

# Measurement of Expected Shortfall, Correlation and Simulation of Stock Return in The Transportation Sector in Asia's Emerging Stock Exchanges Before and After The Covid-19 Pandemic

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## Abstract

The objective of this research is to analyze the market risks encountered by transportation sector companies listed in emerging Asian market countries, as well as the correlation of risks among these companies. Additionally, the study aims to provide a forecasting simulation for the stock prices over the next 100 days. Historical data on daily stock price changes prior to and following the Covid-19 pandemic are utilized. The research methodology employs a normal GARCH model to assess stock volatility, while market risk is determined using the expected shortfall (ES) approach. The Pearson method is employed to calculate the correlation of risks between companies. The forecasting simulation is conducted using the GARCH(1,1) approach for specification and fitting. The findings of this study reveal that transportation sector issuers have exhibited varied responses to the Covid-19 pandemic based on their specific sub-sectors. The correlation between issuers generally demonstrates low values; however, the stock markets of China and Taiwan display a strong positive correlation within the same sub-sector. Future stock price movements over the next 100 days are anticipated to align with the trend observed during the latter part of 2022.

*Keywords:* Market Risk; Covid-19; Expected Shortfall; GARCH; Correlation.

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## 1. Introduction

In 2020, the global emergence of the Covid-19 pandemic sparked a state of emergency and raised serious concerns for the World Health Organization. Its rapid transmission affected people worldwide, surpassing the scale of the 2003 SARS epidemic (Yang & Chen, 2009).

Numerous studies have investigated the impact of the Covid-19 pandemic, with a particular focus on the economic sector. A study conducted by (Wu, Zhang, & Chen, 2022) examined the correlation of risks among global stock markets during the pandemic. The findings revealed a significant influence of Covid-19 on most of the world's stock markets, as evidenced by fluctuations in their indexes. Countries that managed to remain relatively unaffected by the pandemic either implemented strict lockdown measures or effectively controlled the spread of Covid-19. Furthermore, the study observed that countries with lower economic levels exhibited a higher correlation with Covid-19 risk compared to countries with higher economic levels.

The study conducted by (Song, Sui, & Zhao, 2023) demonstrated that the QR-SGED-GARCH model (1.1), in calculating the Expected Shortfall (ES) value, exhibited relatively superior accuracy compared to traditional models like Value at Risk (VaR) in assessing financial market risk during the Covid-19 pandemic. This measurement method assists in predicting financial risk more effectively and enhancing understanding of the evolving dynamics of the stock market.

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Regarding the selection of appropriate modeling techniques for projecting the Expected Shortfall (ES) value, (Fortin, Simonato, & Dionne, 2023) found no significant difference in the accuracy of risk forecasting between univariate and multivariate models.

(Harjoto, Rossi, Lee, & Sergi, 2021) conducted a study on the unprecedented adverse negative shocks that affected the stock market. The results revealed that the impact of the Covid-19 pandemic varied between emerging and developed countries. The study by (Abuzayed, Bouri, Al-Fayoumi, & Jalkh, 2021) demonstrated that systemic risk transmission between individual and global stock markets was bilateral both before and after the Covid-19 pandemic. It was noted that the United States stock market acted as the primary transmitter of stock market risks to and from global markets during the pandemic. On the other hand, the Chinese stock market, being the country where the Covid-19 outbreak first occurred, became the transmitter of the lowest marginal extreme risk to or from the global market after the pandemic spread worldwide.

(Yong & Laing, 2021) conducted a study that indicated multinational companies with global operations displayed relatively more resilience to global shocks triggered by the Covid-19 outbreak. Meanwhile, Harjoto et al. (2021) found that the cases and death rates of Covid-19 affected developing country markets differently compared to developed markets during periods of increasing infections and stable infection rates. The uncertainty arising from the daily increase in Covid-19 cases and death tolls contributed to increased volatility in the equity markets of both developed and developing countries. Previous studies conducted by (Onali, 2020), (Al-Awadhi, Alsaifi, Al-Awadhi, & Alhammedi, 2020), (Baek, Mohanty, & Glambosky, 2020), and (Zhang, Zhuang, Wang, & Lu, 2020) examined the impact of Covid-19 on the stock market. Onali's study (Onali, 2020) indicated that the initial three months of exposure to Covid-19 did not significantly impact the returns on the US stock market, although it demonstrated a positive impact on conditional heteroscedasticity on Dow Jones and S&P returns. (Al-Awadhi et al., 2020), analyzing the Hang Seng and Shanghai Indexes, found a significant negative correlation between the increase in Covid-19 cases and deaths and the daily returns of both stock indexes (Zhang et al., 2020) identified a tail risk network connecting all sectors of the Chinese stock market, leading to systemic risk during the early stages of the Covid-19 outbreak.

Various researchers, including (Bollerslev, 1986), (Bollerslev, 1986), (McKay & Keefer, 1996), (Artzner, 1997), (Artzner, Delbaen, Eber, & Heath, 1999), (Engle & Manganelli, 2004), (Giot & Laurent, 2004), (Lazar & Zhang, 2019), have conducted market risk studies using different approaches. The G30 Group's report introduced the concept of Value at Risk (VaR) as a measure of market risk for the first time. However, Artzner et al. (1997) highlighted the drawbacks of VaR, including its inability to consider losses beyond the defined risk level and the lack of subadditivity. To address these limitations, (Artzner et al., 1999) proposed an alternative method for measuring financial risk known as Expected Shortfall (ES).

While several studies have examined the impact of Covid-19 on the stock market from a return and volatility perspective, research on simulation forecasting for listed companies in the transportation sector remains relatively limited.

This study contributes to the existing literature in two ways. First, it provides guidance to investors, particularly those interested in investing in the transportation sector, by managing investment risk using Expected Shortfall values. These values consider external factors, such as the Covid-19 pandemic, and consider the simulation forecasts for future returns. Second, it contributes to the literature by encouraging further research on risk measurement using the Expected Shortfall approach or other methodologies in different sectors and stock exchanges. This research can explore the occurrence of specific external factors and risk correlations between the studied objects while predicting stock movements with a more comprehensive approach

## **2. Literature Review**

### *2.1. Volatility, Value at Risk and Expected Shortfall Risk Measurement*

Volatility, represented by the standard deviation of returns, is a primary risk measurement used in financial analysis (Danielsson, 2011). However, volatility alone is an adequate risk measure only when financial returns follow a normal distribution, where all statistical properties are captured by mean and variance. In reality, financial instrument returns rarely conform to normal distribution assumptions. Consequently, relying solely on volatility as a risk measure can lead to erroneous conclusions about market risk. (Danielsson, 2011) further explains that the extent of this inaccuracy depends on specific applications.

Value at Risk (VaR) is the most used risk measure after volatility. It provides a single summary statistic of risk, assuming an independent distribution and quantifying losses due to "typical" market movements. Despite well-documented drawbacks, VaR remains the preferred risk measure in the financial industry. VaR strikes a balance among available risk measures and supports practical risk models. Since the mid-1990s, VaR has become the standard risk measurement method in the financial industry, with extensive literature discussing its application (Jorion, 2007). VaR is defined as the estimated maximum loss that could occur during a specific period under normal market conditions at a given confidence level. It aims to answer the question of how much investors could lose during the investment period with a confidence level of  $(1-\alpha)$ .

(Klugman, Panjer, & Willmot, 2012) argue that VaR is not a coherent risk measure since it satisfies properties like translational invariance, positive homogeneity, and monotonicity but fails to meet the subadditivity property. To address this limitation, the risk measure known as Tail-Value at Risk (T-VaR) or Expected Shortfall (ES) was introduced, which does exhibit coherence. ES represents the amount of loss that would be incurred if losses exceed the VaR threshold.

