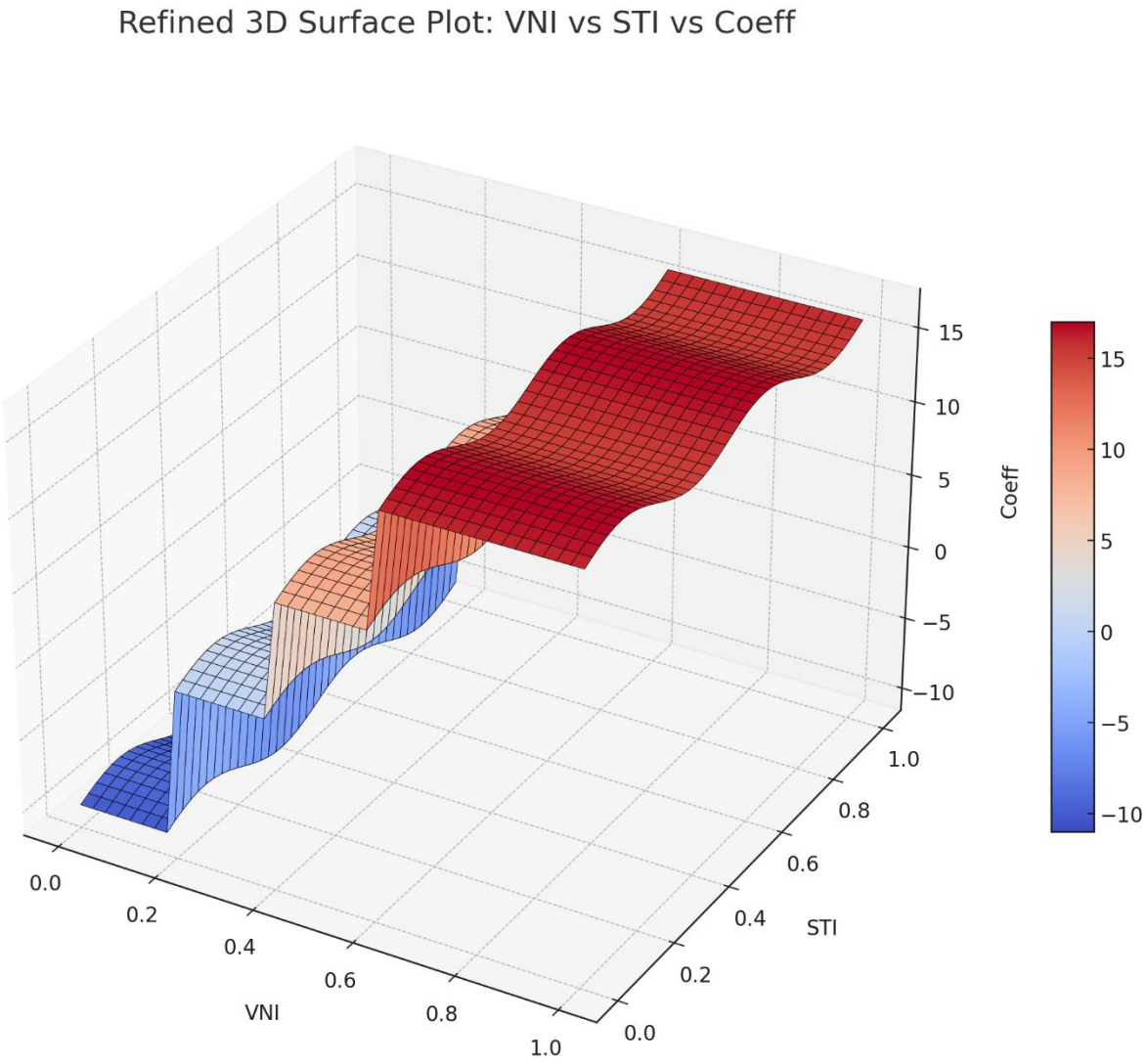

Figure 9.
The post-COVID-19 period.

Figure 9 shows that in the pair VNI and STI, in the lower VNI (0.00 – 0.39), STI has a negative and relatively significant impact, which does not differ much from VNI across most quantiles. In the medium quantile of VNI (0.4 – 0.75), STI has a relatively small impact on VNI across most quantiles; however, in the quantile range (0.4 – 0.55) of VNI, STI has a negative effect in the lower quantile and a positive impact in the higher quantile. Conversely, in the quantile range (0.56-0.75) of VNI, STI has a positive effect in the lower quantile and a negative impact in the higher quantile. In the high quantile range of VNI (0.8 – 1), STI has a negative impact, but it is low.

