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EMPIRICAL STUDY ON RELATIONS BETWEEN MACROECONOMIC VARIABLES AND THE KOREAN STOCK PRICES: AN APPLICATION OF A VECTOR ERROR CORRECTION MODEL

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Abstract. The purpose of this study is to investigate whether current economic activities in Korea can explain stock prices by using a Cointegration test and Variance decomposition methods from a Vector Error Correction Model(VECM). On the basis of preceding researches and theoretical models, five macroeconomic variables that are expected to show close relationship with stock price index were chosen: consumer price index, foreign exchange rate, industrial production, interest rate, M2. Time series data were collected for the period from Oct 2000 to Aug 2015 and in addition to The global financial debacle was considered as another structural break point in this paper. Johansen Cointegration tests demonstrate that stock price levels are significantly related to industrial production, consumer price index, foreign exchange rate, interest rate, M2. Also long-run equilibrium relationship between stock prices and the set of macroeconomic variables exists. As a result of the Johansen Cointegraion test, there is one cointegration relation at most in all period sample and there are 2 cointegration relations at most before The global financial debacle and 3 cointegraion relations at most after The global financial debacle. Variance decomposition methods support the strong explanatory power of macroeconomic variables in contributing to the forecast variance of stock prices. The results of Variance decomposition methods indicate that foreign exchange rate, interest rate and M2 are more important than other variables on the Korean stock market after The global financial debacle.As a result of dividing into two different periods, there is a structural change in Korean capital market after The global financial debacle in 2008.

INTRODUCTION

Background and Purpose of Study

Many previous studies have made a lot of effort to empirically verify there are theoretical relationship between stock prices and macroeconomic variables. It is real economic activity in the period of economic models affect consumption and investment also these changes are closely related stock price index. As a result the changes of the variables depending on the results in the economy is reflected in the stock price.

In general, prediction of the price, there are two approaches. The first is the traditional method of predicting stock price time series model, second is the stock price prediction method according to the econometric model. In the approach to the time-series model to predict the price of stocks it has always had a theoretical rationale that can be observed by reflecting the movement of the stock price implied by any information that affects the share price. In contrast, in the approach to econometric models to predict the price of stocks it has always had a logical rationale that can be explained by the movement of the main macroeconomic variables in financial management and economic theory. A Preliminary Study on Korea's stock price prediction of stock market so far are multiple regression, simultaneous regression equations, ARMAX (Autoregessive Moving Average with Exogeneous Variables) model, VAR (Vector Auto Regression Model), etc. have been used in general. However, this model may have the following problems. When using the multiple regression model, the relationship between macroeconomic variables and stock price index is likely to ignore the dynamic aspects of the show but the stock price index. In

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addition, VAR model is considered all considered variable endogenous and can analyze the static and dynamic mutual relationships of the variables, but has a problem in that loss of the unique information of the time series inherent in the difference procedure of the parameters for the stability of the time series.

How to solve these problems in a VAR model with vector error correction model (Vector Error Correction Model; VECM) it has. According to the most recent econometric analysis of macroeconomic variables, most of macroeconomic variables including the composite stock price index represent non-stable time series rather than stable time series. VECM is a model for verifying the long-term equilibrium relationship and short-term dynamic structural relationship between the time-series variables is to have the cointegration of a time-series relationship with respect to such unstable.

The VAR model is losing the unique characteristics of time series data if the difference to the stability of such an unstable time series. Therefore, using the VEC model to address this problem. Unstable time series data have a model that can determine the short-term as well as long-term equilibrium relationship if the relationship with the co-integration relationships. Using these advantages were conducted this study to evaluate the correlation between the divided before and after the global financial crisis stock index and the macroeconomic variables.

THE THEORETICAL BACKGROUND

Security Valuation Model

The dividend evaluation model is a typical model which represents the relation between stock prices and macroeconomic variables. According to the model, stock prices are discounted value from the expected value of future cash flow by having stocks. This can be represented in equation I as follow:

$$P = \sum_{t=1}^{\infty} \frac{E(CF)}{(1+R)^t}$$

Where P=present value at t, E(CF)= expected cash flow, R= risk adjustment yield from this equation, it is seen that stock price has a positive relation with E(CF), and a negative relation with R.