In 2016, the Basel Committee on Banking Supervision published a document presenting its proposal for the trading book capital requirement policy. Key elements of the proposal include shifting from VaR to Expected Shortfall (ES) as the quantitative risk metric and lowering the confidence level from 99% to 97.5%.

The Basel Committee recognized that using Value at Risk (VaR) to determine regulatory capital requirements has several weaknesses, including its inability to capture tail risk. To address this limitation, (Artzner, 1997) proposed the use of Expected Shortfall (ES), which accounts for losses beyond the VaR level and demonstrates sub-additivity, unlike VaR.

(Jorion, 2007) outlines the steps involved in measuring VaR as follows:

- a. Assess the asset values based on mark-to-market (P) conditions.
- b. Calculate the variability or variance of the risk factor ( $\sigma$ ).
- c. Determine the desired time horizon or holding period (t).
- d. Specify the confidence level ( $\alpha$ ) to be used.

Calculate the largest potential loss from the VaR measurement process using the available data.

Based on the steps, the VaR for a single asset can be computed using the following equation:

$$VaR = P \cdot \sigma \cdot \sqrt{t \cdot \alpha} \tag{2.1}$$

Figures should be prepared taking into account that the printed version will be in black and white. Only the online version may have figures in color. The difference between portfolio VaR measurement and single instrument VaR is that the volatility used is portfolio volatility ( $\sigma_p$ ) which is determined from the volatility and weight of each asset and the correlation between assets. (Bodi, n.d.) calculate the volatility of a portfolio consisting of two assets with the following equation:

$$\sigma_p^2 = \omega_1^2 \sigma_1^2 + \omega_2^2 \sigma_2^2 + 2\omega_1 \omega_2 cov(r_1, r_2) \tag{2.2}$$

Where :

- $\omega_1 \omega_2$  = weight of each asset in the portfolio
- $\sigma_p^2$  = portfolio variance
- $cov(r_1, r_2)$  = covariance between return on asset 1 and asset 2
- $\sigma_{1,2}$  = standard deviation of each asset

Expected Shortfall (ES), also known as Expected Tail Loss, Conditional VaR, or Extreme VaR, considers both the probability of default and the average potential loss. The Basel Committee on Banking Supervision highlighted this as a primary reason for transitioning from Value at Risk (VaR) to ES, as stated in a Consultative Document released in May 2012. The prevalence of VaR in the current framework for quantitative risk measurement can be attributed to historical industry practices and regulatory requirements. However, VaR has notable drawbacks, particularly its

failure to capture tail risk. Therefore, alternative risk metrics that address this weakness are deemed necessary. ES is an example of a risk metric that provides a broader assessment of potential outcomes compared to VaR. Unlike VaR, ES evaluates instrument risk by considering both the magnitude and probability of losses above a specific threshold, thus offering a more comprehensive consideration of tail risk.

Volatility, Value at Risk (VaR), and Expected Shortfall (ES) are all methods used to measure risk in financial instruments.

Expected shortfall (ES), as described by (Dowd, Blake, & Cairns, 2002) and various references, calculates the expected loss that exceeds VaR at a given confidence level. ES serves as an alternative and further development of VaR. When VaR cannot provide information about the magnitude of actual losses beyond its measurement, ES is utilized, as highlighted by (Crouhy, Galai, & Mark, 2001). ES offers several advantages over VaR, as outlined by (Dowd et al., 2002), including meeting sub-additivity requirements that VaR cannot fulfill and providing insights into worst-case scenarios under extreme conditions (fat tail), which VaR fails to accommodate. (Dowd et al., 2002) presents various approaches to calculate ES, one of which involves computing the average tail VaR. ES is determined using the following equation:

$$ES_{\alpha} = \frac{1}{1 - \alpha} \int_{\alpha}^1 q_p dp \tag{2.3}$$

$$ES = e(X/X > VaR) = \sum_{k=(n\alpha)}^n \frac{X_{n(k)}}{(n - n\alpha)} \tag{2.4}$$

ES represents the expected value of X when X is greater than VaR.

Additional approaches that can be employed to calculate ES include optimization, bootstrapping, Monte Carlo simulations, and historical simulations, which were utilized in this study with the assistance of RStudio software.

The distinction between these three methods is as follows: volatility captures the average value, variance quantifies the risk of normally distributed financial instruments based on volatility's standard deviation, and Value at Risk (VaR) estimates the maximum loss for a financial instrument within a certain period under normal market conditions at a specified confidence level (1-α). In contrast, Expected Shortfall (ES) is a market risk measurement method that considers the non-normal distribution by comprehensively accounting for the probability of default as well as the average potential loss (tail risk).

## 2.2. Correlation

Correlation is a crucial factor in measuring portfolio volatility and supporting risk calculations. The correlation coefficient measures the covariance and ranges between -1 (indicating perfect negative correlation) and +1 (indicating perfect positive correlation). A positive correlation coefficient signifies that returns a and b change in the same direction. The correlation is stronger when the coefficient approaches +1, indicating limited diversification benefits. Conversely, a negative correlation suggests that the two returns move in opposite directions, indicating a decrease in the pair of assets, with the extent depending on the correlation coefficient's value. If the correlation coefficient is negative and close to -1, the risk of the two assets in the portfolio approaches zero. A correlation coefficient of zero indicates that changes in the value of one asset have no effect on the value of other assets. The following equation is used to calculate the correlation between return data in a portfolio:

$$\rho_{(a,b)} = \frac{Cov(r_a, r_b)}{\sigma_a \sigma_b} \tag{3.1}$$

Where:

$\rho_{(a,b)}$  = correlation between returns a and b

$Cov(r_a, r_b)$  = Covariance between returns a and b

$\sigma_a \sigma_b$  = standard deviation a and b

### 2.3. Forecasting Simulation of Volatility

The final step in establishing the time series model involves forecasting volatility for upcoming periods using the appropriate models, namely ARIMA(0,0,0) and sGARCH(1,1), by testing the significance of the p-value. Once a significance value of p-value  $< 0.05\%$  is obtained, the model becomes suitable for simulating future forecasts.

The forecasted results provide insights into the potential movements and returns of stocks that may occur in the future. This information can be utilized by potential investors with different investment behaviors, namely risk takers and risk-averse individuals. Risk takers are inclined to embrace risks in their investment decisions, while risk-averse investors tend to avoid risks when making investment choices.

### 2.4. Data

The study utilizes daily stock data from the top ten issuers in the transportation sector, based on market capitalization, in Asian emerging markets including China, India, Indonesia, Korea, Malaysia, Taiwan, and Thailand. The data was sourced from <https://www.tradingview.com> during the specified study period, spanning from January 2018 to December 2022. Historical stock data for analysis purposes was obtained from the website [www.finance.yahoo.com](http://www.finance.yahoo.com) as a secondary source. The dataset covers a daily time interval both before and after the Covid-19 pandemic. The stock data collected represents a time series, capturing stock movements over time. In addition to the transportation sector stocks on Asian emerging markets, the study also incorporates other relevant secondary data sources, including literature related to the research topic.

## 3. Research Method and Materials

### 3.1. Returns Analysis

Returns are the outcomes generated from an investment. Stock returns can be classified into two categories: realized returns and expected returns. Realized returns refer to the returns that have already occurred, calculated based on historical data. The realization of returns holds significance in assessing the performance of a company and serves as a foundation for determining future returns and risks. On the other hand, expected returns pertain to the anticipated returns in the future, which inherently involve uncertainty. To compute daily realized returns, the daily stock closing price data can be employed by utilizing the Log Return or Geometric Rate of Return method, as outlined by Tsay.

