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Determinants of Stock Market Performance: VAR and VECM Designs in Korea and Japan

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ABSTRACT

We examine commodities and macroeconomic factors of the Korean' and Japanese' stock market performance during the period of 1993-2017. Using both Kospi and Nikkei 225 as proxy for stock market performance, we designed a Vector Error Correction Model (VECM) which integrates the econometric model in the short- and long-run. We found that the Korean and Japanese stock market reflects both macroeconomic variables and commodity prices on stock price indices. Our results reveal that each stock market index, GDP growth, inflation rate, interest rate, exchange rate, crude oil WTI price, and gold price perform a cointegration in the long-term, suggesting that Kospi and Nikkei 225 are corrected in -19.6% and -39.6% in each quarter, respectively. In addition, GDP growth, interest rate, exchange rate, oil price, and gold price affect the Kospi short-run performance, while GDP growth, interest rate, and gold price affect Nikkei 225 in the short-term. Using impulse-response function and the variance decomposition, we identified that the most significant impulse on each stock market index is its own shock, and its magnitude declines from the short- to the long-run. Our results are mostly consistent with the experience of other countries, especially Turkey and India, meaning the stock market index has been particularly affected by its own past prices. Our paper complements the literature of corporate finance by comparing the determinants of stock market performance of two Asian countries, including different robustness tests to explain the effect on Kospi and Nikkei 225 of each independent variable. For future research, the authors suggest to include a dummy variable for structural changes to increase the power of the model.

Keywords: Stock Market Performance, Vector Error Correction Model (VECM), Macroeconomic Variables, Commodity Prices.

1. Introduction

Stock market performance is a multi-dimensional investment concept for sellers and buyers of securities since it represents the center of network transactions at a specific price. The stock market plays a key

role in the mobilization of capital in emerging and developing countries, increasing their industry growth and their commerce, as a consequence of liberalized and globalized policies adopted by most of nations (Rakhal, 2018). The free market economy is composed of the stock market and it helps to manage companies' capital from shareholders to investors through the exchange of shares and their ownership. Capital markets facilitate funds movement between saving agents to borrowing agents. Both economic and financial theories argue that stocks' prices are affected

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by the performance of the main macroeconomic variables. The theoretical approach suggests that the performance of the capital market is affected, either positively or negatively, by the overall activity (Al-Majali & Al-Assaf, 2014). Capital markets play a vital role in achieving sustainable economic growth, and its improvement reflects the degree to which the domestic economy is developed and competitive. The capital market is considered as a mirror for economic activity. Stock market indexes typically provide the overall performance of the market or of a specific sector, which gives a signal to the investors about their future movements according to the price impact costs of their decisions. Therefore, when the information asymmetry decreases, the trading costs might be similar between uninformed and institutional traders (Park, 2018), which increases the necessity to analyze the macroeconomic indicators of the market. For instance, if the price of a particular stock is rising, then it is perceived as certain positive news or signals, which are known as bullish perceptions. Contrary, if the price decreases, the market identified it as negative signals called bearish perceptions. Thus, the stock price and index movements indicate the general economic trend of a country, they act as the barometer of the economy as a whole, and they are affected by plenty of factors such as economic, political, international, company-specific, and industry-specific determinants.

However, it is generally complicated to identify the effective factors that affect the stock price index. Stock price movements are affected by market sentiments or expectations about future economic growth trajectory, monetary, and fiscal policy announcements (Singh, 2010). Moreover, the regulatory system of a country and its stock market plays an important role in stock appreciation and depreciation, which aggressively and conservatively affects financial reporting (Boylan, 2015). Therefore, there are no one-size fit specific factors for the stock market performance. Several studies investigate the link between economic variables and stocks' prices, and they can be classified into two groups. The first group considers the effect of macroeconomic factors on

stock prices, while the second group focuses on the link between the stock market volatility and the volatility in macroeconomic indicators. This study is based on the first group since macroeconomic determinants are included in the fundamental analysis of listed companies and this information is transferred to their stock market performance, providing insights into the financial health of firms and their stock's trend. Therefore, investors cannot ignore macro factors within the current economic environment because they can adjust their portfolio to lessen portfolio losses or maximize profits, rising the likelihood of stock valuation and providing confidence signals of the future firm's performance (Tulcanaza-Prieto & Lee, 2019).

In this context, this paper will examine how the main macroeconomic variables, namely GDP growth, inflation rate, interest rate, and exchange rate, and commodities prices such as crude oil WTI price and gold price might affect the stock market index performance in Korea and Japan in the short- and long-run. We will construct both Vector Autoregressive (VAR) model and Vector Error Correction Model (VECM) using quarterly observations from 1993-Q1 (quarter 1) to 2017-Q4 (last quarter) in order to (i) investigate the impulse-response functions to Kospi and Nikkei 225 caused by one standard deviation shock in the remaining variables, (ii) analyze the components of the variance decomposition in the Korean' and Japan's stock market index to verify the structural regularities in the short- and long-term, (iii) identify the existence of long-run cointegration between all variables through Johansen cointegration test, and (iv) determine the short-run causality between all variables.

This study differs from previous investigations since it integrates and provides different statistical test to reinforce the short- and long-term causality between all variables, it calculates the estimated error correction term, which is the speed of adjustment towards equilibrium for Kospi and Nikkei 225, and it compares findings between two Asian countries. Our findings reveal that all seven variables are cointegrated and perform a long-term equilibrium

relationship. In the short-run, Kospi is affected by GDP growth, interest rate, exchange rate, oil price, and gold price, whereas, GDP growth, interest rate, and gold price are the significant variables that affect Nikkei 225. Furthermore, both stock market indexes have been affected by their own past prices (own shock), and their magnitude declines from the short-to the long-run.

The role of the stock market in the economy is to increase capital and to ensure that the funds raised are utilized in the most profitable opportunities. Our study provides empirical evidence of the effects of macroeconomic variables and commodities prices on Kospi and Nikkei 225 since we shed light on how stock market indexes adjust their value in response to changes in the macro-information environment. Our empirical study performs the necessary analysis to answer whether changes in the identified macroeconomic variables and commodities prices affect stock prices in Korea and Japan. Furthermore, our study has a practical significance because a deeper understanding of the behavior of the stock market will allow firms and economic agents to work more efficiently, which is aligned with the efficient market hypothesis. By gaining knowledge about the nature of the relationship between macroeconomic, commodities prices, and stock market indexes, governments can stabilize the stock market and the economy as a whole, which will attract more investors as well as firms and will help control bad economic situations.

The rest of the paper is composed of four sections. The first presents the literature review and the development of hypothesis. The second section shows the research methodology. The third provides empirical results. Finally, the last section analyses the findings and summarizes the outcome of this study before covering conclusions and recommendations for future research.

II. Determinants of Stock Market Performance

Economic theory suggests that there should be a strong link between economic activity and securities prices, given that, the stock price is the discounted present value of the firm's payout, which is based on the investor's expectations. Therefore, many authors have been investigated the relationship between the stock index and macroeconomic variables. Hsing (2011) examines the macroeconomic determinants of Hungary's stock market index using quarterly sample data for the period 2000-2010. His findings reveal a positive relationship between real GDP and the stock market index (Hsing, 2011). Similarly, Levine and Zervos (1996), based on the data of 24 countries over the period 1976-1993, identify that stock market development is strongly positively correlated with economic growth (Levine & Zervos, 1996). In addition, Beck and Levine (2004), using the Generalized Method of Moments (GMM) of 40 countries for the period 1976-1998, demonstrate a strong positive relationship between the stock market development and the economic growth (Beck & Levine, 2004). However, Dimson, Marsh and Staunton (2002), using a sample of stock markets returns from 1900 to 2000 for 16 developed countries, find that over long periods of time, stock market returns are negatively related to GDP growth rate (Dimson, Marsh, & Staunton, 2002). Kwon and Shin (1999) study the relationship between the Korean stock market index and GDP growth employing the Error Correction Model (ECM). Their results indicate that there is a cointegration relationship between the stock index, GDP growth, and other macroeconomic variables, nevertheless, the stock index is not the leading variable of the economic fluctuation (Kwon & Shin, 1999).