In the post-COVID period, the overall impact of the STI index on VNI is lower than during the COVID period, and the level of impact is also more stable across the quantiles. Specifically, in the lower quantile range of VNI (0.00-0.45), STI has a small and equal impact across most quantiles. In the medium quantile of VNI (0.46 – 0.75), the effects of KOPSI decrease; however, it remains relatively even across each quantile. In the high quantile range of VNI, the impact of KOPSI increases compared to the medium quantile range, but it is still not as high as in the lower quantile of VNI.

In summary, during both the COVID and post-COVID periods, the impact of Asian stock markets on the Vietnam stock market was not as high when the market was stable compared to when the market was in unfavorable or favorable conditions. During the COVID period, the impact of Asian stock markets on the Vietnam stock market was more significant than in the post-COVID period. Moreover, the effects level demonstrates more significant asymmetry, as evidenced by the differing coefficients across various quantiles. This clearly reflects the nonlinear dependence of the Vietnam stock market on Asian stock markets during the COVID period, which was more remarkable than in the post-COVID period.

Table 2.
Spillover index results.

During COVID-19 periods					
	r_vni	**r_kopsi**	**r_ssce**	**r_sti**	**From Others**
r_vni	71.38	10.20	7.35	11.07	28.62
r_kopsi	6.29	58.67	10.38	24.65	41.33
r_ssce	7.26	13.12	71.98	7.65	28.02
r_sti	7.04	25.83	6.29	60.84	39.16
Contribution to others	20.59	49.15	24.02	43.37	Overall Spread
Difference	-8.03	7.82	-4.00	4.21	Index: 34.28
The post-COVID-19 period					
r_vni	82.68	8.24	2.62	6.46	17.32
r_kopsi	6.08	68.80	4.20	20.92	31.20
r_ssce	3.43	7.49	83.18	5.90	16.82
r_sti	5.44	21.40	4.29	68.87	31.13
Contribution to others	14.95	37.13	11.10	33.28	Overall Spread
Difference	-2.37	5.93	-5.72	2.15	Index:24.12

Table 2 indicates that the Vietnam stock market experienced higher spillover from other stock markets during the COVID period than in the post-COVID period. During the COVID period, the Vietnamese stock market was most affected by spillover from the Chinese stock market, while in the post-COVID period, it was most influenced by spillover from the South Korean stock market.

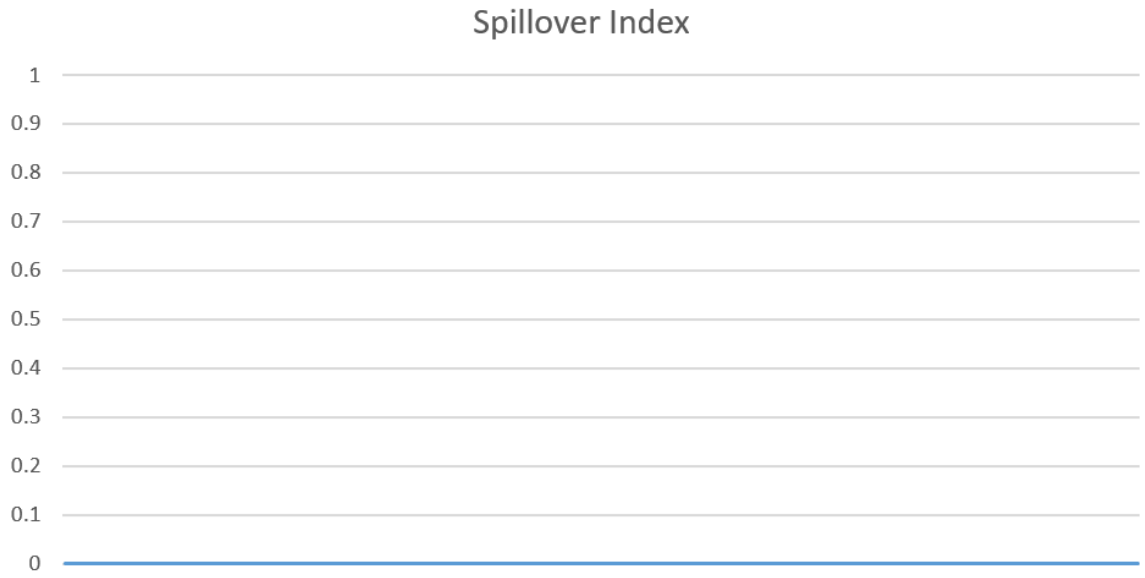

Figure 10.
Spillover index during the COVID period.