### 3.2. Stationary Test

The use of non-stationary data in modeling a time series will result in inaccurate conclusions. Therefore, before carrying out ES measurements, the data must be tested for stationarity to ensure that a time series is in a stationary condition.

### 3.3. Normality test

The normality test aims to determine whether the distribution of stock returns is normally distributed or not. The normality test used is the Jarque-Bera (JB) test. Testing uses the following hypothesis:

H0 : Return is normally distributed.

H1 : Return is not normally distributed.

### 3.4. GARCH modeling

The GARCH model is utilized when the volatility test indicates that the distribution of stock returns exhibits heteroscedasticity. Conversely, if the formed model is assumed to adhere to the autoregressive moving average (ARMA) process, the return model can be expressed as ARMA(p,q) in the following equation:

$$y_t = c + \sum_{i=1}^p \alpha_i y_{t-1} + \sum_{i=1}^q \beta_i y_{t-1} + \varepsilon_t \quad (6.1)$$

## 4. Results and Discussion

### 4.1. Expected Shortfall

#### 4.1.1. China

Chinese transportation stocks exhibit varying levels of risk, as indicated by their Expected Shortfall (ES) values. Among them, Cosco Shipping Holding shares have the highest ES value at -10.7380% with a 99% confidence level. This implies that over the next 100 days, there is a potential one-day loss of 10.7380% based on historical data from the past five years. Consequently, Cosco Shipping Holding shares are considered to carry a relatively high risk for investors. Conversely, Daqin Railway shares have the lowest ES value at -6.0551%, indicating a potential one-day loss of 6.0551% over the next 100 days.

In general, the average ES value for the Chinese stock issuers under study is -7.8701%. This relatively high value signifies a significant risk of loss associated with these shares. Considering the previously discussed volatility of stock returns, which had limited impact during the Covid-19 pandemic, it can be concluded that the relatively high ES value is an inherent risk characteristic of the stocks in question.

#### 4.1.2. India

Among transportation issuers in the Indian stock market, Adani Port Special Economic Zone, which is engaged in marine shipping, has the highest potential risk, with an Expected Shortfall (ES) value of -10.2028%. This implies that each investor in the stock has the potential to experience a one-day loss of 10.2028% of the invested share value within the next hundred days. On the other hand, Blue Dart Express has the lowest risk value among transportation stocks in India, with an ES value of -6.0679% at a 99% confidence level.

The average ES value for Indian transportation stocks is -7.850%. This value is influenced by market fluctuations in response to the Covid-19 pandemic. The relatively high ES value of Indian transportation issuers' shares can be attributed to the market volatility that occurred at the beginning of the pandemic. It is worth noting that prior to the Covid-19 pandemic, the issuers in question exhibited lower volatility based on return data.

#### 4.1.3. Indonesia

In the context of the Indonesian stock market, transportation issuers demonstrate varying levels of risk, with Expected Shortfall (ES) values ranging from -7% to -17%. Nusantara Pelabuhan Handal Tbk, engaged in container operations, faces the highest market risk with an ES value of -17.0244%, while Blue Bird Tbk, involved in land transportation, has the lowest risk with an ES value of -7.3396%.

Nusantara Pelabuhan Handal Tbk, apart from being affected by the Covid-19 pandemic, experiences the largest market risk based on historical data over the past five years. This risk may also be influenced by external factors and the fundamental conditions of the issuer. The nature of the goods traffic business, which is relatively unaffected by government-imposed restrictions on movement, further supports this observation. Notably, Nusantara Pelabuhan Handal Tbk did not experience significant fluctuations during the Covid-19 pandemic, as indicated by the relevant stock return data.

Blue Bird Tbk, despite having the smallest ES value among the stocks studied, is heavily influenced by restrictions on the movement of people during the Covid-19 pandemic. Historical data on the stock returns of Blue Bird Tbk shows significant fluctuations during that period.

The average ES value of transportation stocks in Indonesia is -9.6688%, which primarily stems from the impact of the Covid-19 pandemic. Most stock issuers experienced high return volatility during this period.

#### 4.1.4. Korea

Transportation sector stocks have exhibited a consistent response to external factors, including the Covid-19 pandemic. Several transportation issuers in Korea have shown a higher level of risk, with Expected Shortfall (ES) values ranging from -6.89% to -15.40%, and an average ES value of -10.3142%. This indicates that the Korean transportation sector stock market was significantly impacted by external factors, including the Covid-19 pandemic.

Among the issuers, Hanjin Kal, operating in the airline services industry, carries the highest risk with an ES value of -15.4011%. This means that Hanjin Kal has the greatest likelihood of experiencing a loss equal to its ES value, with a 1/100 chance based on the movement of the share price over the past five years. This heightened risk is attributed to the negative effects of travel restrictions (lockdowns) imposed by the Korean government and destination countries on Hanjin Kal's flights.

The ES values of transportation sector stocks in Korea were strongly influenced by historical data, particularly the significant contraction observed during the early stages of the global spread of the Covid-19 pandemic in 2020. This observation is further supported by the relatively stable condition of stock price movements prior to the pandemic.

#### 4.1.5. Malaysia

The transportation sector in Malaysia has faced significant challenges due to the Covid-19 pandemic, as evident from the Expected Shortfall (ES) values of transportation issuers in the country based on historical data over the past five years. Tasco Bhd, a logistics transportation company, carries the highest risk with an ES value of -19.6401% at a 99% confidence level. This implies that Tasco Bhd, based on historical data, has the potential to incur a one-day loss of 19.6401% within the next 100 trading days. The substantial ES value is attributed to Tasco Bhd's historical record of significant losses during the initial phase of the Covid-19 pandemic, which impacted Malaysia and the rest of the world.

Conversely, Westports Holdings Bhd, operating in the marine shipping sector, has the smallest ES value on the Malaysian stock market, standing at -7.2234%. Although the marine shipping sector was relatively unaffected by movement restrictions during the pandemic, the market response to Westports Holdings Bhd's stocks during that period resulted in a relatively higher risk based on its ES value.

On average, Malaysian transportation stocks have an ES value of -10.4079%, indicating a significant level of risk within the sector, particularly during external events such as the Covid-19 pandemic. This observation is supported by the volatility data of these stocks, which generally experienced a contraction in early 2020 when the pandemic began impacting Malaysia and the rest of the world.

#### 4.1.6. Taiwan

The transportation sector stock market in Taiwan has exhibited a similar pattern to other countries' stock markets, with an average Expected Shortfall (ES) value for each issuer in the range of -9.3096%. However, Taiwan High Speed Railway Corporation, which operates high-speed railways, carries relatively lower market risk compared to other transportation sector issuers in Taiwan, with an ES value of -4.8666%. This indicates that Taiwan High Speed Railway Corporation has a potential one-day loss of only 4.8666% for each share in the next 100 days. The company's strong fundamentals, coupled with Taiwan's government policies in effectively managing the Covid-19 situation, have provided a sense of comfort to investors, resulting in a less pronounced negative reaction to this issuer's shares.

On the other hand, Evergreen Marine Corp., operating in the marine shipping sector, holds the highest ES value of -11.7472%, which is not primarily driven by the Covid-19 pandemic but rather by other factors that contributed to significant volatility in its shares from mid-2020 to the end of 2022. This period coincided with the global recovery phase of the Covid-19 pandemic, including in Taiwan.

