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Dynamic Interaction Between NASDAQ Composite Index and Korean Composite Index

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Abstract: The interaction between global stock markets has significant implications for international capital flow, risk diversification, and currency exchange rates, and it also has a substantial impact on global economic growth. This paper aims to explore the dynamic interaction and mutual influence between the Korean Composite Index (KOSPI) and the Nasdaq Composite Index (IXIC) To provide guidance and assistance to investors and corporate decision makers. This paper uses data from Jan 4, 2022, to Dec 28, 2023. By constructing VAR model, KOSPI and IXIC are analyzed, and pulse analysis and variance decomposition are used for further analysis. According to the impulse response analysis, the influence of the IXIC on the KOSPI will last for four cycles. At the same time, it is found that the influence of the KOSPI on the IXIC will last for four cycles. The variance decomposition results show that the IXIC can explain 19.33% of the market change of the KOSPI, while the KOSPI can explain 6.38% of the market change of the Nasdaq index. This study focuses on the dynamic interaction between the KOSPI and NASDAQ, filling the gap in this area of research, and providing relevant views and ideas for investors and corporate decision makers around the world.

Keywords: VAR, NASDAQ Composite Index, Korean Composite Index.

1. Introduction

In today's era of accelerating globalization, the dynamic interactions between financial markets have become increasingly important. The mutual influence between markets is not only reflected in daily price fluctuations, but also more deeply in the long-term development trends and structural adjustments of economies in various countries. Therefore, exploring the linkage between different market indices is of great significance for understanding the operating laws of the global economy, predicting market trends, and formulating effective investment strategies.

In recent years, there have been many studies on various market relationships. For example, the research of Mensi et al. have shown that the stock markets of BRICS countries are less affected by political and economic factors in the United States [1]. Wang et al. discover that the stock market has a greater spillover effect on the foreign exchange market and emphasized the risk contagion effect of the French stock market on Asian stock markets [2]. In addition, the empirical findings of Bai et al. suggest that the outbreak of infectious diseases has a significant positive effect on the long-term volatility of international stock markets, emphasizing the explanation of how global economic events affect the market [3]. Besides, Zhang et al. found that geopolitical risks have a significant positive

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impact on stock market volatility, emphasizing the influence of political factors on the global economy [4]. Previous research has extensively discovered the connections between global stock markets and various factors such as politics, economy, and global events. But the lack of stock market volatility has a direct impact on the mutual dynamics between countries. As the world's largest economy, the United States has extraordinary influence globally, while South Korea is one of the few developed countries in Asia with strong representation. At the same time, there are significant cultural, economic, and political differences between the United States and Asia. Therefore, this article chooses the stock markets of South Korea and the United States as the research objects.

This article conducts a detailed analysis of the returns of the KOSPI and IXIC in 2022 and 2023 using VAR models, impulse response analysis, and contrast decomposition, filling in the gaps in previous research and providing better investment advice and risk management ideas for investors and managers.

2. Data Collection

This article uses data were found on site: Yahoo Finance. The study selected the performance from Jan 4,2022 to Dec28,2023 for a two-year period. During the data processing, some data that did not match the time was excluded, so the total sample size of the study was 473 data sets. The daily closing price data was found to be non-stationary, and the VAR model requires stationary time series data in order to obtain the correct answer. Therefore, this study used the daily closing price of the KOSPI and the IXIC to calculate the daily return of the KOSPI and the IXIC as the final experimental data. The basic features of the data are shown in Table 1 below.

Table 1: Descriptive statistics of the selected assets

	KOSPI	IXIC
Mean	0.9998	0.9998
Variance	0.0001	0.0003
Max	1.0566	1.0735
Min	0.9648	0.9484

The data in the table shows that the return of the IXIC is slightly higher than that of the KOSPI, but the return of the latter is more stable. The range of returns for the IXIC is larger, and its variance is higher, resulting in much lower stability than that of the KOSPI.