Briefly, the stock price is determined by the interaction between expected return and risk factors, and these factors have close relation, with macroeconomic variables, so that the change of economic situation influences stock price. Thus, the forecasting of stock price through macroeconomic variables is possible.

Macroeconomic Variables

Based on the result of preceding theories and studies, macroeconomic variables are divided into the areas of financial market, foreign market and real economy. We would like choose important macroeconomic variables for representing each market.

Money Supply and Stock Price

Some economists who have followed the footsteps of the post-Keynesian school of economics questioned the importance of money in driving stock prices. It is held that movements in money M2 reflect the shift of money from long-term saving deposits to demand deposits, and vice versa as a result of the preceding changes in stock prices. For instance, rise in stock prices provides an incentive to liquidate long-term saving deposits. The received money is then employed in buying stocks and other financial assets. In the process, demand deposits tend to increase, which in turn raises money M2.

It is argued that the trend is reversed when asset and stock prices falls. It means that it is the change in stock prices that actually causes changes in money M2, not the other way around. If money is not a causing factor, but rather is caused by changes in the stock market, obviously it is not a very helpful indicator. In other words, changes in money supply are simply the manifestation of changes that have already taken place in the stock market. Hence, M2 represents money supply.

Prices of commodities and Stock Price

Investors require a higher yield for the decreasing power of purchasing when price of commodities increases. As a result, the risk adjustment yield increases, so it negatively influences the stock returns. And at the same time, corporations increase their cash flow the increase in the price of commodities. In this case, companies' nominal cash flow increases in the same proportion as inflation, stock can provide hedge effect for inflation. In other words, there is no decrease of return for inflation, and stock can use as a hedge for inflation.

In the preceding studies, inflation which is stable and low- level is expected to show a positive relation between stock and inflation. However, Roll and Ross(1986) and Chen(1991) reported that stocks are not a hedge for inflation, because stock and inflation have a negative relation. In this study, the Consumer Product Index represents prices of commodities.

Interest Rate and Stock Price

According to the dividend evaluation model, when the interest rate increases, the stock price decreases due to the increase risk adjustment yield. The process is like this: when the interest rate increases, the expected return of investors increases, and as a result, stock price decreases, and vice versa. Meanwhile, in the case of bull market, companies have a fast turnover because of the fast correction of sales cash, which reacts by increasing money supply and causes decreasing interest and increasing stock price. In contrast, in the case of a bear market, even though the interest rate decreases, a decrease of investment demand causes a decrease of stock price. Thus, in this study, the 3-year AA- return of corporate bond represents the interest rate.

Real Economy and Stock Price

A company's stock prices may go up or down depending on whether investors think its industry is about to expand or shrink. For example, a company may be run well financially, but if the industry is declining, investors might question the company's capability to keep growing. In that case, the company's stock price may fall. Many industries expand and decrease in cycles. For example, house building declines when interest rates rise. The movement of an economy can be analyzed by various economic variables for production and demand, with the representative indicator being the Gross National Product (GNP). However, the GNP can be available only for a year to year or even quarter. Thus, it is difficult to judge the present economic situation or make a future economic prediction only with GNP. Therefore, for a swift grasp of economic trends, we should use variables which are issued monthly to understand the demand trend or production trend.

International Market and Stock Price

Under an open economy, a national economy has a close relation with the current balance, expert trend and exchange rate. Especially, the international market variables hold a very important role in countries which have large foreign portion of the whole economy such as Korea. Expected cash flow of companies, and as a result, the stock price would decrease, and vice-versa. In this paper, the Won per US dollar represents international market variables.

TABLE 2-1
THE MAIN HYPOTHESIS OF THE RELATIONSHIP BETWEEN THE KOREAN STOCK PRICE AND MACROECONOMIC VARIABLES

Macroeconomic Variables	The relationship with Stock Price	The main hypothesis
Money Supply	+	Monetary Theory
Prices of commodities	+ –	Fisher's theory Fama's Proxy hypothesis
Interest rate	–	Cash Flow Theory, Tobin's Portfolio Theory
Industrial Product Index	+	Cash Flow Theory, Monetary Theory, Tobin's q
Exchange rate	+	Cash Flow Theory