Specifically, using VAR model, Lee (1992) finds that stock returns help to interpret the real activity in the post-war in the United States, while stock returns explain little variation in inflation, contrary, to the strong relationship with the interest rates' variation (Lee, 1992). Mariano and Gong (1997)

investigate the relationship between stock market returns and macroeconomic variables such as inflation rate, growth indices of manufacturing industry, money supply, and others. The authors estimate a restricted and an unrestricted VAR model to analyze the variations of expected and unexpected returns in the Korean stock market, respectively. Their results indicate a considerable predictive ability for both real economic activity and real returns (Mariano & Gong, 1997). Maysami, Howe, and Hamzah (2004) find a negative long-term relationship between the inflation rate and the performance of the stock market index in Singapore. The authors mention that rising inflation is more likely to lead policymakers to tighten policies, generating an effect on the nominal risk-free rate, which increases the discount rate. Thus, the higher inflation rate causes a downward trend in stock prices in Singapore (Maysami, Howe, & Hamzah, 2004).

Beer and Hebein (2008) employ Exponential General Autoregressive Conditional Heteroskedasticity method to explain the relationship between stock prices and exchange rates using data from emerging and developed countries. Their results indicate a positive significant effect from the exchange rate to the stock market price in Canada, Japan, the United States, and India. Furthermore, for advanced nations, their research shows no persistence of volatility in the stock' and exchange rate' markets, oppositely, to the pronounced volatility between both markets in emerging economies (Beer & Hebein, 2008). Similarly, Maysami, Howe, and Hamzah (2004) argue that appreciation in the currency would attract investment pushing up the stock market prices. The authors prove a positive relationship between the Singapore stock market and the exchange rate (Maysami et al., 2004). Shoil and Zakir (2011) consider the short-run' and long-run' dynamic relationship between the Karachi Stock Exchange 100 Index from the Pakistan Stock Exchange and five macroeconomic variables. Using Johansen cointegration technique for the long-run term, the authors demonstrate the positive effect of GDP growth, inflation rate, and exchange rate on KSE 100 Index, while money supply and three-month treasury bills rate affect negatively the Pakistani stock

return (Shoil & Zakir, 2011).

Similarly, Basci and Karaca (2013) perform a VAR model using Istanbul Stock Exchange (ISE 100) index as the dependent variable and exchange rate, gold price, imports, and exports as independent variables. The authors indicate that all variables have seasonal movements, however, all series get stationarity in their first difference. Their results show that Turkish shares have been affected by their own past values (Basci & Karaca, 2013). Shawtari, Salem, Hussain, and Hawariyuni (2016) employ VECM to examine the long-term equilibrium between South Africa's stock index and industrial production, inflation, money supply, and exchange rate. The authors find that all variables are cointegrated in the long-run with stock market prices, suggesting that changes in the macroeconomic policy should take into consideration its effect on the stock market performance (Shawtari, Salem, Hussain, & Hawariyuni, 2016). Conversely, Dassanayake and Jayawardena (2017) establish no statistical significance in the long-run causality from inflation rate, exchange rate, and interest rate on the New Zealand stock market index (Dassanayake & Jayawardena, 2017). Mwaanga and Njebele (2017) employ time series monthly data from 2004 to 2016 to investigate the relationship between Zambia's real effective exchange rate and its stock market index. Their results using Johansen cointegration test reveal the existence of the long-run cointegration between both variables, however, VECM findings show the absence of a short-run relationship between the exchange rate and stock market price in Zambia (Mwaanga & Njebele, 2017). Mireku, Sarkodie, and Poku (2013) show the negative effect from the interest rate and exchange rate on Ghana's stock prices, while the inflation rate indicates a positive association with the stock prices (Mireku, Sarkodie, & Poku, 2013).

In addition, Cheung and Ng's study (1998) exhibits the long-term relationship among stock price indexes, oil prices, money supply, and GDP from Canada, Germany, Italy, Japan, and the United States (Cheung & Ng, 1998). Gjerdre and Saettem (1999) perform a VAR model between stock returns and macroeconomic factors in Norway. The authors demonstrate that

changes in the real interest rate affect the stock returns and the inflation rate, while the stock market is rapidly affected by the oil price changes and delayed affected by changes in the domestic real activity (Gjerde & Sættem, 1999). Giri and Joshi (2017) examine the short- and long-run relationship between stock price and a set of macroeconomic variables for the Indian economy. The authors construct a VECM and find that economic growth, inflation, and exchange rate affect stock prices positively, however, crude oil price affects the stock price negatively. Furthermore, the result of variance decomposition shows that stock market development in India is generally explained by its own shock (Giri & Joshi, 2017). For oil-producing countries, the increase in oil prices reflects a transfer of welfare from the oil-importing nations to oil-exporting countries, generating an effect on the economy. Bjørnland's (2009) findings suggest that rising oil prices will push up the stock price index since the increase in world oil prices stimulates the economy, the aggregate demand, and welfare. Therefore, with a high level of social welfare, people tend to invest in stocks (Bjørnland, 2009). Moore (1990) mentions that one form of risk-free investment is to purchase gold since investors prefer high yield with a certain degree of risk or specific yield with low risk. Gold price movements will affect negatively the stock prices because this commodity can be used as a substitute for the stock itself (Moore, 1990). Raraga and Muharam (2014) analyze the effect of world oil prices and world gold prices on the Jakarta Composite Index (JCI). Cointegration analysis results show that world oil prices, gold prices, and JCI have long-run cointegration. Furthermore, impulse response analysis findings indicate that shocks in the world gold prices are responded negatively by JCI, however, world oil price shocks do not cause movements on JCI (Raraga & Muharam, 2014).

Using the previous theoretical and empirical findings, our hypotheses are:

Hypothesis 1: GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price will affect the stock market index in Korea and Japan in the short-run and long-run.

Hypothesis 2: The most significant impulse on the stock market index is its own shock and its magnitude declines from the short-run to the long-run.

Hypothesis 3: There is a long-term equilibrium relationship between the stock market index, GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price in Korea and Japan.

III. Research Model

A. Source and Measurement of Variables

The variables employed in this research are classified into: (1) stock market index represented by Kospi and Nikkei 225, (2) macroeconomic variables, namely GDP growth, inflation rate, interest rate, and exchange rate, and (3) commodities, such as crude oil WTI price and gold price. All information was collected from the websites of the Organization for Economic Co-operation and Development (OECD) (OECD, 2018) and Investing.com (Investing.com, 2018). Quarterly observations from 1993-Q1 (quarter 1) to 2017-Q4 (quarter 4) are utilized per variable in this study. Variables and their definitions are shown in Table 1.

B. Methodology

The empirical methods of this paper are VAR model and VECM. Firstly, we examine the presence of seasonal movements and unit root in the variables using Augmented Dickey-Fuller (ADF) unit root test to determine whether all series are stationarity in their first difference, which is a requirement to construct VAR and VECM. Second, we identify the selection of lag to the VAR model using Akaike Information Criteria (AIC). Third, we estimate VAR models to investigate the impulse-response functions to Kospi and Nikkei 225 of one standard deviation shock in the remaining variables. Fourth, we analyze the

Table 1. Variables and Definitions

Variables	Definition
Kospi (KS11)	Korea Composite Stock Price Index - quarterly closing stock price.
Nikkei 225	Japan's top 225 blue-chip companies traded on the Tokyo Stock Exchange - quarterly closing stock price.
GDP growth	Percentage change from the previous quarter, based on real GDP.
Inflation rate	Measured by the consumer price index (CPI) in terms of the quarterly growth rate.
Interest rate	Short-term interest rate based on three-month money market rates.
Exchange rate	Price of a nation's currency in terms of another currency - closing price end of the quarter. This study employs (1) Korean Won per American Dollar (KRW/ USD) and (2) Japanese Yen per American Dollar (JPY/USD).
Crude oil WTI price	West Texas Intermediate (WTI or NYMEX) crude oil prices per barrel. The crude oil WTI price is the closing price end of the quarter.
Gold price	Real gold prices per ounce. It consists of the gold closing price end of the quarter.

components of the variance decomposition of Kospi and Nikkei 225 to verify the structural regularities among the factors in the short- and long-term. Fifth, we perform the Johansen cointegration test to validate the cointegration between variables in the long-run. Finally, we construct VECM for Korea and Japan to integrate the econometric model in the short- and long-term since the imbalance proportion is corrected in the next period, which is reinforced by White Test, confirming the short-run causality.

Several businesses and economic time series are far from stationarity when they are presented in their original units of measurement since they usually include trends, cycles, random walking, and non-stationarity behavior. Taking differences between periods may solve the non-stationarity problem. Therefore, we use ADF unit root test to corroborate the stationarity of time series variables. The general equation for ADF is applied to the time series representing by Equation 1: model with an intercept, Equation 2: model with intercept and time trend, and Equation 3: model without intercept or time trend.