The average ES value of issuers in the transportation sector in Taiwan stands at -9.3096%, primarily influenced by historical fluctuations in relevant stock returns observed from early 2020 to the end of 2022.

#### 4.1.7. Thailand

Like the Taiwan stock market, the transportation sector in Thailand has also witnessed volatility due to the impact of the Covid-19 pandemic. However, there are stock issuers in this sector that have shown relative resilience during this challenging period. Bangkok Aviation Fuel Services (BAFS.BA), which specializes in aircraft material storage and supply at Bangkok International Airport, has the lowest risk value with an ES value of -5.7602% at a 99% confidence level. Despite the overall shock experienced by the aviation industry due to Covid-19, BAFS.BA's shares have not undergone significant contraction. This can be attributed to the company's ability to operate during the pandemic, particularly its fuel-supplied cargo plane business, as well as its strong fundamentals.

Conversely, Precious Shipping Public Company Limited, operating in the marine shipping sector, recorded the highest ES value of -12.8065%. This indicates that these shares have a risk of a one-day loss of 12.8065% in the next hundred days. The company experienced a loss of over 15% at the onset of the Covid-19 pandemic, which served as the basis for calculating its ES value in this study. This highlights the increased risk level of Precious Shipping Public Company Limited's shares in response to the negative market sentiment during the early stages of the pandemic.

**Table 1.** ES Value on China Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	002352.SS	S.F. Holding Co	-6,9038%
2	601919.SS	Cosco Shipping Holding	-10,7380%
3	601111.SS	Air China Limited	-8,0691%
4	600009.SS	Shanghai International Airport	-8,0719%
5	600029.SS	China Southern Airlines Company Limited	-7,6478%
6	600018.SS	Shanghai Internatinal Ports (Group) Limited	-7,3998%
7	601006.SS	Daqin Railway	-6,0551%
8	600115.SS	China Eastern Airlines Corporation Limited	-7,2834%
9	600221.SS	Hainan Airlines Holding Company Limited	-8,7836%
10	601018.SS	Ningbo Zhousan Port Company Limited	-7,7492%

**Table 2.** ES Value on India Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	ADANI PORT.NS	Adani Ports Special	-10,2028%
2	INDIGO.NS	Interglobe Aviation	-9,6263%
3	CONCOR.NS	Container Corporation	-8,4420%
4	GMRINFRA.NS	GMR Airports Infra	-9,8121%
5	BLUEDART.NS	Blue Dart Expres	-6,0679%
6	ALLCARGO.NS	All Cargo Logistic	-9,0925%
7	SCI.NS	Shipping CP India	-9,0624%
8	GESHIP.NS	Great Eastern Shipping	-8,6669%
9	VRLLOG.NS	VRL Logistic Ltd	-7,9539%
10	TCIEXP.NS	TCI Express Ltd	-8,5739%

**Table 3.** ES Value on Korea Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	JSMR.JK	Jasa Marga	-7,8508%
2	TMAS.JK	Temas Tbk	-11,1901%
3	CMNP.JK	Citra Marga Nushapala Persada	-10,0389%
4	SMDR.JK	Samudera Indonesia	-8,5673%
5	BIRD.JK	Blue Bird Tbk	-7,3396%
6	PSSI.JK	IMC Pelita Logistic Tbk	-8,4107%
7	SHIP.JK	Sillo Maritime Perdana Tbk	-7,5792%
8	PORT.JK	Nusantara Pelabuhan Handal Tbk	-17,0244%
9	META.JK	Nusantara Infrastructure Tbk	-9,1894%
10	MBSS.JK	Mitrabahtera Segara Sejati Tbk	-9,4984%

The average ES value of Thailand's transportation sector shares stands at 8.4703%. This relatively high ES value is primarily driven by historical data for each stock, reflecting the contraction experienced at the beginning of the Covid-19 pandemic, particularly during the early months of 2020.

**Table 4.** ES Value on Indonesia Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	011200.KS	Hunday Merc Mar	-10,3715%
2	003490.KS	KAL	-11,6773%
3	086280.KS	Huyundai Glovis	-7,6949%
4	097950.KS	CJ Cheiljedang	-8,3156%
5	028670.KS	Pan Ocean	-10,6360%
6	180640.KS	Hanjinkal	-15,4011%
7	006040.KS	Dongwon Ind	-6,8914%
8	089590.KS	Jeju Air	-10,2063%
9	020560.KS	Asiana Airlines	-14,2044%
10	004360.KS	Sebang	-7,7434%

**Table 5.** ES Value on Malaysia Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	3816.KL	MISC Bhd	-6,0974%
2	5246.KL	Wesport Holding Bhd	-7,2234%
3	5014.KL	Malaysia Airports Holding Bhd	-7,6735%
4	5099.KL	Capital A Bhd	-15,7471%
5	5032.KL	Bintulu Ports Holding Bhd	-6,9598%
6	0078.KL	Gdex Bhd	-11,3446%
7	0186.KL	Perak Transit Bhd	-8,3231%
8	5908.KL	DKSH Holding Bhd	-8,1930%
9	5140.KL	Tasco Bhd	-19,6401%
10	5173.KL	Shin Yang Shipping Corp Bhd	-12,8774%

**Table 6.** ES Value on Taiwan Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	2603.TW	Evergreen Marine Corp.	-11,7472%
2	2609.TW	Yang Ming Marine Transport Corp	-10,6717%
3	2615.TW	Wan Hai Line	-10,3568%
4	2633.TW	Taiwan high Speed Rail Corp	-4,8666%
5	2618.TW	Eva Airways	-9,5516%
6	2610.TW	China Airlines	-9,3753%
7	2637.TW	Wisdom Marine Line Co Limited	-9,5915%
8	2606.TW	U Ming Marine Transport Corp	-9,5012%
9	2607.TW	Evergreen Intl Storage Transport Co	-9,2552%
10	5607.TW	Farglory Free Trade Zone Investment	-8,1789%

**Table 7.** ES Value on Thailand Stocks

No	Issuers Code	Issuer	Expected Shortfall p=99%
1	AOT.BK	Airports of Thailand Public Company	-6,7316%
2	BEM.BK	Bangkok Expressway and Metro	-6,7932%
3	BTS.BK	BTS Group Holdings Public Company	-6,8212%
4	WHA.BK	WHA Corporation Public Company Limited	-9,2475%
5	AAV.BK	Asia Aviation Public Company Limited	-9,6587%
6	BA.BK	Bangkok Airways Public Company Limited	-8,6719%
7	RCL.BK	Regional Container Lines Public Company	-9,5073%
8	PSL.BK	Precious Shipping Public Company Limited	-12,8065%
9	BAFS.BK	Bangkok Aviation Fuel Services	-5,7602%
10	SJWD.BK	SCGJWD Logistic Public Company Limited	-8,7055%

## 4.2. Correlation

The results of calculating the correlation to returns between issuers of each country studied are presented in Table 8 to Table 14. And the following is an analysis of the correlation of returns between stocks in each country.

### 4.2.1. China

In general, there is a positive correlation among the returns of issuers in the transportation sector stock market in China, with correlation values ranging from 0.1850 to 0.9012. Issuers operating in related fields such as aviation and ports exhibit significant positive correlations.

For instance, Air China Ltd and China Southern Airlines have a correlation value of 0.9012, Air China Ltd and China Eastern Airlines have a correlation value of 0.8462, and Shanghai International Port and Ningbo Zhousan Port Ltd have a correlation value of 0.6050. These findings indicate that stock issuers within the same sub-sector tend to respond similarly to market conditions.