3. Methods

Sims first proposed and proved the feasibility of VAR in analyzing economic problems and explained how VAR models analyze the dynamic relationships between economic variables [5]. This paper uses the VAR model in the process of studying the KOSPI and the IXIC. As an efficient research tool, VAR model has been widely taken use of in the field of economic research in recent years, which can deal with multiple groups of interacting time series type data. The return changes of the KOSPI and the IXIC conform to the type of time series data, and the VAR model can be used to conduct the dynamic interaction between the two. The data representation of the VAR model used in this paper is as followed.

$$Rt_K = u_K + \sum_{i=1}^{p} \beta_{I1,i} R_{IXIC,t-i} + \sum_{i=1}^{p} \beta_{K1,i} R_{KOSPI,t-i} \quad (1)$$

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$$Rt_I = u_I + \sum_{i=1}^{p} \beta_{I2,i} R_{IXIC,t-i} + \sum_{i=1}^{p} \beta_{K2,i} R_{KOSPI,t-i} \quad (2)$$

For this VAR model, Rt_K denotes the KOSPI return at time, Rt_I denotes the IXIC return at time u_K and u_I are constants, $\beta_{I1,i}$, $\beta_{K1,i}$,i, $\beta_{I2,i}$, $\beta_{K2,i}$ are coefficients to be estimated, ϵ 1,t, ϵ 2,t Represent error terms, p is the number of lags included in the model.

The use of impulse response functions can better analyze the dynamic impact of a variable in a VAR model when it is subjected to an "exogenous shock" on other variables. It is an important tool for studying the dynamic impact relationship between variables, especially suitable for analyzing the mutual influence between market indices.

By analyzing the IRFs between the KOSPI and the IXIC, we can gain a deeper understanding of the interaction mechanism between these two market indices, as well as how changes in one market affect the other.

4. Result

4.1. ADF

Before using the VAR model to analyze the dynamic interaction between the KOSPI and the IXIC, it is necessary to ensure that the time series data used in the analysis is smooth. Using VAR models requires modeling the correlations or contemporaneous relationships between time series [6]. Only stationary time series can be analyzed using VAR model. In this paper, the unit root test is used for the data of IXIC and KOSPI to determine whether the data obtained in this paper meets the basic requirements of stability. The ADF test results are shown in Table 2. It is easy to see that the p values of both KOSPI and IXIC are less than 0.01 at the critical values of 1%, 5% and 10%. Therefore, the null hypothesis of the existence of unit root is rejected. The KOSPI and the IXIC are both flat.

Table 2: Unit Root Test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistics-IXIC		-22.5234	0.0000
Text critical values:	1% level	-3.9776	
	5% level	-3.4194	
	10% level	-3.1323	
Augmented Dickey-Fuller test statistics-IXIC		-21.6847	0.0000
	1% level	-3.9776	
	5% level	-3.4194	
	10% level	-3.1323	

4.2. VAR Stability

The stability of VAR model will affect the predictive ability and statistical properties of the model, so it is necessary to judge the stability of VAR model when using VAR model for analysis [7]. In this paper, unit circle is used to test the stability of VAR model. The Figure 1 shows the unit circle test results.

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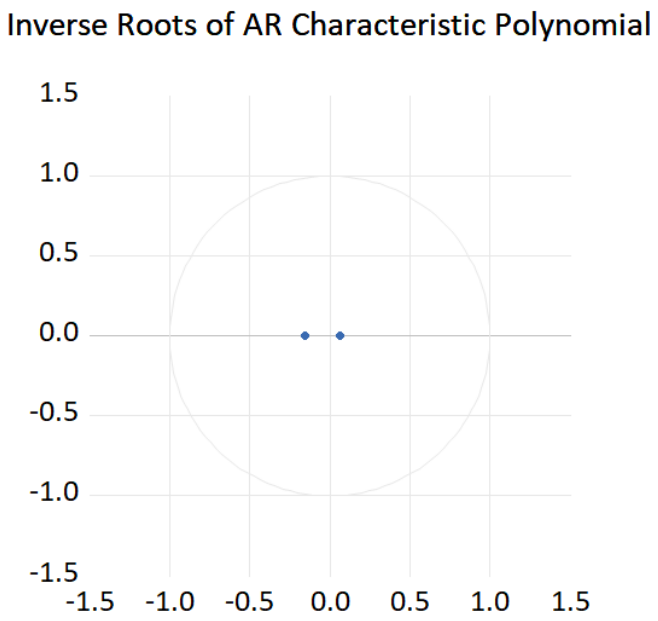