Previous Studies

A Domestic Research

Jung and Chung (2002) investigated the long-run equilibrium relationship between stock prices and six macroeconomic variables, using Johansen's co-integration analysis. In addition, using Hansen and Johansen (1993)'s recursive likelihood ratio test of the constant co-integration space, this study analyzed the stability of co-integrating vectors, i.e., the structural shift of the relationships between the macroeconomic variables. They found that the Korean market is co-integrated with six macroeconomic forces. However, the regime shift was found some time in 1987. Thus with the dummy variable for the structural changes, this study investigated the long-run relationship between stock prices and macroeconomic variables and showed that the signs of a co-integrating vector were the same as the signs expected by the hypothesis. The stock prices were negatively related with the long-term interest rate, the oil prices and Korean won against the US dollars, and positively related with the inflation, the industrial production, and the money supply.

An Overseas Research

Lee(1992) employed a four-variable VAR system real stock returns, real interest rates, growth in industrial production, and rate of inflation with a constant and six lags for the postwar period from 1947 to 1987. His major findings were three. First, stock return appears Granger-causally prior and helps to explain a substantial fraction of the variance in real activity, which responds positively to shocks in stock returns. Second, with interest rates in the VAR system, stock returns explain little variation in inflation; however, interest rates explain a substantial fraction of the variation in inflation, with inflation responding negatively to shocks in real interest rates. Lastly, inflation explains little variation in real activity, which responded negatively to shocks in inflation for the postwar period. He concluded that there was no causal linkage between stock returns and money supply growth, hence no causal relation between stock returns and inflation. One of the practical implications of his findings was that the negative correlation between stock returns and inflation observed for the post war period may not be a reliable relation for purposes of prediction.

DATA AND RESEARCH METHOD

Data and Analysis Period

Data

In this paper, we used KOSPI as a monthly data from Oct. 2000 to Aug. 2015 for analyzing the relation between stock price and macroeconomic variables. We chose five variables(money supply, inflation, interest rate, industrial production, Won per US dollars) to consider variables which were used in the Chen, Roll and Ross(1986) study and in previous articles. We used the consumer price index (CPI), which was 100 in 2010, as representing inflation; M2 in billion won as representing money supply; the 3-year AA- return of corporate bond as representing the interest rate; industrial production(IP), which was 100 in 2010, Data used in this paper was sourced from homepages for the Economic Statistics System, the Korea Energy Economics Institute, the Korea Maritime Institute. All data were converted to log value.

Analysis Period

This study from Oct. 2000 to Aug. 2015 is set by the sample 1. And because of the global financial crisis that is a large structural change point in Sep. 2008, we divided the whole period into two period, that is, from Oct. 2010 to Sep. 2008 is set by the sample 2 and from Oct. 2008 to Aug. 2015 is set by the sample 3. Also this paper includes a purpose of check the effect of the global financial crisis in Korean stock market.

Research Method

Unit root test

A unit root test tests whether a time series variable is non-stationary using an autoregressive model. The most famous test is the Augmented Dickey-Fuller(ADF) test. Another test is the Phillips-Perron test. Both these tests use the existence of a unit root as the null hypothesis. The testing procedure for the ADF test is the same as for the Dickey-Fuller test but it is applied to the model.

$$\triangle y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{k} \delta_i \triangle y_{t-i} + \epsilon_t$$

Where α is a constant, β the coefficient on a time trend and p the lag order of the autoregressive process. Imposing the constraints $\alpha = 0$ and $\beta = 0$ corresponds to modeling a random walk and using the constraint $\beta = 0$ corresponds to modeling a random walk with a drift. By including lags of the order p the ADF formulation allows for higher-order autoregressive processes. This means that the lag length p has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion, Bayesian information criterion or the Hannon Quinn criterion.

The unit root test is then carried out under the null hypothesis $\gamma = 0$ against the alternative hypothesis of $\gamma < 0$. Once a value for the test statistic $DF = \frac{\hat{\gamma}}{SE(\hat{\gamma})}$ is computed it can be compared to the relevant critical value for the Dickey-Fuller Test. If the test statistic is greater (in absolute value) than the critical value, then the null hypothesis of $\gamma = 0$ is rejected and no unit root is present.

Johansen co-integration test

Next, the step of testing co-integration needs to be implemented. Co-integration method has been developed by Granger as a new method in research of long term equilibrium relationships between variables. Then, this theory has been further developed with joint study made by Engle-Granger and relationships between long term equilibrium relationships and short term dynamic relationships. It became possible to reveal whether unstationary series in the level act together in the long term, thanks to Engel-Granger co-integration test developed by Engle and Granger and Johansen co-integration test developed by Johansen and Juselius (1990).