### 4.2.2. India

In India, issuers of transportation stocks generally exhibit a positive correlation, although the correlation values are relatively low, below 0.3. This suggests that there is limited mutual influence among the issuers in terms of market response to their respective shares.

### 4.2.3. Indonesia

In the Indonesian transportation stock market, the correlation values between issuers range from -0.0350 to 0.2775. This indicates the presence of a negative correlation between certain issuers, particularly the CMNP toll road company, and several issuers in the Port and container sub-sector, although the magnitude of the correlation is very small. Furthermore, the correlation among other positive issuers remains in a low range, suggesting that most issuers in the Indonesian transportation sector do not exert a strong influence on each other.

### 4.2.4. Korea

The transportation sector stock market in Korea exhibits a lack of significant influence among issuers, as indicated by the positive correlation values ranging from 0.0904 to 0.5812.

### 4.2.5. Malaysia

In Malaysia, a similar pattern is observed in the stock market for the transportation sector, with relatively low correlation values, even below 0.3. This suggests that the issuers in the Malaysian transportation sector do not have a significant impact on each other.

### 4.2.6. Taiwan

Conversely, the transportation sector stock market in Taiwan demonstrates a notable correlation and interdependence among issuers. The correlation values between these issuers exceed 0.5 and even surpass 0.8. Particularly, issuers engaged in marine shipping and ports show a strong influence on each other in responding to the stock market.

### 4.2.7. Thailand

Similarly to Malaysia, the transportation sector issuers in Thailand also exhibit a limited correlation in terms of market response. The correlation values among issuers in Thailand generally fall below 0.5, except for the correlation value of 0.5773 between Asia Aviation and Bangkok Airways, as well as the correlation values ranging from 0.5 to 0.65 between Bangkok Expressway & Metro, Airport of Thailand, and BTS Group Holding.

**Table 8.** Correlation between Chinese Stock Issuers

Correlation	S.F. Holding Co	Cosco Shipping Holding	Air China Limited	Shanghai Intl Airport	China Southern Airlines Co Ltd	Shanghai Intl Ports Ltd	Daqin Railway	China Eastern Airlines Co Ltd	Hainan Airlines Holding Co Ltd	Ningbo Zhousan Port Co Ltd
S.F. Holding Co	1,0000	0,2038	0,2479	0,2551	0,2658	0,2382	0,2382	0,1850	0,2688	0,2408
Cosco Shipping Holding		1,0000	0,3459	0,2293	0,3409	0,3775	0,2475	0,3564	0,1833	0,4005
Air China Limited			1,0000	0,4964	<b>0,9012</b>	0,3490	0,3720	<b>0,8463</b>	0,3458	0,3545
Shanghai International Airport				1,0000	0,4888	0,2845	0,2784	0,4719	0,2723	0,2529
China Southern Airlines Co Ltd					1,0000	0,3605	0,3743	<b>0,8682</b>	0,3623	0,3567
Shanghai International Ports Ltd						1,0000	0,3044	0,4093	0,2260	<b>0,6050</b>
Daqin Railway							1,0000	0,3872	0,2387	0,3210
China Eastern Airlines Co Ltd								1,0000	0,3657	0,3839
Hainan Airlines Holding Co Ltd									1,0000	0,2577
Ningbo Zhousan Port Co Ltd										1,0000

**Table 9.** Correlation between India Stock Issuers

Correlation	Adani Ports Special	Interglobe Aviation	Container Corporation	GMR Airports Infra	Blue Dart Expres	All Cargo Logistic	Shipping CP India	Great Eastern Shipping	VRL Logistic Ltd	TCI Express Ltd
Adani Ports Special	1,0000	0,2716	0,3267	0,3913	0,2278	0,2967	0,3451	0,2681	0,3018	0,2471
Interglobe Aviation		1,0000	0,2200	0,2679	0,1279	0,2125	0,2169	0,1742	0,2344	0,1889
Container Corporation			1,0000	0,3216	0,1958	0,2559	0,2679	0,1985	0,2718	0,1978
GMR Airports Infra				1,0000	0,2428	0,3062	0,3847	0,2317	0,2280	0,2278
Blue Dart Expres					1,0000	0,1616	0,1630	0,1336	0,1848	0,1681
All Cargo Logistic						1,0000	0,2774	0,2072	0,3566	0,2517
Shipping CP India							1,0000	0,3146	0,2383	0,2415

Great Eastern Shipping VRL	1,0000	0,1770	0,2104
Logistic Ltd TCI Express Ltd		1,0000	0,2281
			1,0000

**Table 10.** Correlation between Indonesia Stock Issuers

Correlation	Jasa Marga	Temas Tbk	Citra Marga Nushapala Persada	Samudera Indonesia	Blue Bird Tbk	IMC Pelita Logistic Tbk	Sillo Maritime Perdana Tbk	Nusantara Pelabuhan Handal Tbk	Nusantara Infrastructure Tbk	Mitrabahaatera Segara Sejati Tbk
Jasa Marga	1,0000	0,1241	0,0620	0,1968	0,2218	0,1334	0,0673	0,0353	0,1463	0,2106
Temas Tbk		1,0000	<b>(0,0350)</b>	0,2031	0,0560	0,0934	0,0494	0,0191	0,0514	0,1267
Citra Marga Nushapala Persada			1,0000	0,0502	0,0027	0,0093	<b>(0,0061)</b>	<b>(0,0151)</b>	0,0159	0,0762
Samudera Indonesia				1,0000	0,1462	<b>0,2755</b>	0,0857	0,0239	0,0688	0,2021
Blue Bird Tbk					1,0000	0,0693	0,0418	0,0259	0,1344	0,1296
IMC Pelita Logistic Tbk						1,0000	0,0382	<b>(0,0137)</b>	0,0820	0,1645
Sillo Maritime Perdana Tbk							1,0000	0,0259	0,0717	0,0166
Nusantara Pelabuhan Handal Tbk								1,0000	0,0076	<b>(0,0226)</b>
Nusantara Infrastructure Tbk									1,0000	0,0800
Mitrabahaatera Segara Sejati Tbk										1,0000

**Table 11.** Correlation between Korea Stock Issuers

Correlation	Hyundai Merc Mar	KAL	Hyundai Glovis	CJ Cheiljedang	Pan Ocean	Hanjinkal	Dongwon Ind	Jeju Air	Asiana Airlines	Sebang
Hyundai Merc Mar	1,0000	0,3428	0,2524	0,2393	<b>0,5075</b>	0,1499	0,1926	0,2986	0,2534	0,2567
KAL		1,0000	0,2792	0,3411	0,3934	0,3764	0,2050	<b>0,5812</b>	0,4821	0,2867
Hyundai Glovis			1,0000	0,2347	0,3453	0,1012	0,2004	0,2294	0,2103	0,2369
CJ Cheiljedang				1,0000	0,3516	0,1319	0,2795	0,2693	0,2621	0,2469
Pan Ocean					1,0000	0,1917	0,2201	0,3441	0,3201	0,3120
Hanjinkal						1,0000	0,0904	0,2488	0,2421	0,1643
Dongwon Ind							1,0000	0,2434	0,1697	0,1754
Jeju Air								1,0000	0,4772	0,2911
Asiana Airlines									1,0000	0,2301
Sebang										1,0000