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + b_i \sum_{i=1}^m \Delta y_{t-i} + \epsilon_t \quad (1)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \delta Y_{t-1} + b_i \sum_{i=1}^m \Delta y_{t-i} + \epsilon_t \quad (2)$$

$$\Delta Y_t = \delta Y_{t-1} + b_i \sum_{i=1}^m \Delta y_{t-i} + \epsilon_t \quad (3)$$

Where:

Δ : differentiating factor,

Y_t : matrix of variables,

α_0 : matrix of intercepts,

α_1 : matrix of time trend coefficients,

b_i : matrix of variables coefficient,

m : optimal lag period which makes the residual white noises,

ϵ_t : matrix of residual white noise.

The null hypothesis is $H_0: \delta=0$, there is a unit root (no stationarity). Contrary, the alternative hypothesis is $H_1: \delta<0$, there is not a unit root (stationarity).

The VAR model is one of the most popular methodologies used for the multivariate time series analysis since its flexibility and successful forecast capability. VAR models were popularized in econometrics by Sims (1980), who advocated non-theoretical explanation for the relationships between different time series caused by their interdependence. The best lag length for the VAR model is when AIC shows the lowest value. The general mathematical expression of VAR is represented in Equation 4.

$$y_t = \alpha_0 + \sum_{i=1}^N \alpha_i y_{t-i} + \epsilon_t \quad (4)$$

Where:

Y_t : matrix of variables,

α_0 : matrix of intercepts,

α_i : matrix of variables coefficients,

ϵ_t : matrix of residual white noise.

The impulse-response function is a test for sign identification and duration of the effect of a shock to the endogenous variable, while the variance decom-

position distinguishes the proportion of the information that one variable contributes to the other. Two or more variables are cointegrated if they show co-movements or stable relationships in the long-run (Engle & Granjer, 1987). Two-time series are cointegrated if both series become stationary in their first difference denoted as I(1) and it is expected to have a linear combination between both variables. Johansen Cointegration Test examines several cointegration vectors between variables using systems of equations. Johansen Cointegration Test for a VAR model of p order is denoted in Equation 5.

$$y_t = \alpha y_{t-1} + \dots + \alpha_p y_{t-p} + Bx_t + \epsilon_t \quad (5)$$

Where:

y_t : vector of k non-stationary variables,

x_t : vector of d deterministic variables,

ϵ_t : the innovation vector.

If there is cointegration between variables, the short-term nature of the relationship between the variables can be expressed by ECM or also called VECM. The model includes both the short- and long-run causality. The cointegration term provides a correction mechanism in the long-run relationship between variables, while the variables are adjusted in the short-term. Johansen Cointegration Test verifies the cointegration and determines the number of cointegrated vectors. Thus, the hypotheses for the cointegration test are:

H_0 : $r=0$, inexistence of cointegrated vectors,

H_1 : $r=1$, existence of cointegrated vectors.

If there is more than one cointegrated vector:

H_0 : $r \leq 1$, there is less than one cointegrated vector,

H_1 : $r=2$, there is more than one cointegrated vector.

When non-stationarity variables are cointegrated, a VAR in the first difference becomes misspecified since the existence of a common trend. Thus, the model should incorporate one period lagged residual from the vectors to generate a VECM. The generalized Korea and Japan VECM is presented in Equation (6).

$$\begin{aligned} \Delta StockMarketIndex_{1,t} &= \mu_{1,t} - \phi_1 [StockMarketIndex - \gamma_0 \\ &\quad - \gamma_1 GDPGrowth - \gamma_2 InflationRate \\ &\quad - \gamma_3 InterestRate - \gamma_4 ExchangeRate \\ &\quad - \gamma_5 Crude Oil WTI - \gamma_6 Gold]_{t-1} \\ &\quad + \sum_{i=1}^j \beta_{1,i} \Delta StockMarketIndex_{1,t-i} \\ &\quad + \sum_{i=1}^j \beta_{2,i} \Delta GDPGrowth_{1,t-i} \\ &\quad + \sum_{i=1}^j \beta_{3,i} \Delta InflationRate_{1,t-i} \\ &\quad + \sum_{i=1}^j \beta_{4,i} \Delta InterestRate_{1,t-i} \\ &\quad + \sum_{i=1}^j \beta_{5,i} \Delta ExchangeRate_{1,t-i} \\ &\quad + \sum_{i=1}^j \beta_{6,i} \Delta Crude Oil WTI_{1,t-i} \\ &\quad + \sum_{i=1}^j \beta_{7,i} \Delta Gold_{1,t-i} + \epsilon_{1,t} \end{aligned} \quad (6)$$

Where:

Δ : differencing factor,

$StockMarketIndex_{1,t}$: stock market index, composed

by: (1) Kospi and (2) Nikkei 225,

$\mu_{1,t}$: intercept (short-run),

ϕ_1 : error correction term,

γ_0 : intercept (long-run),

$\gamma_1 \sim \gamma_6$: level of parameter adjustment, the adjustment factor is the long-term error correction,

$\beta_{1,j} \sim \beta_{7,j}$: factor of the short-term dynamic adjustment,

j : lag period,

$\epsilon_{1,t}$: the residual white noise.

The statistical significance of the error correction term in VECM shows that macroeconomic variables and commodities prices have significant explanatory power for the current and future stock price values. Therefore, if all the time series are integrated with order one and cointegrated, there should be a Johansen cointegration causality in at least one direction as one (some) variables can forecast the other(s) (Dassanayake & Jayawardena, 2017). Finally, the test of short-term causality is performed with the standard Wald F test as shown in Equation (7).

$$F_c = \frac{[(ESSR - ESSU)/n]}{[ESSU/(T - m - n)]} \quad (7)$$

Where:

$ESSR$: residual sum of squares of the restricted regression,

$ESSU$: residual sum of squares of the unrestricted regression,

T : number of observations in the unrestricted regression,
 m and n : optimal order of lags.

IV. Empirical Analysis and Results

The first step of the time series analysis is to investigate the properties of these series individually. This study employs ADF unit root test to examine the unit root in all the variables and check the order of model's integration. After seasonal adjustment,

all series have been determined stationary in their first difference. Thus, the null hypothesis of unit root test is rejected at the 1% level for all variables in their first difference. Therefore, Korean and Japanese variables are stationary or all variables are stable at their first difference. The results of ADF Unit Root Test were shown in Table 2.

The selection of the lag order of the VAR model is based on AIC. The eighth order of VAR model was chosen for Korea and Japan, which is shown in Table 3.

The impulse-response function indicates the degree of event transmission from one variable to the others. This study only analyzes the response of the variables

Table 2. Results of Unit Root Test - ADF Test Statistics

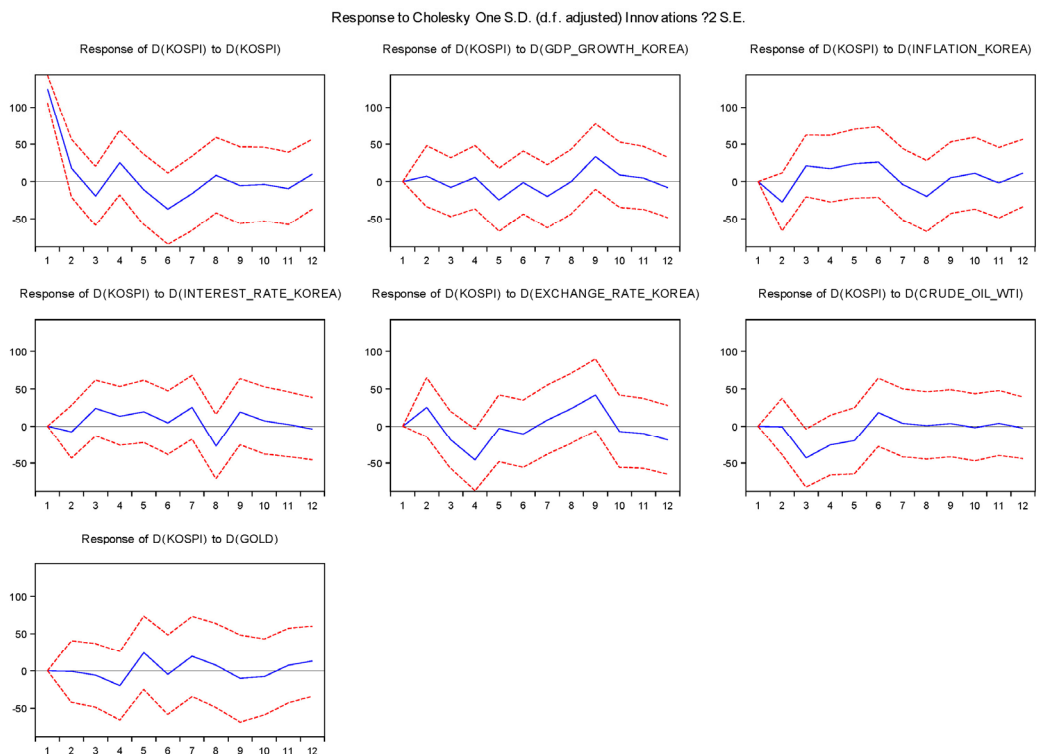
Variable	Order	Intercept Equation (1)	Trend and Intercept Equation (2)	None Equation (3)
Kospi	Level	-0.391	-2.278	1.110
	First difference	-8.864***	-8.882***	-8.763***
Nikkei 225	Level	-1.535	-1.205	-0.138
	First difference	-8.574***	-8.704***	-8.615***
GDP growth Korea	Level	-1.167	-1.543	-1.590
	First difference	-8.605***	-8.557***	-8.638***
GDP growth Japan	Level	-1.318	-1.417	-1.562
	First difference	-8.453***	-8.406***	-8.497***
Inflation rate Korea	Level	-1.199	-2.088	-1.748
	First difference	-4.708***	-4.677***	-4.463***
Inflation rate Japan	Level	-2.214	-3.257	-1.621
	First difference	-6.809***	-6.810***	-6.843***
Interest rate Korea	Level	-1.895	-2.873	1.625
	First difference	-8.279***	-8.258***	-8.214***
Interest rate Japan	Level	-3.919	-3.437	-1.515
	First difference	-8.476***	-8.773***	-8.322***
Exchange rate Korea	Level	-2.483	-3.195	-0.045
	First difference	-12.483***	-12.460***	-12.535***
Exchange rate Japan	Level	-2.372	-2.361	-0.329
	First difference	-4.876***	-4.854***	-4.902***
Crude oil WTI price	Level	-1.567	-1.798	-0.400
	First difference	-9.578***	-9.555***	-9.608***
Gold price	Level	-0.458	-1.616	0.979
	First difference	-5.487***	5.475***	-5.355***