Before analyzing the cointergration test, we need to determine the optimal lag lengths which can be selected by using the Akaike Information Criterion (AIC), Schwarz information Criterion (SC). The principle is that the decrease of the sum of squared residuals after adding lagged term is more than the increase of penalty term. Hence, the minimum value of AIC and SC is the optimal lag length of cointegration test. Generally, the optimal lag length is determined based on the AIC and SC, but if the values of AIC and SC are not the minimum values at the same time, we employ sequential modified LR test statistic (LR) to make the selection. And Hypothesis to be examined with Johansen cointegration test to be applied on the study has been presented below:

H_0: There is no cointegration relationship between variables.

H_1: There is cointegration relationship between variables.

The Granger Causality test

A time series X is said to Granger-cause Y if it can be shown, usually through a series of F-tests on lagged values of X (and with lagged values of Y also known), that those X values provide statistically significant information about future values of Y. The test works by first doing a regression of ΔY on lagged values of ΔY. Once the appropriate lag interval for Y is proved significant (t-stat or p-value), subsequent regressions for lagged levels of ΔX are performed and added to the regression provided that they 1) are significant in and of themselves and 2) add explanatory power to the model. More than 1 lag level of a variable can be included in the regression model, provided it is statistically significant and provides explanatory power. The researcher is often looking for a clear story, such as X granger-causes Y but not the other way around. In the real world, often, difficult results are found such as neither granger-causes the other, or that each granger-causes the other.

Furthermore, Granger causality does not imply true causality. If both X and Y are driven by a common third process, but with a different lag, there would be Granger causality. Yet, manipulation of one process would not change the other.

Using the Granger-causality test, there are two regression analysis models to check to see what is causing between X and Y as follows and the results of the Granger causality test are shown in following the <table 3-1>.

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + \epsilon_{1t}$$

$$X_t = \sum_{i=1}^{n} \gamma_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + \epsilon_{2t}$$

TABLE 3-1
DECISION METHOD OF THE GRANGER CAUSALITY TEST

$H_0 : \alpha_i = 0$	$H_0 : \delta_i = 0$	Direction of the Granger-causality
reject	adoption	X granger-causes Y
adoption	reject	Y granger-causes X
reject	reject	each granger-causes the other
adoption	adoption	neither granger-causes the other

The Vector Error Correction Method(VECM)

It is quite possible for random walks to be related to each other so that a regression of one random walk on the other has a stationary error term. For example let $\Delta x_t = \epsilon, \Delta y_t = u$ and let $y_t + x_t$ be stationary. The simplest example is that $y_t = -x_t + v$. That is, let one random walk be the negative of the other – allowing for some error. Then the sum is simply a random error with no unit root or autocorrelation. If the combination of unit root variables is not unit root then there must be some relationship between them. This is if and only if statement. If you find co-integration then a relationship exists, if not it does not. Therefore if you are interested in establishing that a relationship exists between unit root variables, this is equivalent to establishing co-integration. That relationship is called the co-integrating vector, which for our example is since the sum is stationary. There is a way to write a system that captures all the relationships and avoids unit roots. Consider:

$$\Delta x_t = \alpha_1(\beta_1 y_{t-1} + \beta_2 x_{t-1}) + \epsilon_t + v_t$$

$$\Delta y_t = \alpha_2(\beta_1 y_{t-1} + \beta_2 x_{t-1}) + u_t + v_t$$

This is called a vector error correction model. The error correction comes from the co-integrating relationship. The betas contain the co-integrating equation and the alphas the speeds of adjustment. If y and x are far from their equilibrium relationship, either y or x or both must change, the alphas let the data choose.