**Table 12.** Correlation between Malaysia Stock Issuers

Correlation	MISC Bhd	Wesport Holding Bhd	Malaysia Airports Holding Bhd	Capital A Bhd	Bintulu Ports Holding Bhd	Gdex Bhd	Perak Transit Bhd	DKSH Holding Bhd	Tasco Bhd	Shin Yang Shipping Corp Bhd
MISC Bhd	1,0000	0,1782	0,2088	0,1410	0,0375	0,1128	0,1193	0,0769	0,0539	0,0686
Wesport Holding Bhd		1,0000	0,2256	0,1817	0,0386	0,1347	0,1371	0,0985	0,0502	0,0882
Malaysia Airports Holding Bhd			1,0000	0,4224	0,0789	0,1129	0,1075	0,1723	0,1184	0,1085
Capital A Bhd				1,0000	0,0759	0,1479	0,1738	0,1582	0,0833	0,1042
Bintulu Ports Holding Bhd					1,0000	0,0156	0,0379	0,0883	0,0355	0,0004
Gdex Bhd						1,0000	0,1976	0,1511	0,1271	0,2540
Perak Transit Bhd							1,0000	0,1114	0,0904	0,2036
DKSH Holding Bhd								1,0000	0,0774	0,0809
Tasco Bhd									1,0000	0,1769
Shin Yang Shipping Corp Bhd										1,0000

**Table 13.** Correlation between Taiwan Stock Issuers

Correlation	Evergreen Marine Corp.	Yang Ming Marine Transport	Wan Hai Line	Taiwan high Speed Rail Corp	Eva Airways	China Airlines	Wisdom Marine Line Co Ltd	U Ming Marine Transport Corp	Evergreen Intl Storage Trans Co	Farglory FTZ Investment
Evergreen Marine Corp.	1,0000	<b>0,8168</b>	<b>0,7574</b>	0,2903	0,4126	0,4153	<b>0,6409</b>	<b>0,6063</b>	<b>0,6219</b>	0,3506
Yang Ming Marine Transport		1,0000	<b>0,7050</b>	0,2783	0,4004	0,3972	<b>0,6206</b>	<b>0,5864</b>	<b>0,5917</b>	0,3783
Wan Hai Line			1,0000	0,2574	0,3974	0,4110	<b>0,6630</b>	<b>0,6049</b>	<b>0,6243</b>	0,3598
Taiwan high Speed Rail Corp				1,0000	0,4083	0,3833	0,3039	0,3109	0,2679	0,2933
Eva Airways					1,0000	<b>0,8495</b>	0,4249	0,4277	0,4189	0,4039
China Airlines						1,0000	0,4259	0,4319	0,4353	0,3899
Wisdom Marine							1,0000	<b>0,7432</b>	<b>0,6276</b>	0,3714

Correlation	Evergreen Marine Corp.	Yang Ming Marine Transport	Wan Hai Line	Taiwan high Speed Rail Corp	Eva Airways	China Airlines	Wisdom Marine Line Co Ltd	U Ming Marine Transport Corp	Evergreen Intl Storage Trans Co	Farglory FTZ Investment
Line Co Ltd										
U Ming Marine Transport Corp								1,0000	<b>0,6105</b>	0,4126
Evergreen Intl Storage Trans Co									1,0000	0,4405
Farglory FTZ Investment										1,0000

**Table 14.** Correlation between Thailand Stock Issuers

Correlation	Airports of Thailand	Bangkok Expressway and Metro	BTS Group Holdings	WHA Corporation Public	Asia Aviation	Bangkok Airways	Regional Container	Precious Shipping	Bangkok Aviation Fuel Services	SCGJWD Logistic
Airports of Thailand	1,0000	<b>0,5255</b>	<b>0,5798</b>	0,4874	0,4522	0,3709	0,1592	0,2462	0,4956	0,2802
Bangkok Expressway and Metro		1,0000	<b>0,6462</b>	0,4687	0,3627	0,3474	0,1935	0,2375	0,4053	0,3123
BTS Group Holdings			1,0000	0,4706	0,3894	0,3579	0,1811	0,2469	0,3861	0,2935
WHA Corporation Public				1,0000	0,4187	0,3670	0,1670	0,2886	0,4040	0,3643
Asia Aviation					1,0000	<b>0,5773</b>	0,2149	0,3047	0,4456	0,2603
Bangkok Airways						1,0000	0,2328	0,2173	0,4011	0,2765
Regional Container							1,0000	0,4506	0,2026	0,2481
Precious Shipping								1,0000	0,2645	0,2769
Bangkok Aviation Fuel Services									1,0000	0,2444
SCGJWD Logistic										1,0000

#### 4.3. Forecasting Simulation

To ensure the suitability of the selected GARCH model for forecasting simulations, it is essential to calculate specifications and fittings. By examining the values of the  $\alpha$  and  $\beta$  parameters and the significance of the p-value for the chosen specifications, it has been determined that the standard GARCH model with ARFIMA (0,0,0) in the normal distribution is suitable for forecasting the data returns of each issuer.

The simulation results, including estimated stock price movements and projected returns, for issuers from each country, are presented in Figures 1 to 7. Below is an analysis of the simulation outcomes for stock price movements in each country.

#### 4.3.1. *China*

There are several issuers in China's transportation sector that show potential for an increase in share prices in the next 100 days. These include Cosco Shipping Holding, Shanghai International Airport, Shanghai International Ports Ltd, and China Eastern Airlines Co Ltd. However, there are also issuers that are projected to maintain a relatively stable share value by the end of 2022.

Specifically, Hainan Airlines Holding Co. Ltd is anticipated to experience a potential decrease in its share price within the first 100 days of 2023. On the other hand, Ningbo Zhousan Port Co. Ltd. has the potential for an increase, but its prices are expected to remain within the range of their value at the end of 2022.

#### 4.3.2. *India*

It is estimated that most issuers in India's transportation sector will not undergo significant fluctuations in stock trading for the next 100 days.

#### 4.3.3. *Indonesia*

Jasa Marga, Nusantara Infrastructure Tbk, and Mitrahahtera Segara Sejati Tbk are expected to have potential share price increases. However, other issuers are likely to experience stagnation, with their share value remaining relatively close to their value at the end of 2022.

#### 4.3.4. *Korean*

KAL and Hanjin Kal are among the transportation sector issuers in Korea that could potentially experience upward price movements. However, while some other issuers may see fluctuations in the first 100 days of 2023, they are expected to remain relatively stagnant.