Note: *** indicates statistical significance at the 1% level.

Table 3. VAR Lag Order Selection Criteria

Lag	Korea			Japan		
	LR	FPE	AIC	LR	FPE	AIC
0	NA	2.49E+14	53.014	NA	9.38E+11*	47.433
1	195.934	6.92E+13*	51.730	76.655	1.10E+12	47.586
2	76.340	7.58E+13	51.803	59.661	1.50E+12	47.878
3	66.831	8.85E+13	51.911	72.779	1.60E+12	47.900
4	79.799*	7.87E+13	51.701	76.500*	1.50E+12	47.743
5	56.691	9.66E+13	51.747	51.461	2.03E+12	47.884
6	56.485	1.12E+14	51.647	55.005	2.44E+12	47.815
7	42.385	1.72E+14	51.690	43.760	3.61E+12	47.825
8	46.608	2.27E+14	51.396*	51.979	4.07E+12	47.373*

Note: LR: Sequential modified LR test statistic (each test at the 5% level), FPE: Final prediction error, AIC: Akaike information criterion, and * indicates lag order selected by the criterion.

**Figure 1.** Impulse-Response Function for VAR (8) Model - Korea

D(Kospi) and D(Nikkei_225) before a shock of the remaining variables. Both variables represent the first difference (D) of the stock market index in Korea and Japan, respectively. Twelve periods or three years is the analysis-time horizon to explain the impulse-

response results. Figure 1 shows that Kospi applies the highest boost on the same variable during the examined period. The response of Kospi to itself is positive and negative. The negative responses are evidenced during the third, fifth to seventh, and ninth

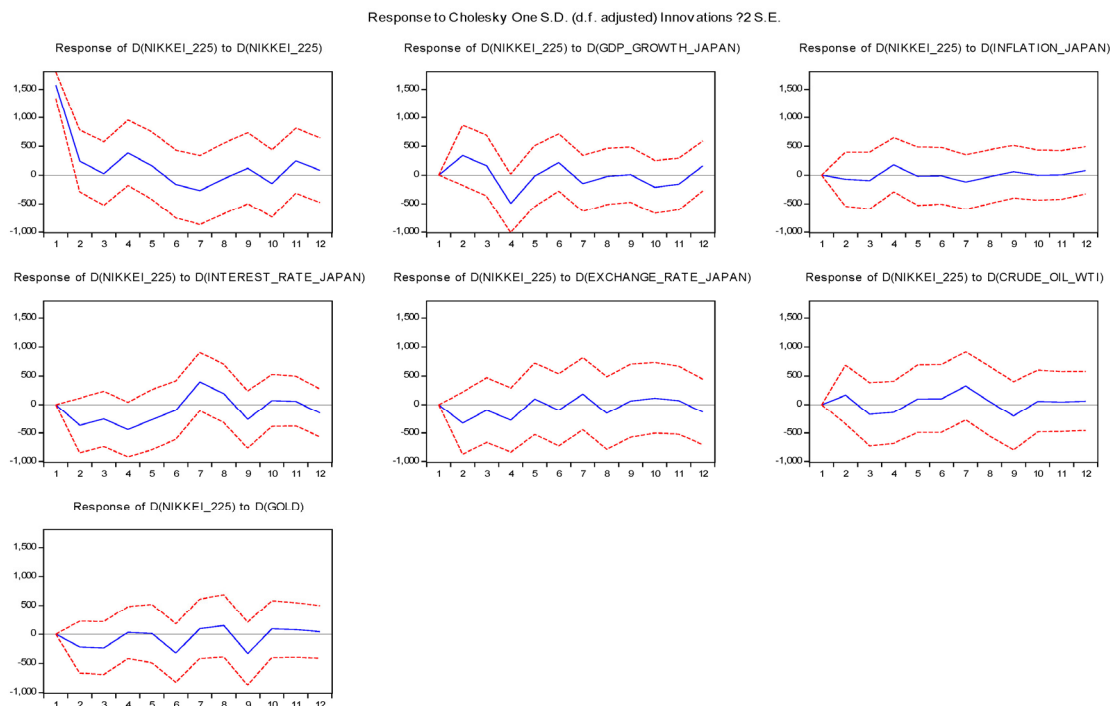


Figure 2. Impulse-Response Function for VAR (8) Model - Japan

to eleventh period, while the positive responses are shown in the remaining periods. It means that in the future, one standard deviation (SD) shock to Kospi might have a noticeable positive impact on the same variable (own effect) from the first to the second period, then its own effect is negative during the third period, continued by a positive effect in the fourth period. The highest negative impact is shown during the sixth period, opposite to the highest positive effect in the first and fourth periods. Furthermore, the additional variables present a similar random behavior, adopting positive and negative responses. Thus, hypothesis 1 is accepted, meaning that shocks to GDP growth, inflation rate, interest rate, exchange rate, crude oil WTI price, and gold price might generate a different effect on Kospi in the short-run and long-run since the positive and negative responses observed throughout the study period.

Figure 2 shows that Nikkei 225 applies the highest improvement during the studied period. The response of Nikkei 225 to the same variable is both positive

and negative. The negative responses are evidenced from the sixth to eighth period, and tenth period, while the positive responses are presented from the first to fifth, ninth, and eleventh to twelfth periods. It means that in the future, one SD shock to Nikkei 225 initially performs a noticeable positive impact on the same variable (own effect) from the first to fifth period, and it changes into negative effect until the eighth period. The highest negative impact is shown during the seventh period, opposite to the highest positive effect in the first and fourth periods. The positive and negative responses of Kospi and Nikkei 225 to themselves are similar in the short-term and long-term. Therefore, hypothesis 1 is accepted.