THE EMPIRICAL ANALYSIS RESULTS

Basic Data Analysis

TABLE 4-1

BASIC DATA ANALYSIS OF MACROECONOMICS VARIABLES OF CLASSIFIED SAMPLES

Sample 1. The basic statistics for raw data						
	KOSPI	M2	CPI	LTR	IP	EXCH
Mean	1410.953	1352952.	93.43622	5.007933	90.10894	1122.218
Median	1517.120	1324033.	93.20200	5.170000	91.40000	1125.090
Maximum	2153.130	2218660.	110.2200	8.72000	119.4000	1453.350
Minimum	504.0400	696854.0	73.68700	1.98000	59.90000	914.8100
Std.Dev	534.7717	447999.2	11.41738	1.495451	14.36611	116.7143
Skewness	-0.302347	0.189971	-0.041267	0.120143	-0.143273	0.246725
Kurtosis	1.564846	1.665587	1.635507	2.643181	1.857261	2.732259
Sample 1. The statistics for data converted to log value						
	KOSPI	M2	CPI	LTR	IP	EXCH
Mean	7.163153	14.06056	4.529737	0.048765	4.487867	7.017701
Median	7.324569	14.09619	4.534769	0.050408	4.515245	7.025618
Maximum	7.674678	14.61241	4.702478	0.083606	4.782479	7.281627
Minimum	6.222656	13.45433	4.299826	0.019607	4.0962677	6.818716
Std.Dev	0.447298	0.343893	0.123678	0.014232	0.164408	0.103866
Skewness	-0.639267	-0.121834	-0.162355	0.085581	-0.353040	0.000121
Kurtosis	1.961574	1.633497	1.698043	2.627269	2.002310	2.536936

KOSPI-The Korea Composite Stock Price Index, M2-Money Supply, CPI-Consumer price Index, LTR- 3-year AA- return of corporate bond represents the interest rate,, IP-Industrial Product Index, EXCH-Exchange rate

Sample 2. The basic statistics for raw data						
	KOSPI	M2	CPI	LTR	IP	EXCH
Mean	1046.024	979730.2	84.08276	5.798542	79.20313	1104.950
Median	874.3200	946548.8	84.54250	5.570000	78.20000	1139.315
Maximum	2004.550	1395719.	95.78600	8.720000	102.4000	1325.360
Minimum	504.0400	696854.0	73.68700	3.730000	59.90000	914.8100
Std.Dev	431.7707	187043.9	5.894376	1.058696	9.285625	133.0479
Skewness	0.609268	0.520663	0.074486	0.460071	0.189939	0.072699
Kurtosis	2.101822	2.437823	2.018137	2.868239	2.258875	1.593899
Sample 2. The statistics for data converted to log value						
	KOSPI	M2	CPI	LTR	IP	EXCH
Mean	6.870521	13.77748	4.429367	0.056317	4.365212	7.000341
Median	6.773445	13.76058	4.437252	0.054204	4.359266	7.038180
Maximum	7.603175	14.14892	4.562117	0.083606	4.628887	7.189439
Minimum	6.222656	13.45433	4.200826	0.036621	4.092677	6.818716
Std.Dev	0.406161	0.187445	0.070189	0.009985	0.117371	0.120921
Skewness	0.187334	0.195248	-0.029144	0.435428	-0.026318	-0.029762
Kurtosis	1.747153	2.209171	1.975959	2.841964	2.255704	1.556367

KOSPI-The Korea Composite Stock Price Index, M2-Money Supply, CPI-Consumer price Index, LTR- 3-year AA- return of corporate bond represents the interest rate,, IP-Industrial Product Index, EXCH-Exchange rate

Sample 3. The basic statistics for raw data						
	KOSPI	M2	CPI	LTR	IP	EXCH
Mean	1833.040	1784631.	104.2547	4.093494	102.7229	1142.192
Median	1937.730	1773173.	106.0200	4.170000	103.7000	1122.940
Maximum	2153.130	2218660.	110.2200	8.560000	119.4000	1453.350
Minimum	1073.950	1403984.	93.35600	1.980000	83.50000	1018.700
Std.Dev	261.8526	208435.9	4.671896	1.406363	6.915136	91.15457
Skewness	-1.468181	0.178672	-0.523354	1.006235	-0.453606	1.612990
Kurtosis	4.411764	2.239603	1.847133	4.303566	3.345662	5.594451
Sample 3. The statistics for data converted to log value						
	KOSPI	M2	CPI	LTR	IP	EXCH
Mean	7.501618	14.38798	4.645828	0.040030	4.629733	7.037779
Median	7.569272	14.38828	4.663628	0.040854	4.641502	7.023706
Maximum	7.674678	14.61241	4.702478	0.082133	4.782479	7.281627
Minimum	6.979099	14.15482	4.557617	0.019607	4.424847	6.926283
Std.Dev	0.164256	0.116980	0.045398	0.013423	0.068784	0.075615
Skewness	-1.777203	-0.031840	-0.031840	0.960741	-0.673129	1.388483
Kurtosis	5.432853	2.212639	2.212639	4.183547	3.605541	4.923436