#### 4.3.5. *Malaysia*

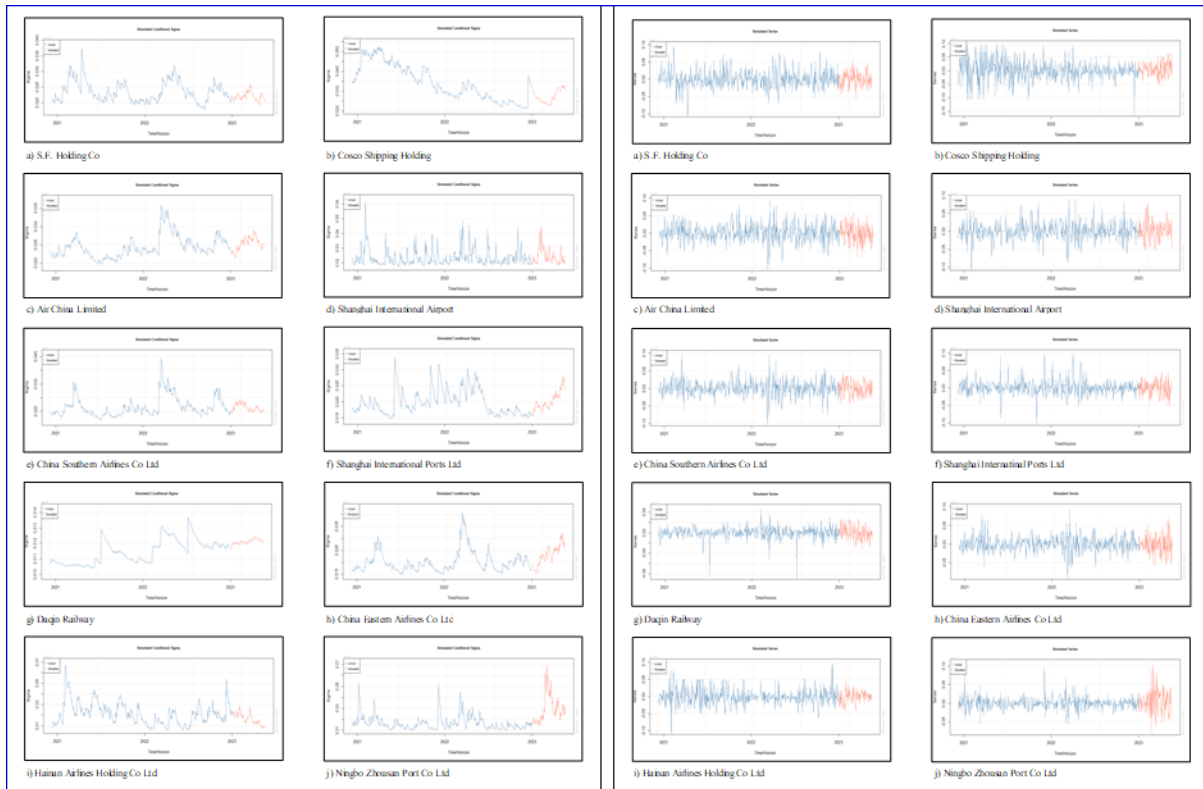
Malaysia Airports Holding Bhd, Bintulu Port Holding Bhd, and Perak Transit Bhd from the Malaysian stock market have the potential for fluctuations in the value of active shares and ongoing upward movement for at least the next 100 days. Meanwhile, other issuers experienced minor changes in value that were not significant or tended to remain relatively stable compared to their share value at the end of 2022.

#### 4.3.6. *Taiwan*

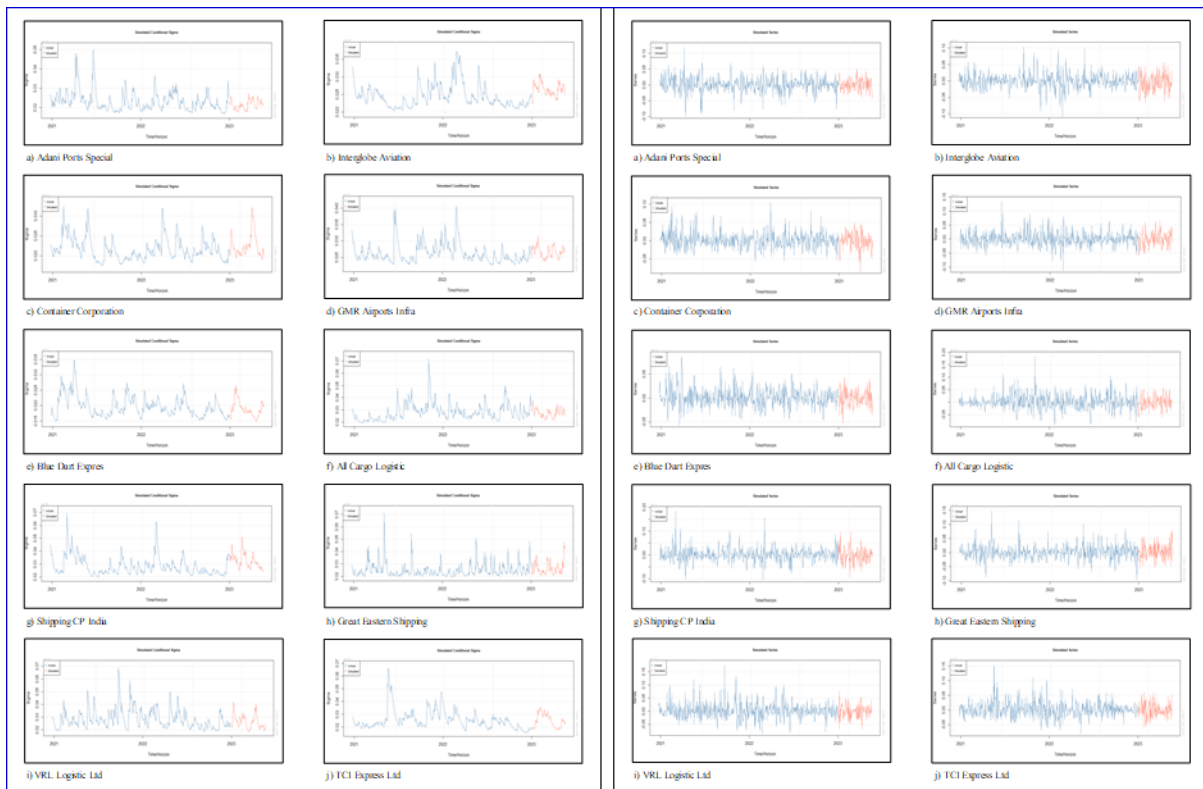
In Taiwan, Eva Airways is an issuer in the transportation sector that could experience significant positive movements. However, other issuers, despite experiencing varying levels of volatility, have the potential for relatively smaller share price increases over the next 100 days.

#### 4.3.7. *Thailand*

The stock market for the transportation sector in Thailand, according to the simulation results of stock movement forecasting for the first 100 days of 2023, is generally relatively stable in terms of share price movements for all its issuers.



**Figure 1.** Conditional Sigma and Volatility Simulation for the next 100 days of Chinese Issuers



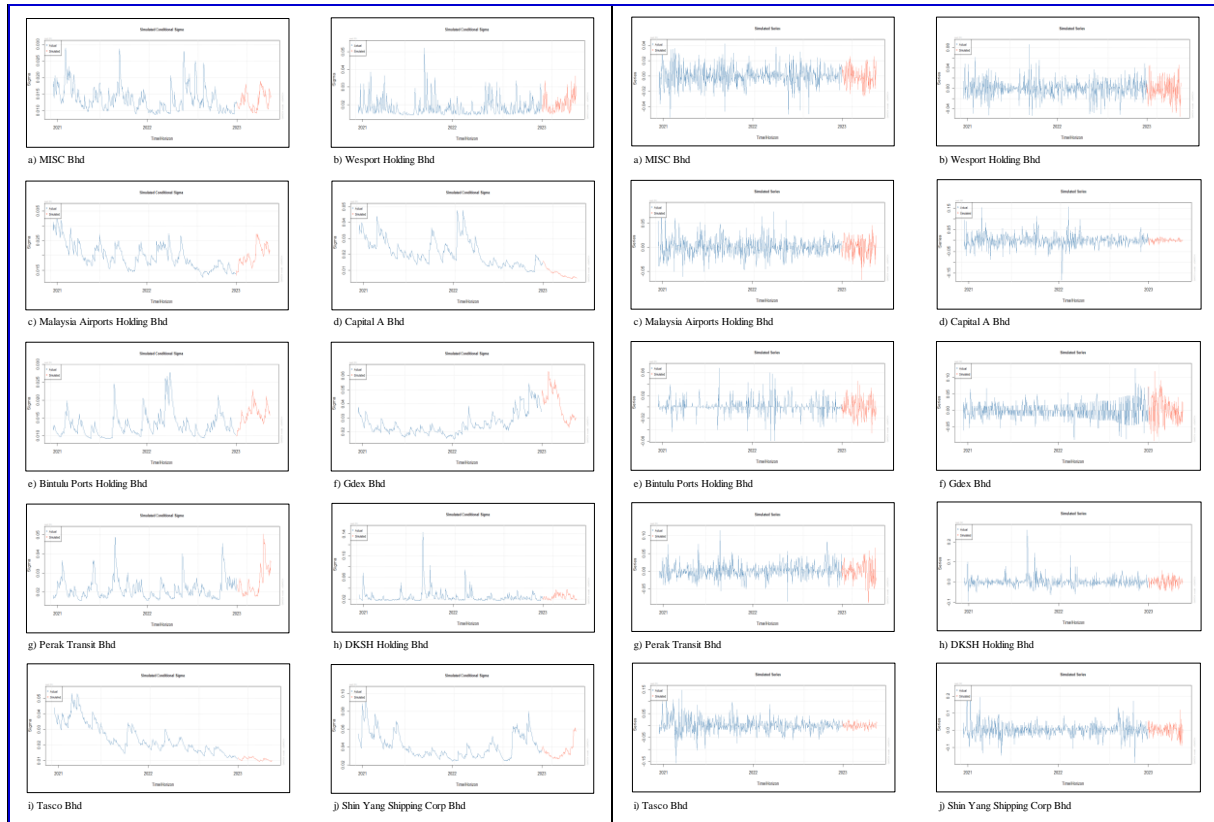
**Figure 2.** Conditional GMR Sigma and Volatility Simulation for the next 100 days of Indian Issuers