Figure 10 shows that the Spillover Index quantifies COVID-19-related financial shocks spread across different markets. When the spillover index is high, various asset classes, industries, or economies depend highly on one another. The pandemic's heightened worldwide anxiety led to synchronized market moves due to spillover effects. Liquidity concerns and policy actions probably caused the financial sectors to be more volatile. Gold and bonds, which are considered safe-haven assets, may have dampened the impact on stocks by absorbing shocks. There is growing evidence of systemic risk and financial contagion due to increased cross-market spillovers. Interest rate reductions and stimulus programs were examples of policy actions that affected the dynamics of spillovers. Comparing the pre- and post-COVID eras to evaluate economic recovery is helpful. Portfolio risk management benefits from an understanding of spillover effects. Policymakers can use this information to help them create measures to ensure financial stability.

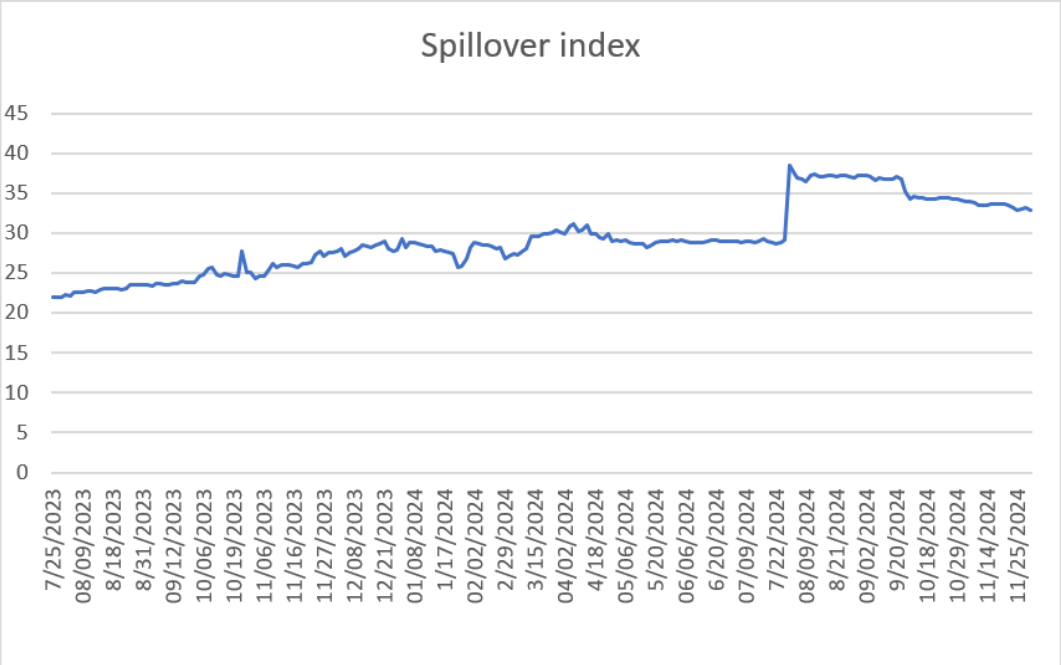

Figure 11.
Spillover index during the post-COVID period.

Figure 11 shows that post-COVID financial shocks spread across markets are reflected in the Spillover Index. A decrease in spillover intensity indicates market stabilization and decreased contagion risk. However, long-lasting spillovers can lead to fundamental changes or prolonged economic uncertainty. Delayed policy effects and global disruptions may continue to cause financial sectors to endure volatility. Varying recovery rates are shown by spillover patterns differing across various industries. As people's willingness to take risks increases, the spillover effects on safe-haven assets such as bonds and gold may be less pronounced. Continual changes to market interdependencies are caused by fiscal policies and central banks' policies. Financial resilience can be better understood by comparing spillover levels before, during, and after a pandemic. Data like this can help investors diversify their holdings and reduce risk exposure. Policymakers can better maintain the financial system's stability if they have a firm grasp of spillover dynamics.

4.4. Discussion of Findings

Increased volatility and sharp price swings were among the many adverse effects of the COVID-19 epidemic on world financial markets. STI had the lowest mean return during COVID-19 at 0.0015, while VNI had the highest at 0.0696. After COVID, the market's performance declined, and SSCE (-0.0037) went downhill [18-20]. The magnitude of market changes is indicated by the maximum and minimum figures. The two stocks that took a hit during COVID-19 were KOSPI (-8.7670) and VNI (-8.5295). Even more severe losses occurred in the post-COVID era for VNI (-11.7902) and KOSPI (-12.6463), indicating new economic difficulties.