Figure 3 presents the Kospi variance decomposition. Variance decomposition indicates from which variables share variance is formed. For instance, in the short-run (quarter 2), an impulse on Kospi can cause 91.30% fluctuation in Kospi (own shock), while a shock to inflation rate can contribute 4.36% variation in Kospi, an impulse on exchange rate might generate 3.71%

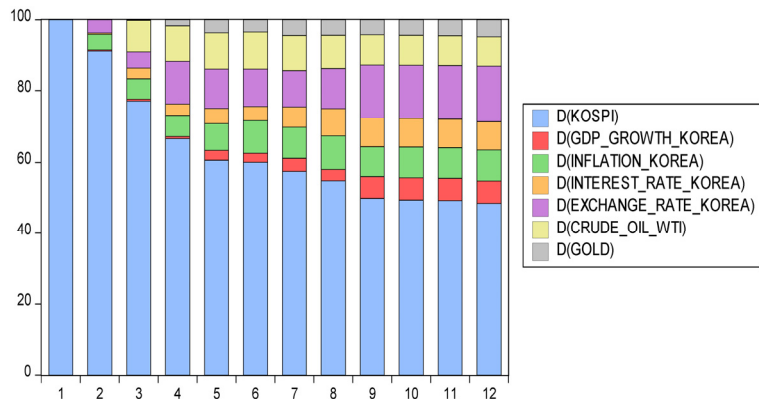


Figure 3. D(Kospi) - Variance Decomposition using Cholesky Factors

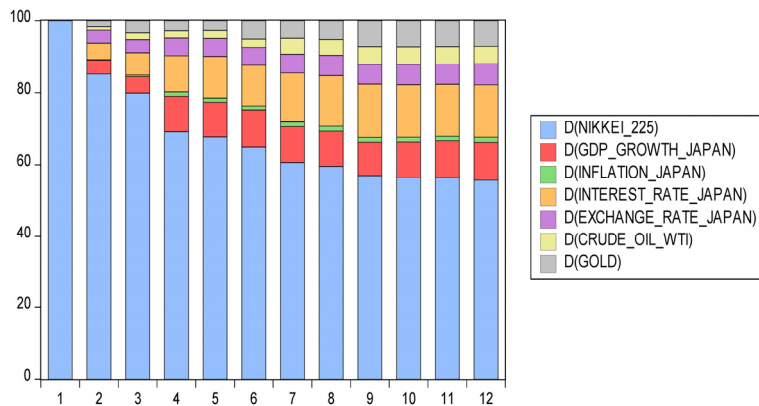


Figure 4. D(Nikkei_225) - Variance Decomposition using Cholesky Factors

fluctuation in Kospi, a shock to interest rate can contribute 0.32% fluctuation in the variance of Kospi, finally, and an impulse on GDP growth, crude oil price, and gold price might cause 0.31% variation in Kospi. In the long-run (quarter 12), a shock to Kospi can contribute 48.36% fluctuation to Kospi (own shock), while an impulse on exchange rate might cause a 15.63% variation Kospi, and a shock to inflation rate can generate 8.81% fluctuation in Kospi. In addition, an impulse on crude oil price, interest rate, GDP growth, and gold price can contribute 8.42%, 7.76%, 6.25%, and 4.77% variation in Kospi, respectively. We conclude that the Kospi contribution in the variation of the same variable (own shock) decreases from the short-run (quarter 2: 91.30%) to the long-run (quarter 12: 48.36%) while the remaining

variables maintain or increase their effect on the Kospi fluctuation during the short-run and long-run. Thus, hypothesis 2 is accepted, meaning that the most significant impulse on the stock market index is its own shock and its magnitude declines from the short-run to the long-run. Appendix 1 provides the specific percentages of Kospi variance decomposition.

Figure 4 presents the Nikkei 225 variance decomposition. In the short-run (quarter 2), a shock to Nikkei 225 can contribute 85.15% fluctuation to Nikkei 225 (own shock), while an impulse on interest rate might cause 4.54% variation in Nikkei 225, and a shock to GDP growth can generate 3.95% fluctuation in Nikkei 225. In addition, an impulse on exchange rate, gold price, crude oil price, and inflation rate might contribute 3.58%, 1.66%, 0.96%, and 0.16% variation

Table 4. Number of Cointegration Relations by Model

Series	Data Trend	None	None	Linear	Linear	Quadratic
	Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
		No Trend	No Trend	No Trend	Trend	Trend
Series 1 - Korea	Trace	4	4	5	4	5
	Max-Eig	4	3	3	4	4
Series 2 - Japan	Trace	7	4	4	4	7
	Max-Eig	4	4	4	4	4

Note: (a) Selected at the 0.05 level, critical values based on MacKinnon-Haug-Michelis (1999).

(b) Lags interval: 1 to 8 since both models are VAR (8).

(c) Series 1 - Korea: D(KOSPI) D(GDP_GROWTH_KOREA) D(INFLATION_KOREA) D(INTEREST_RATE_KOREA) D(EXCHANGE_RATE_KOREA) D(CRUDE_OIL_WTI) D(GOLD).

(d) Series 2 - Japan: D(NIKKEI_225) D(GDP_GROWTH_JAPAN) D(INFLATION_JAPAN) D(INTEREST_RATE_JAPAN) D(EXCHANGE_RATE_JAPAN) D(CRUDE_OIL_WTI) D(GOLD).

in Nikkei 225, respectively. In the long-run (quarter 12), an impulse on Nikkei 225 can cause 55.60% fluctuation in Nikkei 225 (own shock), while a shock to interest rate can contribute 14.62% variation in Nikkei 225, an impulse on GDP growth might generate 10.53% fluctuation in Nikkei 225, a shock to gold price can contribute 7.07% fluctuation in the variance of Nikkei 225. Finally, an impulse on the exchange rate, crude oil price, and inflation rate might cause a 12.18% variation in Nikkei 225. We conclude that the Nikkei 225 contribution in the variation of the same variable (own shock) decreases from the short-run (quarter 2: 85.15%) to the long-run (quarter 12: 55.60%) while the remaining variables maintain or increase their effect on the Nikkei 225 fluctuation during the short-run and long-run. Therefore, hypothesis 2 is accepted, suggesting that the most significant impulse on the stock market index is its own shock and its magnitude declines from the short-run to the long-run. Appendix 1 provides the specific percentages of Nikkei 225 variance decomposition.

Johansen cointegration test is performed to verify the cointegration between variables. Johansen's cointegration null hypothesis establishes that there is no cointegrated equation or no cointegration between variables. The test is divided into trace and maximum eigenvalue (Max-Eig) tests. For both tests, we reject the Johansen cointegration null hypothesis for Korea and Japan models at the 5% level. There are at least three and four cointegrated equations between the seven variables in Korea and Japan models, respectively.

Thus, we accept hypothesis 3, all seven variables are cointegrated, meaning that there is a long-term equilibrium relationship between the stock market index, GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price in Korea and Japan. Table 4 shows the cointegration relation results per model.

To choose the correct specification of VECM, we use AIC and Schwarz Criteria. Findings reveal that the best model for Korea and Japan is the intercept model and trend with four lags. In addition, Johansen Cointegration Test is performed for Korea and Japan models. Table 5 illustrates the results of Johansen Cointegration using Trace and Maximum Eigenvalue tests. For Korea and Japan VECM, both tests indicate four cointegrating equations at the 0.05 level. These results are consistent with hypothesis 3, suggesting that all seven variables are cointegrated, therefore, there is a long-term equilibrium relationship between the stock market index, GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price in Korea and Japan.

VECM allows integrating the econometric model in the short- and long-term since the imbalance proportion is corrected in the next period. Thus, the error term reflects the deviation in t period respect to its long-term behavior. We proved that after seasonal adjustment, all series have been determined stationary in their first difference, then we estimated VECM using four lags. Appendix 2 provides a VECM estimation for Korea and Japan. Both models reflect

Table 5. Johansen Cointegration Test Results

Korea - Unrestricted Cointegration Rank Test						
Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	270.746*	150.559	0.000	82.097*	50.600	0.000
At most 1	188.649*	117.708	0.000	59.920*	44.497	0.001
At most 2	128.729*	88.804	0.000	53.991*	38.331	0.000
At most 3	74.738*	63.876	0.005	36.426*	32.118	0.014
At most 4	38.312	42.915	0.134	20.409	25.823	0.221
At most 5	17.904	25.872	0.350	11.550	19.387	0.458
At most 6	6.354	12.518	0.417	6.354	12.518	0.417
Japan - Unrestricted Cointegration Rank Test						
Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	334.239*	150.559	0.000	113.776*	50.600	0.000
At most 1	220.464*	117.708	0.000	74.732*	44.497	0.000
At most 2	145.732*	88.804	0.000	56.989*	38.331	0.000
At most 3	88.742*	63.876	0.000	44.104*	32.118	0.001
At most 4	44.639	47.915	0.063	23.493	25.823	0.099
At most 5	21.146	25.872	0.173	14.541	19.387	0.220
At most 6	6.605	12.518	0.388	6.605	12.518	0.388

Note: * Denotes rejection of the hypothesis at the 0.05 level, ** MacKinnon-Haug-Michelis (1999) p-values.

(a) Lags interval (in first difference): 1 to 8.

(b) Korea VECM - Series: D(KOSPI) D(GDP_GROWTH_KOREA) D(INFLATION_KOREA) D(INTEREST_RATE_KOREA) D(EXCHANGE_RATE_KOREA) D(CRUDE_OIL_WTI) D(GOLD). Trace test and Max-eigenvalue tests indicate four cointegrating equations at the 0.05 level.