Figure 1: VAR stability test judgement for IXIC and KOSPI

It is found that the feature roots of the VAR model are all less than 1, and the feature roots of all variables fall in the garden. The model constructed in this paper is effective.

4.3. Impulse Response

Impulse Response Function (IRF) is an important tool for analyzing and understanding the dynamic interaction between variables in a system. Impulse response function can reveal the dynamic response of various variables in a time series system when it is subjected to an exogenous shock [8]. The short-term and long-term effects of shocks on system variables can be analyzed using IRF. The dynamic interaction between the KOSPI and the Nasdaq Composite is a very systematic one, and IRF can help understand and visualize the interaction between them. The Figure 2 and the Figure 3 show the application of impulse response in the research process of this paper. The horizontal axis shows the number of cycles after the pulse, and the vertical axis shows the level of response after the shock. The solid line represents the path of the impulse response, and the two dashed lines represent the confidence interval at the 95% level.

Figure 2 shows the level of influence of the IXIC on the KOSPI in different cycles. The Nasdaq's influence on the KOSPI will last for five cycles. In the first two cycles, the influence of the IXIC on the KOSPI gradually increased, in the latter three cycles, the influence of the IXIC continued to decrease, and after the fifth cycle, it went to 0. In the whole process of pulse influence, there are alternating fluctuations of positive influence and negative influence.

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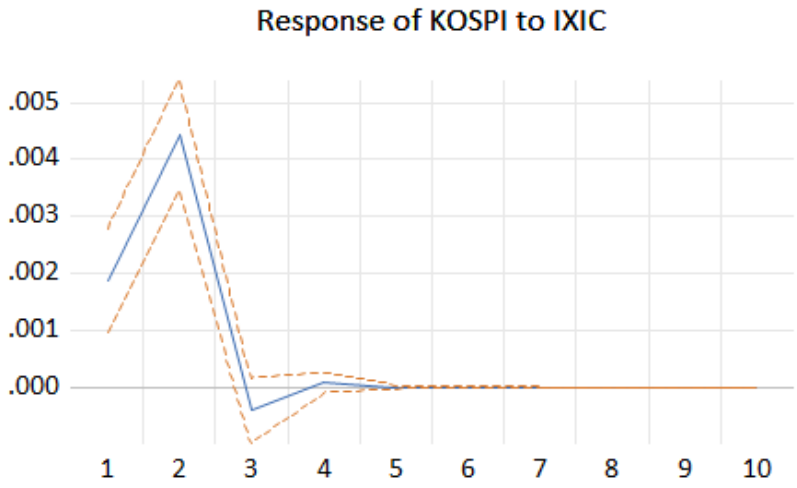

Figure 2: impulse response of KOSPI to IXIC

Figure 3 shows the level of influence of the IXIC by the KOSPI over different periods. The KOSPI's influence on the Nasdaq lasted only four cycles. At the beginning, the pulse impact of the KOSPI on the IXIC was almost non-existent, equal to about 0, and reached the maximum immediately in the second cycle, and then fell rapidly and showed a negative correlation in the third stage, and the pulse impact reached 0 in the fourth cycle.