During COVID-19, market volatility was much higher as assessed by standard deviation, with the most volatile indexes being VNI (1.7997) and KOSPI (1.6151). STI (0.8197) had the most significant degree of stability post-COVID compared to other indices. The occurrence of extreme price shocks is shown by the fact that all return distributions are non-normal, as confirmed by the Jarque-Bera test [21-23]. At the 1% significance level, the ADF test found that all indices are stationary, which means that stock returns are mean-reverting. During COVID-19, the results of the ARCH (2) test showed that there was time-varying volatility. Volatility persistence for VNI and KOSPI fell after COVID-19, while it was high for SSCE and STI, suggesting that market uncertainty persisted. Looking at the two time periods, it is clear that market dangers are still present in the post-COVID era, but volatility is lower. Variations in stock prices are still affected by structural shifts in the financial markets, shifting investor attitudes, and international economic policy.

According to the results, investors should use risk management techniques to deal with unknowns. To make smart financial decisions, it's helpful to understand how market circumstances change during times of crisis and recovery [24-26]. Future research should examine how the pandemic will affect market trends and stability in the long run. The Spillover Index shows the way COVID-19-related financial shocks rippled through equity markets. Being less reliant on other markets, VNI (71.38%) and SSCE (71.98%) kept most of their shocks during the pandemic. Significant spillovers from outside sources were absorbed by KOSPI (58.67%) and STI (60.84%), indicating a more interdependent market structure [27-29]. KOSPI was the biggest shock contributor, at 49.15%, in terms of transferring volatility across regions. STI was behind, providing 43.37 percent of the total, while VNI and SSCE had lesser percentages. The enormous financial contagion and increased market interconnectedness during the crisis are reflected in the overall spillover index, which is 34.28%.

As a result of less market interconnection after COVID-19, spillover effects decreased. Eighty-two percent of VNI and eighty-three percent of SSCE became more independent, requiring fewer outside resources. Despite this, KOSPI (68.80%) and STI (68.87%) continued to absorb some foreign volatility, but not quite as much. There was less financial contagion and

more market independence as the spread index fell to 24.12%. The contribution to spillovers and the importance of KOSPI and STI were lower than during COVID-19, although they remained significant [30, 31].

When comparing the two time periods, SSCE showed the most significant improvement in stability, with the most considerable spillover reduction of -5.72%. Persistent volatility transmission is indicated by KOSPI's differential (+5.93%) [32, 33]. There was a general decrease in cross-market dependency, with VNI and STI exhibiting moderate reductions in spillover influence. While global markets appear to have steadied in the post-pandemic era, some economies still depend heavily on other economies [34]. Investors may put more faith in local market circumstances rather than international patterns if financial contagion is reduced, which means there is less systemic danger. It is possible that regional events or policy changes could still cause cross-market volatility, given the ongoing susceptibility of KOSPI and STI to external forces. Opportunities for more predictable investment settings arise when spillover intensity is lower, but new dangers must be closely monitored.

As a result of market resiliency and the success of financial stability measures implemented after the pandemic, the spillover index has been falling. However, to see if the financial markets will return to how they were before the epidemic or maintain their independence, we must keep an eye on them. Investors can use these results to fine-tune their portfolio strategies, considering changing spillover patterns to balance their exposure to local and global markets.

5. Conclusion and Policy Recommendations

5.1. Conclusions

The stock market's actions before, during, and after COVID-19 show that financial dynamics, volatility, and spillover effects changed significantly. High spillover indices and higher cross-market contagion suggest that markets were more volatile, suffered significant fluctuations, and had stronger financial interdependencies during the epidemic. While VNI and SSCE showed considerable self-containment, stock indices like STI and KOSPI were significantly affected by outside shocks. The Jarque-Bera and ARCH (2) tests revealed continuous volatility and non-normal return distributions and highlighted how unpredictable financial movements were during the crisis. There was less volatility and fewer spillover effects in the financial markets after COVID. The overall spillover index's fall showed weaker financial contagion and increased market independence. Global economic conditions and policy initiatives appear to be shaping financial stability since some markets, including KOSPI and STI, still show signs of being exposed to external effects. Investment decision-makers should still consider sector-specific risks and structural changes, even when VNI and SSCE become increasingly self-contained.

The results show that investors should use adaptive risk management techniques. Market developments and global economic policies must be closely monitored to address the remaining uncertainties, even though the spillover index has decreased post-pandemic, indicating lesser systemic risk. To ensure markets can handle future shocks, policymakers should consider ways to make them more financially resilient. Investors may optimize their diversity, manage their exposure to local and global markets, and minimize risks efficiently by understanding the shifting financial landscape.