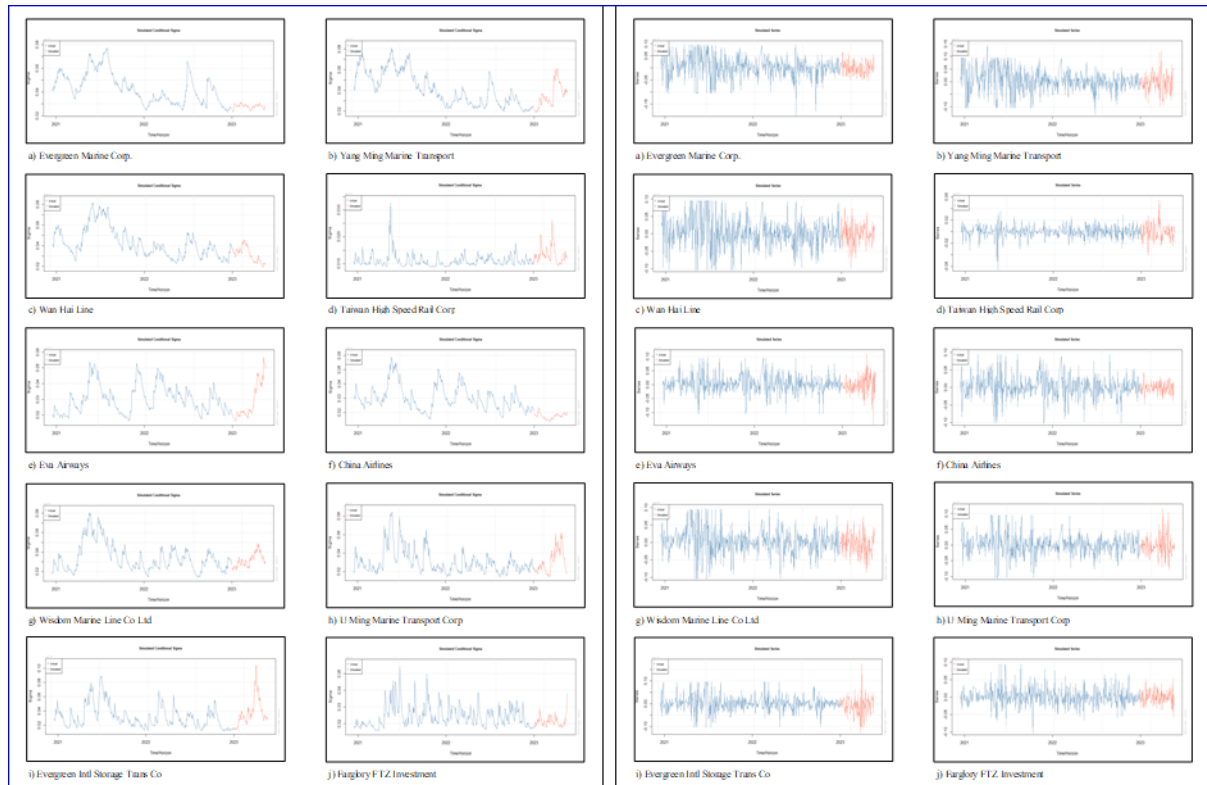
**Figure 3.** Conditional Sigma and Volatility Simulation for the next 100 days of Indonesia Issuers



**Figure 4.** Conditional Sigma and Volatility Simulation for the next 100 days of Korean Issuers



**Figure 5.** Conditional Sigma and Volatility Simulation for the next 100 days of Malaysian Issuers



**Figure 6.** Conditional Sigma and Volatility Simulation for the next 100 days of Taiwan Issuers



**Figure 7.** Conditional Sigma and Volatility Simulation for the next 100 days of Thailand Issuers

## 5. Conclusion

The Expected Shortfall (ES) value of transportation stock issuers experienced a significant increase following the onset of the Covid-19 pandemic in early 2020, except for issuers in the Chinese stock market. This increase in risk, as indicated by the ES value, was primarily driven by the negative market response and return volatility data during the early phase of the pandemic. However, for transportation stock issuers in China, although the average ES value was relatively high, it was not influenced by the Covid-19 pandemic but rather reflected natural risks associated with the specific issuers.

The correlation between transportation stock issuers in several Asian emerging market countries during various stages of the Covid-19 pandemic showed generally low values, indicating a lack of significant mutual influence among issuers in the transportation sector. However, notable exceptions were observed in the Chinese and Taiwanese stock markets, where a relatively strong positive correlation was observed within the same sub-sectors, particularly in air transportation and land transportation, with correlation coefficients ranging from 0.6 to 0.9. Similarly, in the Thai stock market, while most issuers exhibited relatively weak positive correlations, issuers within the same sub-sector demonstrated higher correlation coefficients (ranging from 0.5 to 0.8), particularly in the air transportation sub-sector.

The results of research related to forecast simulations of stock price movements over the next 100 days indicate that, in general, the price movements and stock returns of transportation sector issuers in Asian emerging market stock markets tend to follow the trend observed in the final period of 2022, with a few exceptions in the Chinese stock market. Issuers such as Cosco Shipping Holding, Shanghai International Airport, Shanghai International Ports Ltd., and China Eastern Airlines Co Ltd. have the potential for positive movements in their share prices, while Hainan Airlines Holding Co Ltd. is expected to experience a potential decline. On the Indonesian stock market, issuers of Jasa Marga shares, Nusantara Infrastructure Tbk, and Mitrahahtera Segara Sejati Tbk could potentially experience increased returns. In Korea, issuers such as KAL and Hanjin Kal also have the potential for share price increases over the next 100 days. Similarly, issuers like Malaysia Airports Holding Bhd, Bintulu Port Holding Bhd, and Perak Transit Bhd are likely to see potential increases in stock prices on the Malaysian stock market. Eva Airways on the Taiwan stock market is expected to experience similar trends.

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