KOSPI-The Korea Composite Stock Price Index, M2-Money Supply, CPI-Consumer price Index, LTR- 3-year AA- return of corporate bond represents the interest rate, IP-Industrial Product Index, EXCH-Exchange rate

Correlation Analysis

In the whole period(sample 1), by the relation between KOSPI and the exchange rate, Won per United States Dollar has a negative correlation for KOSPI. For Korea, correlation of exchange rate and KOPSI has a negative correlation, which shows the Korean economy is highly dependent on exports. The LTR is known as having a negative correlation; it has a weak negative correlation with KOSPI, so its influence is not significant. CPI and IP have a strong positive correlation with KOSPI, which shows KOSPI can be a hedge role for inflation. KOSPI has also a strong positive correlation with M2.

Next in the sample 2, it is almost same as the sample 1. Won per United States Dollar has a negative correlation for KOSPI and the LTR is known as having a negative correlation. CPI and IP have a strong positive correlation with KOSPI and KOSPI has also a strong positive correlation with M2.

And in the sample 3, the results of correlation are the same as sample1 and 2 but the degree of correlation is weaker than other samples.

TABLE 4-2

THE CORRELATION ANALYSIS OF MACROECONOMICS VARIABLES OF CLASSIFIED SAMPLES

Sample 1. 2000. 10 ~ 2015. 08						
	KOSPI	M2	CPI	LTR	IP	EXCH
KOSPI	1.000000	0.916368	0.923205	-0.621608	0.930358	-0.485723
M2	0.916368	1.000000	0.994981	-0.714110	0.954755	-0.210235
CPI	0.923205	0.994981	1.000000	-0.734348	0.954230	-0.243670
LTR	-0.621608	-0.715755	-0.735708	1.000000	-0.687142	0.337120
IP	0.930358	0.954755	0.954230	-0.687142	1.000000	-0.317961
EXCH	-0.485723	-0.210235	-0.243670	0.337120	-0.317961	1.000000

Sample 2. 2000. 10 ~ 2008. 09						
	KOSPI	M2	CPI	LTR	IP	EXCH
KOSPI	1.000000	0.930947	0.926639	-0.245085	0.896991	-0.886579
M2	0.930947	1.000000	0.986768	-0.336547	0.924559	-0.843393
CPI	0.926639	0.986768	1.000000	-0.416512	0.911271	-0.859816
LTR	-0.245085	-0.334627	-0.414983	1.000000	-0.338115	0.440874
IP	0.896991	0.924559	0.911271	-0.338115	1.000000	-0.820288
EXCH	-0.886579	-0.843393	-0.859816	0.440874	-0.820288	1.000000

Sample 3. 2008. 10 ~ 2015. 08						
	KOSPI	M2	CPI	LTR	IP	EXCH
KOSPI	1.000000	0.765953	0.818312	-0.842945	0.739444	-0.915070
M2	0.765953	1.000000	0.957328	-0.943208	0.739114	-0.741742
CPI	0.818312	0.957328	1.000000	-0.919459	0.748890	-0.798035
LTR	-0.842945	-0.943208	-0.919459	1.000000	-0.749854	0.784322
IP	0.739444	0.739114	0.748890	-0.749854	1.000000	-0.706506
EXCH	-0.915070	-0.741742	-0.798035	0.784322	-0.706506	1.000000

The result of Unit root test

As the result of the ADF unit root test for variables in the sample 1, the null hypothesis which unit root exists was not rejected for the raw data. After 1 st differencing, the null hypothesis which unit root exists was rejected, so we can say that variables are stationary. Therefore the variables in this paper flow in an I(1) process. In the sample 2, as the result of the ADF unit root test for variables, the null hypothesis which unit root exists was not rejected for the raw data except CPI. After 1 st differencing, the null hypothesis which unit root exists was rejected, so we can say that variables are stationary. Lastly in the sample 3, as the result of the ADF unit root test for variables, the null hypothesis which unit root exists was not rejected for the raw data except LTR and EXCH. After 1 st differencing, the null hypothesis which unit root exists was rejected, so we can say that variables are stationary.