The markets have fully recovered from the volatility caused by COVID, but there is still a need for research on the long-term structural changes, the impact of monetary policy, and how financial interdependence is changing. Keeping the financial system stable is essential for long-term market growth and investor safety as economies worldwide adapt.

5.2. Policy Recommendations

Through the quantile-on-quantile regression method, the research results have clearly highlighted the nonlinear relationship and complex interactions between the Vietnam and Asian stock markets. The study also utilized the spillover index developed by Diebold and Yilmaz (2012) to determine the extent of spillover from Asian stock markets to Vietnam. Understanding the connection between the Vietnam stock market and the stock markets of Asian countries will provide investors with a stronger foundation for building investment portfolios and making business decisions. The research findings will also assist policymakers by providing evidence regarding the degree of market connectivity of each country, which can serve as a basis for developing supportive and regulatory policies for the market. The following measures should be taken by policymakers to strengthen the economy, the market, and investor faith in light of the results of analyses of stock market performance, volatility, and spillover effects both during and after COVID-19:

(1) Strengthening financial stability and risk management: Financial stability must be ensured to lessen the impact of future crises and maintain investors' faith. Policymakers should improve market surveillance systems that detect unusual volatility patterns early to reduce systemic risks. Market stability during economic downturns can be achieved by developing contingency measures for financial shocks, such as liquidity support programs. Macroprudential restrictions must be implemented to curb unsustainable investment practices and rein in excessive speculation. Governments should fortify stress-testing protocols to gauge the robustness of financial institutions against market shocks. Reducing systemic vulnerabilities can be achieved by encouraging capital buffers for financial enterprises and banks. Better cooperation across regulatory agencies can be achieved by forming financial stability councils. Proactive policy responses are ensured by strengthening early warning systems during an economic downturn. Investors should be educated on risk management measures through government-sponsored financial literacy programs. The risks of market manipulation can be mitigated by promoting the involvement of institutional investors. Market confidence and the attraction of long-term investments are both enhanced by transparent financial policies. Improved risk management will lead to more stable and resilient markets in the financial landscape following COVID.

(2) Promoting market independence and reducing spillover risks: An opportunity to strengthen market independence and lessen reliance on external factors has arisen due to decreased spillover effects post-COVID. Policymakers should promote market diversification techniques to prevent financial systems from becoming too vulnerable to outside shocks. Strengthening

internal capital flows and promoting resilience are achieved through encouraging domestic institutional investment. In times of global uncertainty, financial markets can be stabilized by enabling the creation of safe-haven assets like government bonds and gold. Increasing regional financial cooperation might also lessen your vulnerability to foreign market volatility. Capital flow management regulations must be implemented to prevent unexpected withdrawals of funds from outside sources. Governments may do more to encourage investment in local businesses by strengthening corporate credit rating systems. One way to fortify regional financial markets is to assist small and medium-sized enterprises (SMEs). Reducing reliance on specific industries susceptible to outside shocks is one goal of encouraging sectoral diversity. One way to lessen the blow of market swings is to teach investors how to manage the risks in their portfolios. Reducing economic vulnerabilities and promoting long-term sustainability are two outcomes of bolstering financial autonomy.

(3) Improving monetary and fiscal policies for post-COVID recovery: The stabilization of financial markets and economic recovery assistance are greatly influenced by monetary and fiscal policies. Monetary policy should be flexible enough to allow for both economic growth and inflation control to be achieved. Maintaining liquidity without causing excessive market movements is possible through adjusting interest rate policy. Industries that took a significant hit after COVID-19 should be the primary targets of targeted fiscal stimulus programs. To foster economic stability in the long run, governments should make sure that they invest strategically in infrastructure and innovation. Liquidity management and loan distribution can be strengthened through improved cooperation between financial institutions and central banks. Preventing excessive currency volatility can be achieved by strengthening exchange rate policies. A more equitable allocation of funds for economic recovery can be achieved by implementing a progressive taxation policy. Those most at risk of experiencing financial hardship can find refuge in stronger social safety nets. Promoting long-term economic prosperity is the goal of private-sector investment initiatives launched after the COVID-19 pandemic. Public debt management that is open and honest helps keep the country's creditworthiness and the faith of investors high. These strategies can maintain Economic growth and stability in the long run.