(c) Japan VECM - Series: D(NIKKEI225) D(GDP_GROWTH_JAPAN) D(INFLATION_JAPAN) D(INTEREST_RATE_JAPAN) D(EXCHANGE_RATE_JAPAN) D(CRUDE_OIL_WTI) D(GOLD). Trace test and Max-eigenvalue tests indicate four cointegrating equations at the 0.05 level.

an Adjusted R-Squared of 42.0% and 47.6%, and F-statistics of 3.108 and 3.639, which proves their validity. The result of Equation 7 is presented for Korea and Japan VECM.

Cointegrating equations (long-run models):

$$\begin{aligned} \text{CointEq1}_{t-1} = & 1.000 * \text{KOSPI}_{t-1} - 75.925 * \text{GDPGrowth}_{t-1} - 40.751 \\ & * \text{Inflation}_{t-1} - 66.910 * \text{InterestRate}_{t-1} + 0.617 * \text{ExchangeRate}_{t-1} \\ & - 5.868 * \text{CrudeOilWTI}_{t-1} - 0.261 * \text{Gold}_{t-1} - 0.377 * \text{@TREND}(93Q1) \\ & + 6.117 \end{aligned}$$

$$\begin{aligned} \text{CointEq1}_{t-1} = & 1.000 * \text{NIKKEI225}_{t-1} - 1597.789 * \text{GDPGrowth}_{t-1} \\ & - 1816.574 * \text{Inflation}_{t-1} + 4236.706 * \text{InterestRate}_{t-1} - 46.815 \\ & * \text{ExchangeRate}_{t-1} - 158.931 * \text{CrudeOilWTI}_{t-1} + 27.185 * \text{Gold}_{t-1} \\ & - 8.069 * \text{@TREND}(93Q1) + 79.112 \end{aligned}$$

Estimated VECM with stock market index as target variable:

$$\begin{aligned} \text{D(KOSPI)}_t = & -0.196 * \text{CointEq1}_{t-1} + 0.208 * \text{D(KOSPI)}_{t-1} + 0.341 \\ & * \text{D(KOSPI)}_{t-2} + 0.399 * \text{D(KOSPI)}_{t-3} + 0.343 * \text{D(KOSPI)}_{t-4} \\ & + 10.330 * \text{D(GDPGrowth)}_{t-1} + 2.958 * \text{D(GDPGrowth)}_{t-2} + 14.820 \\ & * \text{D(GDPGrowth)}_{t-3} + 3.812 * \text{D(GDPGrowth)}_{t-4} - 0.215 \\ & * \text{D(Inflation)}_{t-1} + 25.295 * \text{D(Inflation)}_{t-2} + 15.216 \\ & * \text{D(Inflation)}_{t-3} + 39.133 * \text{D(Inflation)}_{t-4} - 16.346 \\ & * \text{D(InterestRate)}_{t-1} - 1.269 * \text{D(InterestRate)}_{t-2} - 1.455 \\ & * \text{D(InterestRate)}_{t-3} + 2.700 * \text{D(InterestRate)}_{t-4} + 0.765 \\ & * \text{D(ExchangeRate)}_{t-1} + 0.942 * \text{D(ExchangeRate)}_{t-2} + 0.418 \\ & * \text{D(ExchangeRate)}_{t-3} + 0.340 * \text{D(ExchangeRate)}_{t-4} - 2.734 \\ & * \text{D(CrudeOilWTI)}_{t-1} - 4.865 * \text{D(CrudeOilWTI)}_{t-2} - 3.315 \\ & * \text{D(CrudeOilWTI)}_{t-3} - 4.457 * \text{D(CrudeOilWTI)}_{t-4} - 0.405 \\ & * \text{D(Gold)}_{t-1} - 0.368 * \text{D(Gold)}_{t-2} - 0.455 * \text{D(Gold)}_{t-3} \\ & - 0.026 * \text{D(Gold)}_{t-4} + 0.457 \end{aligned}$$

$$\begin{aligned} \text{D(NIKKEI225)}_t = & -0.298 * \text{CointEq1}_{t-1} - 0.081 * \text{D(NIKKEI225)}_{t-1} \\ & - 0.207 * \text{D(NIKKEI225)}_{t-2} + 0.003 * \text{D(NIKKEI225)}_{t-3} + 0.176 \\ & * \text{D(NIKKEI225)}_{t-4} - 176.478 * \text{D(GDPGrowth)}_{t-1} + 62.463 \\ & * \text{D(GDPGrowth)}_{t-2} - 292.466 * \text{D(GDPGrowth)}_{t-3} + 64.977 \\ & * \text{D(GDPGrowth)}_{t-4} - 681.722 * \text{D(Inflation)}_{t-1} - 689.551 \\ & * \text{D(Inflation)}_{t-2} - 117.893 * \text{D(Inflation)}_{t-3} + 62.488 \\ & * \text{D(Inflation)}_{t-4} + 1533.112 * \text{D(InterestRate)}_{t-1} + 865.003 \\ & * \text{D(InterestRate)}_{t-2} - 587.581 * \text{D(InterestRate)}_{t-3} - 1908.342 \\ & * \text{D(InterestRate)}_{t-4} + 39.150 * \text{D(ExchangeRate)}_{t-1} + 41.118 \\ & * \text{D(ExchangeRate)}_{t-2} - 8.270 * \text{D(ExchangeRate)}_{t-3} + 37.808 \end{aligned}$$

$$\begin{aligned}
& * D(\text{ExchangeRate})_{t-4} - 54.260 * D(\text{CrudeOilWTI})_{t-1} - 53.842 \\
& * D(\text{CrudeOilWTI})_{t-2} - 35.227 * D(\text{CrudeOilWTI})_{t-3} - 18.481 \\
& * D(\text{CrudeOilWTI})_{t-4} + 11.087 * D(\text{Gold})_{t-1} + 5.391 * D(\text{Gold})_{t-2} \\
& + 4.987 * D(\text{Gold})_{t-3} + 5.425 * D(\text{Gold})_{t-4} + 21.744
\end{aligned}$$

The estimated error correction term CointEq1 is -0.196 and -0.298 for Korea and Japan VECM, respectively. This coefficient represents the error correction term or speed of adjustment towards equilibrium. The adjustment coefficients show that Kospi and Nikkei 225 are corrected in -19.6% and -39.8% in each period, respectively. For instance, if Kospi value is below its equilibrium level in KWR 100, it will be adjusted in KWR 19.60 in the next quarter, while if Nikkei 225 is below its equilibrium level in JPY 1,000, it will be modified in JPY 298.00 during the next period. Furthermore, we evidenced that the sign of CointEq1 is negative and significant at the 5% and 1% level for Korea and Japan VECM, respectively. Thus, hypothesis 3 is accepted. We conclude that there is a long-run causality running from GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price to the stock market index. The long-run equations in Korea and Japan reveal that GDP growth, inflation rate, and crude oil price in $t-1$ period, have a significant negative (at least 5% level) relationship with the cointegration term in $t-1$ period, while the interest rate in the previous period affects significantly negative and positive to CointEq1 coefficient in Korea and Japan models, respectively. The regression coefficient of Korea's exchange rate is significant (1% level) and positive in the cointegration equation, however, it is insignificant and negative in Japan's cointegration equation. Finally, gold price shows a significant positive relationship with the error correction term in Japan VECM, opposite to the insignificant and negative coefficient evidenced in Korea VECM.

The results of Korea VECM indicate that Kospi in the short-term is affected significantly positive (5% level) by Kospi (-4), GDP_Growth (-4), Exchange_Rate (-1), and Exchange_Rate (-2). These findings suggest that in the short-term, Kospi was positively affected by Kospi itself and GDP growth in a period of one year earlier (four quarters), while it was affected

by the exchange rate in a period of one quarter and two quarters previous, meaning that, if there is an increase in the exchange rate on the previous two-quarters period, it will rise Kospi value in the current period. Contrary, Kospi is significantly negatively affected at the 5% level by Interest_Rate (-2), Crude_Oil_WTI (-2), and Crude_Oil_WTI (-4), and at the 10% level by Crude_Oil_WTI (-3), Gold (-1), and Gold (-3). These results convey that in the short-term, Kospi was negatively affected by the interest rate in a period of two quarters earlier, crude oil price in a period from two to four quarters previous, and gold price in a period of one and three quarters earlier. For instance, if the interest rate drops in the previous two quarters, the Kospi value will rise in the current period.