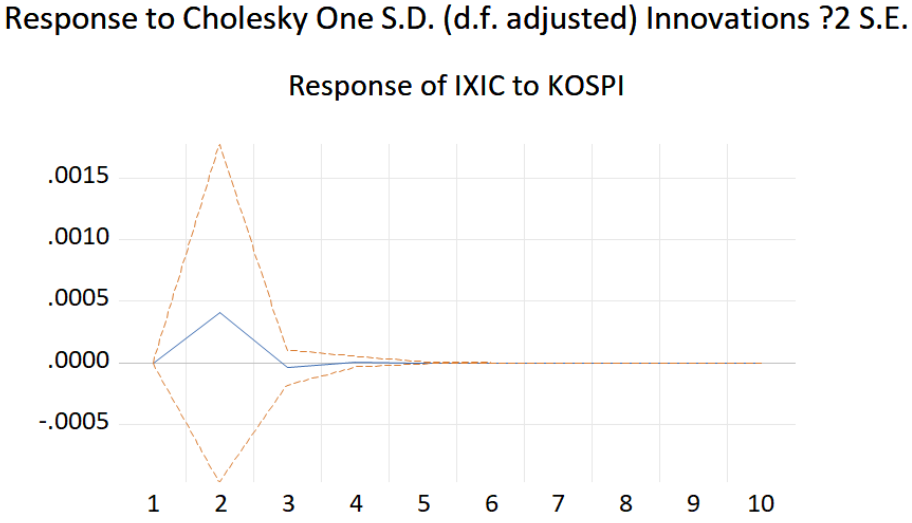

Figure 3: impulse response of IXIC to KOSPI

4.4. Variance Decomposition

Variance decomposition is another important analysis tool in VAR models, which is used to evaluate which other variables influence the prediction error variance of each variable [9]. Quantify the contribution of each explanatory variable to the total variance by decomposing the variance of the

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prediction error (how much of the error is caused by other variables in the model) [10]. The variance decomposition results are shown in Table 3 and Table 4.

Table 3: Variance Decomposition of KOSPI (%)

Period	S.E.	KOSPI	IXIC
1	0.0010	100.0000	0.0000
2	0.0110	83.3911	16.6089
3	0.0110	83.2643	16.7357
4	0.0110	83.2594	16.7406
5	0.0110	83.2593	16.7407
6	0.0110	83.2593	16.7047
7	0.0110	83.2593	16.7407
8	0.0110	83.2593	16.7407
9	0.0110	83.2593	16.7407
10	0.0110	83.2593	16.7407
Cholesky Ordering: KOSPI IXIC			

As the cycle continues to advance, the volatility of the IXIC can ultimately explain the fluctuations of around 16.74% in the KOSPI.

Table 4: Variance Decomposition of IXIC (%)

Period	S.E.	KOSPI	IXIC
1	0.0100	3.4668	96.5332
2	0.0110	3.4996	96.5004
3	0.0110	3.4991	96.5009
4	0.0110	3.4991	96.5009
5	0.0110	3.4991	96.5009
6	0.0110	3.4991	96.5009
7	0.0110	3.4991	96.5009
8	0.0110	3.4991	96.5009
9	0.0110	3.4991	96.5009
10	0.0110	3.4991	96.5009
Cholesky Ordering: KOSPI IXIC			

As the cycle continues to advance, the final volatility of the KOSPI can explain around 3.50% of the volatility of the IXIC.

5. Conclusion

The South Korean stock market and the US stock market have a clever dynamic interaction, with the impact of the IXIC and the South KOSPI on each other lasting for four cycles. At the same time, the impact of the IXIC on the KOSPI is greater than the impact of the KOSPI on the IXIC.

In the future, research can continue to conduct more in-depth analysis from the perspectives of exchange rates, investment decisions, and risk management, in order to determine the dynamic interaction level between the South KOSPI and the IXIC at what exchange rate levels the US dollar and the Korean won experience. How investors can adjust their future investment portfolios at different times to achieve higher levels of returns and reduce international investment risks.

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