(4) Strengthening financial market transparency and regulation: Market trust and investment security are predicated on financial openness and robust regulatory systems. Ethical financial practices can only be achieved if lawmakers raise the bar for corporate governance. Requiring more thorough financial disclosures boosts confidence among investors and makes the market more stable. A better way to analyze risks and detect fraud is to implement monitoring systems powered by artificial intelligence and real-time data analytics. Governments must update their financial reporting standards to align with industry norms worldwide. Better regulatory monitoring aids in the identification and prevention of market manipulation. There will be fewer financial crimes and more trust in the economy if anti-money laundering (AML) procedures are strengthened. Regulatory enforcement is guaranteed to be neutral by establishing independent financial watchdog agencies. Harmonizing rules and enhancing market stability can be achieved through promoting cross-border financial cooperation. Fair market practices are encouraged by simplifying regulations that protect investors. Enhancing accountability is the goal of establishing whistleblower protection schemes. Increased foreign investment, longer-term viability, and a more resilient economy are all outcomes of a financially open market.

(5) Encouraging foreign direct investment (FDI) and sustainable growth: Reviving the economy and ensuring stable markets in the long run are both made possible by foreign direct investment (FDI). By maintaining consistent policies and being transparent with regulations, governments may make their economies more appealing to investors. Foreign investors can quickly enter the market if bureaucratic procedures are simplified. Investments between countries and economic cooperation are boosted by more substantial bilateral trade agreements. Sustainable development and the attraction of ESG-conscious investors are both advanced by green finance efforts. Growth in the economy driven by innovation can be facilitated by improving digital infrastructure. Governments should offer tax incentives for sustainable initiatives to promote long-term investment commitments. Financial zones welcoming foreign direct investment (FDI) can increase investor trust. It is possible to create a risk-free setting for investment by bolstering protections for intellectual property rights. Advancements in infrastructure and technology can be accelerated by promoting public-private partnerships (PPPs). Diversification, financial stability, and the possibility of long-term growth are all encouraged by a well-structured foreign direct investment policy.

6. Limitations and Future Research

6.1. Limitations

This study has significant limitations, but it sheds light on financial market behavior during and after COVID-19. The study may miss some worldwide financial patterns because it only covers four stock indices (VNI, KOSPI, SSCE, and STI). Expanding the dataset to include North American and European markets could broaden the results. Past data may not represent the present or future due to changes in the governmental, market, or financial systems. Another problem is descriptive statistics and spillover index analysis, which provide static insights. These methods illuminate past tendencies but may miss changing interdependencies and market behaviors. Advanced econometric models with time-varying parameters or machine learning predictions may reveal more. Additionally, the lack of precise modeling of external macroeconomic variables like inflation, geopolitical risks, and policy changes makes stock market volatility harder to understand. The study ignores behavioral finance issues like investor mood and psychological biases. These variables may have affected market reactions. Understanding market psychology and sentiment-driven volatility could improve future studies. Finally, the economy's long-term implications are unknown in the post-COVID age. Future studies should monitor these characteristics to identify long-term financial market changes.

6.2. Future Research

Future studies should analyze more stock indexes from various places to better comprehend financial contagion and interdependencies. Dynamic spillover models, machine learning, and deep learning algorithms can improve future spillover impact and market volatility predictions in modern econometric and AI-based models. Future studies should include macroeconomic variables to understand how interest rates, inflation, government stimulus programs, and geopolitical risks affect stock market behavior. Due to their dynamic nature, spillover indices may reveal how financial markets adapt post-COVID-19. Applied behavioral finance and investor sentiment analysis of psychological aspects affecting market reactions can improve stock market understanding. This includes speculative bubbles and fear-driven selling. Future studies may examine sector-specific spillover effects in banking, technology, healthcare, and energy to assess financial contagion resistance. With the shift toward sustainable finance in global markets, future research should examine the ripple impacts of ESG investments, green bonds, and climate change-related financial concerns. Future research should analyze global financial market structural changes, such as digital finance and regulatory changes, due to financial sector reforms and technological developments after the COVID-19 pandemic. Future studies should overcome these limits and study these research methodologies to better understand post-pandemic financial stability, spillover effects, and long-term investment plans.

References

[1] O. S. Alp, B. Canbaloglu, and G. Gurgun, "Stock liquidity, stock price crash risk, and foreign ownership," *Borsa Istanbul Review*, vol. 22, no. 3, pp. 477-486, 2022. https://doi.org/10.1016/j.bir.2021.06.012

[2] O. A. Aluko and F. T. Kolapo, "Macroeconomic factors and stock market development in sub-Saharan Africa: Does the measure of stock market development matter?," *Transnational Corporations Review*, vol. 12, no. 1, pp. 53-62, 2020. https://doi.org/10.1080/19186444.2019.1683433