The results of Nikkei 225 VECM shows that Nikkei 225 in the short-term is significantly positive affected at the 5% level by Nikkei 225 (-4) and Gold (-1) and at the 10% level by Gold (-4). These findings represent that in the short-term, Nikkei 225 was positively affected by Nikkei 225 itself in a period of one year earlier, and by the gold price at one and four quarters previous, suggesting that, if there is an increase in the Nikkei 225 value in the previous year, it will raise its value in the current period. Oppositely, Nikkei 225 is significantly negatively affected by Interest_Rate (-4) and GDP_Growth (-4), at the 5% and 10% significance level, respectively. These results suggest that in the short-term, Nikkei 225 was negatively affected by the interest rate and GDP growth in a period of one year earlier. If there is an increase in the interest rate in the previous year, Nikkei 225 value will decrease in the current period.

The remaining variables have no significant effect on Kospi and Nikkei 225 in the short-term. To sum up, VECM in both countries performs a similar significantly positive short-run association between the stock market index and its own value in the previous year, and a significantly negative short-run association with the interest rate in the previous two-quarter period and one-year period for Korea and Japan models, respectively.

In addition, we performed White Test for the

models' robustness, verifying the short-run causality. Results are provided in Appendix 3. Findings reveal that there is a significant short-run causality running from interest rate to Kospi (5% level), exchange rate to Kospi (5% level), GDP growth to Kospi (10% level), crude oil price to Kospi (10% level), gold price to Kospi (10% level). On the other hand, there is a significant short-run relationship from GDP growth to Nikkei 225 (5% level), interest rate to Nikkei 225 (5% level), and gold price to Nikkei 225 (10% level). These results clarify and reinforce hypothesis 1, suggesting that GDP growth, interest rate, exchange rate, oil price, and gold price affect the Kospi short-run performance, while GDP growth, interest rate, and gold price affect Nikkei 225 in the short-run. The remaining variables are not significantly associated in the short-run with Kospi and Nikkei 225. Table 6 summarizes the coefficient sign and level of significance for Korea and Japan VECM in the short- and long-term.

Our findings are consistent with previous studies. We found a significantly positive short-term relationship between GDP growth and Kospi, which is coherent with Hsing's (2011) results in Hungary. In addition, we found a significantly negative long-term relationship between GDP growth and both stock market indexes Kospi and Nikkei 225, agreeing with Dimson, Marsh, and Staunton's (2002) findings in 16 developed countries. Kwon and Shin (1999) identify a cointegration (long-run) relationship between the Korean stock market index, GDP growth, and other macroeconomic variables,

which is corroborated by our study using VECM in Korea and Japan. In addition, we show a significantly negative long-term relationship between the stock market index in Korea and Japan and the inflation rate in each country, which is consistent with Maysami, Howe, and Hamzah's (2004) and Shawtari, Salem, Hussain and Hawariyuni's (2016) outcome in Singapore and South Africa, respectively. Mireku, Sarkodie and Poku (2013) achieve a significantly negative effect from the interest rate to Ghana's stock market, consistently to our negative results in the short-term in Japan, and in the short- and long-run in Korea. Beer and Hebein (2008) establish a significantly positive effect from exchange rate to the stock market price in Canada, India, Japan, and the United States, coherently with Mwaanga and Njebele's (2017) findings in Zambia and our short- and long-run results in Korea. Giri and Joshi (2017) identify a significant negative short- and long-term relationship between crude oil price and stock price in India, agreeing with our results for Korea and Japan VEC models. Raraga and Muharam (2014) establish a long-run cointegration between world oil prices, gold prices, and JCI in Indonesia, which is reinforced by our findings. Finally, Basci and Karaca's (2013) results show ISE 100 has been especially affected by its own past values, similarly to Giri and Joshi's (2017) findings in India, and our results of impulse-response function and variance decomposition for Kospi and Nikkei 225.

Table 6. Coefficient Sign and Level of Significance for Korea and Japan VECM

Variables	Korea VECM		Japan VECM	
	Long-Term	Short-Term	Long-Term	Short-Term
Error correction term	-**		-***	
Stock Market Index		+		+
GDP Growth	-***	+	-***	-*
Inflation Rate	-**	+/-	-***	+/-
Interest Rate	-***	-**	+	-**
Exchange Rate	+	+	-	+/-
Crude Oil WTI Price	-***	-***	-***	-
Gold price	-	-*	+	+

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

V. Conclusion

This manuscript investigated the factors that might affect the short-run and long-run performance of two stock market indexes in Korea and Japan, using quarterly observations from 1993-Q1 to 2017-Q4. This study employed GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price to test their effect on Kospi and Nikkei 225. All series have been determined stationary in their first difference. We found that shocks on all seven variables achieve both positive and negative impacts on Kospi and Nikkei 225 in the short- and long-term. The most significant impulse on each stock market index is its own shock, which declines from the short- to the long-run. In addition, we detected and verified the long-term equilibrium relationship (cointegration) between all seven variables through Johansen cointegration test, resulting in four cointegration equations at 0.05 level with an estimated error correction term (speed of adjustment towards equilibrium) of -0.196 and -0.298 for Korea and Japan VECM, suggesting that Kospi and Nikkei 225 are corrected in -19.6% and -29.8% in each quarter, respectively. Finally, we performed White Test for robustness check. Findings indicate that GDP growth, interest rate, exchange rate, oil price, and gold price affect the Kospi short-run performance, while GDP growth, interest rate, and gold price effect Nikkei 225 in the short-run. The remaining variables are not associated in the short-run with Kospi and Nikkei 225. The impulse-response findings using three years as the analysis-time horizon indicate that Kospi and Nikkei 225 applied the highest positive and negative boost on themselves. These results are reinforced by the variance decomposition of each stock market index, showing that in the short-run (quarter 2), an impulse on Kospi and Nikkei 225 causes 91.30% and 85.15% fluctuation in each variable (own shock), respectively. Nevertheless, their own effect decreases in the long-run (quarter 12) until 48.36% (Kospi own shock) and 55.60% (Nikkei 225 own shock). Then, the second most important impulse for Kospi' and Nikkei 225's

fluctuation is received by the exchange rate and the interest rate, respectively.

This paper contributes to the prior literature by comparing empirical studies about the determinants of stock market index movements to identify the common variables and methodologies in each case. We constructed VAR models for Kospi and Nikkei 225, however, their statistics were not significant. We proceed to estimate VECM, which integrates the econometric model in the short- and long-term since the imbalance proportion is corrected in the next period. We showed, using different robustness tests, the short- and long-term effects on Kospi and Nikkei 225 generated by GDP growth, inflation rate, interest rate, exchange rate, crude oil price, and gold price. For future research, the authors suggest to include a dummy variable for structural changes in order to achieve higher power when prior information is present (e.g. the world financial crisis), which affects directly or indirectly to the stock market price and its performance.

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Appendix

Appendix 1. Variance Decomposition using Cholesky Factors

Variable: D(KOSPI)									
Period	S.E.	D(KOSPI)	D(GDP_GROWTH_KOREA)	D(INFLATION_KOREA)	D(INTEREST_RATE_KOREA)	D(EXCHANGE_RATE_KOREA)	D(CRUDE_OIL_WTI)	D(GOLD)	
1	124.388	100.000	0.000	0.000	0.000	0.000	0.000	0.000	
2	131.506	91.304	0.297	4.356	0.321	3.715	0.003	0.005	
3	144.816	77.059	0.527	5.703	3.013	4.751	8.778	0.169	
4	158.920	66.523	0.571	5.918	3.230	12.165	9.870	1.722	
5	167.110	60.592	2.713	7.386	4.280	11.034	10.341	3.654	
6	174.456	60.031	2.495	8.993	3.994	10.478	10.578	3.432	
7	179.455	57.536	3.586	8.544	5.750	10.124	10.051	4.409	
8	184.453	54.672	3.394	9.250	7.607	11.240	9.516	4.322	
9	193.472	49.771	6.062	8.475	7.881	14.919	8.686	4.205	
10	194.474	49.298	6.212	8.718	7.942	14.895	8.605	4.329	
11	195.206	49.155	6.225	8.661	7.897	15.046	8.586	4.431	
12	197.319	48.360	6.255	8.812	7.762	15.629	8.418	4.764	
Variable: D(NIKKEI)									
Period	S.E.	D(NIKKEI 225)	D(GDP_GROWTH_JAPAN)	D(INFLATION_JAPAN)	D(INTEREST_RATE_JAPAN)	D(EXCHANGE_RATE_JAPAN)	D(CRUDE_OIL_WTI)	D(GOLD)	
1	1,570.980	100.000	0.000	0.000	0.000	0.000	0.000	0.000	
2	1,722.949	85.154	3.950	0.167	4.537	3.578	0.958	1.657	
3	1,779.040	79.889	4.539	0.448	6.261	3.655	1.839	3.370	
4	1,969.602	69.032	9.969	1.198	10.130	4.905	1.993	2.773	
5	1,999.414	67.650	9.681	1.173	11.602	5.009	2.190	2.695	
6	2,051.097	64.893	10.338	1.119	11.258	4.983	2.343	5.065	
7	2,149.233	60.626	9.883	1.334	13.636	5.296	4.414	4.811	
8	2,169.974	59.555	9.708	1.325	14.159	5.681	4.392	5.179	
9	2,224.925	56.938	9.235	1.333	14.848	5.493	4.988	7.165	
10	2,246.302	56.298	9.927	1.308	14.669	5.645	4.965	7.187	
11	2,269.437	56.366	10.212	1.282	14.439	5.639	4.912	7.151	
12	2,287.820	55.605	10.529	1.391	14.623	5.879	4.906	7.067	

Note: S.E.: Standard errors.