[3] T. Ando, M. Greenwood-Nimmo, and Y. Shin, "Quantile connectedness: Modeling tail behavior in the topology of financial networks," *Management Science*, vol. 68, no. 4, pp. 2401-2431, 2022. https://doi.org/10.1287/mnsc.2021.3984

[4] R. Arshad, H. Zada, K. Sohag, W.-K. Wong, E. Ullah, and H. Raza, "Does US monetary policy uncertainty affect returns of Asian Developed, emerging, and frontier equity markets? Empirical evidence by using the quantile-on-quantile approach," *Heliyon*, vol. 10, no. 12, pp. 1–14, 2024. https://doi.org/10.1016/j.heliyon.2024.e32962

[5] I. Bakanauskienė, R. Bendaravičienė, N. Juodelytė, and J. Vveinhardt, "Sustainability of Nasdaq-listed companies: The effects of participation in the UNGC," *Polish Journal of Management Studies*, vol. 21, no. 1, pp. 87-103, 2020. https://doi.org/10.17512/pjms.2020.21.1.07

[6] K. Banda, J. H. Hall, and R. P. Pradhan, "The impact of macroeconomic variables on industrial shares listed on the Johannesburg Stock Exchange," *Macroeconomics and Finance in Emerging Market Economies*, vol. 12, no. 3, pp. 270-292, 2019. https://doi.org/10.1080/17520843.2019.1599034

[7] J. Calvimontes *et al.*, "Small-scale gold mining and the COVID-19 pandemic: conflict and cooperation in the Brazilian Amazon," *The Extractive Industries and Society*, vol. 7, no. 4, pp. 1347-1350, 2020. https://doi.org/10.1016/j.exis.2020.08.013

[8] S. Chancharat and N. Chancharat, "Asymmetric spillover and quantile linkage between the United States and ASEAN+ 6 stock returns under uncertainty," *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 10, no. 3, p. 100317, 2024. https://doi.org/10.1016/j.joitmc.2024.100317

[9] M.-P. Chen, P.-F. Chen, and C.-C. Lee, "Frontier stock market integration and the global financial crisis," *The North American Journal of Economics and Finance*, vol. 29, pp. 84-103, 2014. https://doi.org/10.1016/j.najef.2014.05.004

[10] U. Cherubini, E. Luciano, and W. Vecchiato, *Copula methods in finance*. New Jersey: John Wiley & Sons, 2004.

[11] I. Ciftci, E. Tatoglu, G. Wood, M. Demirbag, and S. Zaim, "Corporate governance and firm performance in emerging markets: Evidence from Turkey," *International Business Review*, vol. 28, no. 1, pp. 90-103, 2019. https://doi.org/10.1016/j.ibusrev.2018.08.004

[12] H. C. Ezeaku, S. A. Asongu, and J. Nnanna, "Volatility of international commodity prices in times of COVID-19: Effects of oil supply and global demand shocks," *The Extractive Industries and Society*, vol. 8, no. 1, pp. 257-270, 2021. https://doi.org/10.1016/j.exis.2020.12.013

[13] D. Gabauer, "Volatility impulse response analysis for DCC-GARCH models: The role of volatility transmission mechanisms," *Journal of Forecasting*, vol. 39, no. 5, pp. 788-796, 2020. https://doi.org/10.1002/for.2648

[14] L. R. Glosten, R. Jagannathan, and D. E. Runkle, "On the relation between the expected value and the volatility of the nominal excess return on stocks," *The Journal of Finance*, vol. 48, no. 5, pp. 1779-1801, 1993. https://doi.org/10.1111/j.1540-6261.1993.tb05128.x

[15] A. Güngör and H. Taştan, "On macroeconomic determinants of co-movements among international stock markets: evidence from DCC-MIDAS approach," *Quantitative Finance and Economics*, vol. 5, no. 1, pp. 19-39, 2021. https://doi.org/10.3934/QFE.2021002

[16] R. Gürkaynak, H. c. G. Karasoy-Can, and S. S. Lee, "Stock market's assessment of monetary policy transmission: The cash flow effect," *The Journal of Finance*, vol. 77, no. 4, pp. 2375-2421, 2022. https://doi.org/10.1111/jofi.13163

[17] M. A. Harjoto, F. Rossi, and J. K. Paglia, "COVID-19: Stock market reactions to the shock and the stimulus," *Applied Economics Letters*, vol. 28, no. 10, pp. 795-801, 2021. https://doi.org/10.1080/13504851.2020.1781767

[18] M. B. Hasan, M. Mahi, T. Sarker, and M. R. Amin, "Spillovers of the COVID-19 pandemic: Impact on global economic activity, the stock market, and the energy sector," *Journal of Risk and Financial Management*, vol. 14, no. 5, p. 200, 2021. https://doi.org/10.3390/jrfm14050200

[19] P. He, Y. Sun, Y. Zhang, and T. Li, "COVID–19's impact on stock prices across different sectors – An event study based on the Chinese stock market," *Emerging Markets Finance and Trade*, vol. 56, no. 10, pp. 2198–2212, 2020. https://doi.org/10.1080/1540496X.2020.1785865

[20] I. C. Iuga, S. Rabab Mudakkar, and L. L. Dragolea, "Time of COVID-19: Stability analysis of stocks, exchange rates, minerals and metals markets," *Economic Research*, vol. 36, no. 1, pp. 1527-1548, 2023. https://doi.org/10.1080/1331677X.2022.2090403

[21] H. Joe, *Multivariate models and multivariate dependence concepts*. London: Chapman and Hall/CRC, 1997.

[22] M. T. Kartal, H. M. Ertuğrul, and T. Ulussever, "The impacts of foreign portfolio flows and monetary policy responses on stock markets by considering COVID-19 pandemic: Evidence from Turkey," *Borsa Istanbul Review*, vol. 22, no. 1, pp. 12-19, 2022. https://doi.org/10.1016/j.bir.2021.06.003

[23] S. Keswani, V. Puri, and R. Jha, "Relationship among macroeconomic factors and stock prices: cointegration approach from the Indian stock market," *Cogent Economics & Finance*, vol. 12, no. 1, pp. 1–20, 2024. https://doi.org/10.1080/23322039.2024.2355017

[24] W. Mohti, A. Dionísio, P. Ferreira, and I. Vieira, "Contagion of the subprime financial crisis on frontier stock markets: A copula analysis," *Economies*, vol. 7, no. 1, pp. 1–14, 2019. https://doi.org/10.3390/economies7010015

[25] N. K. Otinga, P. Obi, and F. Mugo-Waweru, "Stock market participation puzzle: A systematic review and bibliometric analysis," *Cogent Business & Management*, vol. 11, no. 1, pp. 1–24, 2024. https://doi.org/10.1080/23311975.2024.2396531

[26] C. Pflueger and G. Rinaldi, "Why does the Fed move markets so much? A model of monetary policy and time-varying risk aversion," *Journal of Financial Economics*, vol. 146, no. 1, pp. 71-89, 2022. https://doi.org/10.1016/j.jfineco.2022.06.002

[27] J. Schrank, "The impact of a crisis on monetary policy's influence on financial markets: Evidence from the COVID-19 pandemic," *Cogent Economics & Finance*, vol. 12, no. 1, pp. 1–15, 2024. https://doi.org/10.1080/23322039.2024.2322874

[28] N. Shrydeh, M. Shahateet, S. Mohammad, and M. Sumadi, "A revised approach to testing for asymmetric intermarket spillover effects," *Cogent Economics & Finance*, vol. 13, no. 1, pp. 1–21, 2025. https://doi.org/10.1080/23322039.2024.2440440

[29] N. M. Thomas, S. Kashiramka, S. S. Yadav, and J. Paul, "Role of emerging markets vis-à-vis frontier markets in improving portfolio diversification benefits," *International Review of Economics & Finance*, vol. 78, pp. 95-121, 2022. https://doi.org/10.1016/j.iref.2021.11.012

[30] A. Ti and Z. A. Husodo, "Navigating volatility spillover amidst investor extreme fear in stablecoin and financial markets," *Cogent Economics & Finance*, vol. 12, no. 1, pp. 1–21, 2024. https://doi.org/10.1080/23322039.2024.2408276

[31] Y. Wang, J. Wu, and Y. Shi, "Stock index prediction using global market indices: A Granger causality-based graph representation learning method," *Procedia Computer Science*, vol. 221, pp. 797-804, 2023. https://doi.org/10.1016/j.procs.2023.08.053

[32] P. Zhang, Y. Sha, and Y. Xu, "Stock market volatility spillovers in G7 and BRIC," *Emerging Markets Finance and Trade*, vol. 57, no. 7, pp. 2107-2119, 2021. https://doi.org/10.1080/1540496X.2021.1908256

[33] W. Zhang and P. Wang, "Investor attention and the pricing of cryptocurrency market," *Evolutionary and Institutional Economics Review*, vol. 17, pp. 445-468, 2020. https://doi.org/10.1007/s40844-020-00182-1

[34] J. Zuo, "Impact of monetary policy on the stock market volatility: A GARCH-MIDAS approach in Malaysian economy," *Cogent Economics & Finance*, vol. 13, no. 1, p. 2459183, 2025.