Appendix 2. VECM estimation

CointegratingEq:	CointEq1	CointegratingEq:	CointEq1
Kospi(-1)	1.000	Nikkei225(-1)	1.000
GDP_Growth(-1)	-75.925*** [-9.35001]	GDP_Growth(-1)	-1,597.789*** [-6.57185]
Inflation(-1)	-40.751** [-2.07986]	Inflation(-1)	-1,816.574*** [-3.00633]
Interest_Rate(-1)	-66.910*** [-5.80250]	Interest_Rate(-1)	4,236.706** [2.42258]
Exchange_Rate(-1)	0.617*** [2.69919]	Exchange_Rate(-1)	-46.815 [-0.94520]
Crude_Oil_WTI(-1)	-5.868*** [-2.86640]	Crude_Oil_WTI(-1)	-158.931*** [-3.54480]
Gold(-1)	-0.261 [-1.19727]	Gold(-1)	27.185*** [2.69263]
@TREND(93Q1)	-0.377 [-1.48571]	@TREND(93Q1)	-8.069 [-0.81407]
C	6.117	C	79.112
Error Correction:	D(KOSPI)	Error Correction:	D(NIKKEI225)
CointEq1	-0.196** [-2.06766]	CointEq1	-0.298*** [-2.82713]
D(Kospi(-1))	0.208 [0.47069]	D(Nikkei225(-1))	-0.081 [-0.35973]
D(Kospi(-2))	0.341 [0.90815]	D(Nikkei225(-2))	-0.207 [-1.07070]
D(Kospi(-3))	0.399 [1.40532]	D(Nikkei225(-3))	0.003 [0.01866]
D(Kospi(-4))	0.343** [1.96104]	D(Nikkei225(-4))	0.176** [2.0029]
D(GDP_Growth(-1))	10.330 [0.40671]	D(GDP_Growth(-1))	-176.478 [-0.71055]
D(GDP_Growth(-2))	2.958 [0.15636]	D(GDP_Growth(-2))	62.463 [0.28507]
D(GDP_Growth(-3))	14.820 [1.01167]	D(GDP_Growth(-3))	-292.466 [-1.48504]
D(GDP_Growth(-4))	3.812** [2.31296]	D(GDP_Growth(-4))	-264.977* [1.77451]
D(Inflation(-1))	-0.215 [-0.00459]	D(Inflation(-1))	-681.722 [-1.03212]
D(Inflation(-2))	25.295 [0.59707]	D(Inflation(-2))	-689.551 [-1.13335]
D(Inflation(-3))	15.216 [0.44087]	D(Inflation(-3))	-117.893 [-0.24027]
D(Inflation(-4))	39.133 [1.62613]	D(Inflation(-4))	62.488 [0.17009]
D(Interest_Rate(-1))	-16.346 [-0.41553]	D(Interest_Rate(-1))	1,533.112 [0.82992]
D(Interest_Rate(-2))	-1.269** [-2.04087]	D(Interest_Rate(-2))	865.003 [0.59635]

Appendix 2. Continued

Error Correction:	D(KOSPI)	Error Correction:	D(NIKKEI225)
D(Interest_Rate(-3))	-1.455 [-0.06454]	D(Interest_Rate(-3))	-587.581 [-0.48049]
D(Interest_Rate(-4))	2.700 [0.16326]	D(Interest_Rate(-4))	-1,908.342** [-2.00104]
D(Exchange_Rate(-1))	0.765** [2.11896]	D(Exchange_Rate(-1))	39.150 [0.67657]
D(Exchange_Rate(-2))	0.942** [2.41067]	D(Exchange_Rate(-2))	41.118 [0.73697]
D(Exchange_Rate(-3))	0.418 [1.07243]	D(Exchange_Rate(-3))	-8.270 [-0.18796]
D(Exchange_Rate(-4))	0.340 [1.29262]	D(Exchange_Rate(-4))	37.808 [1.13257]
D(Crude_OIL_WTI(-1))	-2.734 [-1.15782]	D(Crude_OIL_WTI(-1))	-54.260 [-1.08066]
D(Crude_OIL_WTI(-2))	-4.865** [-2.10937]	D(Crude_OIL_WTI(-2))	-53.842 [-1.36797]
D(Crude_OIL_WTI(-3))	-3.315* [-1.65751]	D(Crude_OIL_WTI(-3))	-35.227 [-1.25494]
D(Crude_OIL_WTI(-4))	-4.457*** [-2.81902]	D(Crude_OIL_WTI(-4))	-18.481 [-0.98707]
D(Gold(-1))	-0.405* [-1.66086]	D(Gold(-1))	11.087** [2.40749]
D(Gold(-2))	-0.368 [-1.31136]	D(Gold(-2))	5.391 [1.30838]
D(Gold(-3))	-0.455* [-1.65883]	D(Gold(-3))	4.987 [1.33286]
D(Gold(-4))	-0.026 [-0.11445]	D(Gold(-4))	5.425* [1.83128]
C	0.457 [0.03325]	C	21.744 [0.14275]
R-Squared	0.620	R-Squared	0.656
Adj. R-Squared	0.420	Adj. R-Squared	0.476
Sum sq. Resids	1.08E+06	Sum sq. Resids	1.31E+08
S.E. equation	132.886	S.E. equation	1,468.218
F-statistics	3.108	F-statistics	3.639
Log-likelihood	-572.669	Log-likelihood	-798.486
Akaike AIC	12.887	Akaike AIC	17.691
Schwarz SC	13.779	Schwarz SC	18.584
Mean dependent	0.073	Mean dependent	9.326
S.D. dependent	174.541	S.D. dependent	2,028.036
Determinant resid covariance (dof adj.)	1.43E+13	Determinant resid covariance (dof adj.)	1.63E+11
Determinant resid covariance	6.93E+11	Determinant resid covariance	7.91E+09
Log-likelihood	-2,215.083	Log-likelihood	-2,004.856
Akaike information criterion	52.725	Akaike information criterion	48.252
Schwarz criterion	59.841	Schwarz criterion	55.368
Number of coefficients	263	Number of coefficients	263

Note: Numbers inside the parenthesis are t-statistics. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Appendix 3. Short-Run Causality - Wald Test

Variable	Test Statistic	Value	Probability	Variable	Test Statistic	Value	Probability
Kospi	F-statistic	1.431	0.235	Nikkei225	F-statistic	1.733	0.154
	Chi-square	5.723	0.221		Chi-square	6.932	0.140
GDP_Growth	F-statistic	2.316	0.067*	GDP_Growth	F-statistic	2.726	0.037**
	Chi-square	9.003	0.061*		Chi-square	10.903	0.028**
Inflation	F-statistic	1.281	0.287	Inflation	F-statistic	0.779	0.543
	Chi-square	5.125	0.275		Chi-square	3.116	0.539
Interest_Rate	F-statistic	2.551	0.048**	Interest_Rate	F-statistic	2.974	0.026**
	Chi-square	10.026	0.040**		Chi-square	11.896	0.018**
Exchange_Rate	F-statistic	2.605	0.044**	Exchange_Rate	F-statistic	1.389	0.248
	Chi-square	10.420	0.034**		Chi-square	5.557	0.235
Crude_Oil_WTI	F-statistic	2.159	0.084*	Crude_Oil_WTI	F-statistic	0.535	0.711
	Chi-square	8.634	0.071*		Chi-square	2.140	0.710
Gold	F-statistic	2.059	0.097*	Gold	F-statistic	2.044	0.099*
	Chi-square	8.100	0.088*		Chi-square	8.177	0.085*

Note: ** and * indicate statistical significance at the 5% and 10% level, respectively.