The result of the unit root test for variables in this empirical analysis is shown as follows.

TABLE 4-3
UNIT ROOT TEST OF CLASSIFIED SAMPLES

Sample 1. 2000.10 ~ 2015. 08						
	KOSPI	M2	CPI	LTR	IP	EXCH
Level	-2.442712	-1.437112	-0.061635	-2.725652	-1.631296	-2.005321
1st Difference	-9.829211 ***	-5.058045 ***	-10.06385 ***	-8.682520 ***	-3.833310 **	-9.098753 ***

Sample 2. 2000.10 ~ 2008. 09						
	KOSPI	M2	CPI	LTR	IP	EXCH
Level	-1.742149	-0.589214	-3.871881 **	-0.822983	-1.327805	-1.106780
1st Difference	-7.075454 ***	-6.557912 ***	-7.268625 ***	-8.151811 ***	-10.37339 ***	-6.448642 ***

Sample 3. 2008.10 ~ 2015. 08						
	KOSPI	M2	CPI	LTR	IP	EXCH
Level	-1.940663	-1.191813	-0.586080	-6.521123 ***	-2.852734	-3.186019 **
1st Difference	-8.919975 ***	-7.129473 ***	-10.16492 ***	-6.876940 ***	-5.366831 ***	-7.128981 ***

- * Critical Value 10%, ** Critical Value 5%, *** Critical Value 1%

The result of the Granger Causality test

For the result of the Granger causality test in the sample 1, KOSPI does granger-cause M2, CPI, LTR and IP. Especially there are two-way granger-causalities between LTR, IP and KOSPI. And EXCH does granger-cause KOSPI. Next, for the result of the Granger causality test in the sample 2, KOSPI does granger-cause M2, CPI, IP, EXCH and there are two-way granger-causalities between M2, EXCH and KOSPI. Lastly, for the result of the Granger causality test in the sample 3, KOSPI does granger-cause M2, LTR, IP and there is two-way grager-causality between IP and KOSPI.

TABLE 4-4
THE GRANGER CAUSALITY TEST OF A CLASSIFIED SAMPLES

null hypothesis	Sample 1		Sample 2		Sample 3	
	Time lag 2	Time lag 4	Time lag 2	Time lag 4	Time lag 2	Time lag 4
KOSPI ↛ M2	4.158438*	5.185138**	6.765203**	5.990982**	0.413730	10.78820**
M2 ↛ KOSPI	0.560734	1.368820	3.323169*	12.25917**	0.156145	2.954838*
KOSPI ↛ CPI	0.169433	3.767399**	4.804807*	6.555792**	0.004743	2.608039*
CPI ↛ KOSPI	3.749322*	1.397656	1.488358	0.724071	2.718013	3.444950*
KOSPI ↛ LTR	1.436873	10.41870**	0.319718	0.520945	2.883765	12.11671**
LTR ↛ KOSPI	1.687258	4.961635**	1.168975	0.602750	2.433699	2.736513*
KOSPI ↛ IP	2.777855	7.798031**	3.343883*	6.757133**	5.109326**	4.952944**
IP ↛ KOSPI	1.342696	11.63862**	3.392607*	2.320442	1.796625	5.043823**
KOSPI ↛ EXCH	0.240077	1.842179	5.341632**	4.283361**	0.131921	2.874621*
EXCH ↛ KOSPI	1.586014	8.635739**	7.750067**	8.266016**	0.194847	3.400293*

- * Critical Value 5%, ** Critical Value 1%

Analysis Result of the VECM

The result of the Johansen Co-integration test

We can know that the variables used in this paper were I(1) series through a unit root test for all variables in this empirical analysis. In many previous researches, after Unit root test, VECM was estimated by converting a stable series for an unstable time series. However, this method overlooks the equilibrium relation which is long- term dynamic and stable between series. In other words, even though time series variables are not stable, co-integration exists between two variables if the linear relation is stable. If variables are differenced because they are unstable before verifying the existence of co-integration, in this process, long-term information may be lost. If there is no co-integration between variables, VAR analysis should be done; otherwise VAR, including the long-term equilibrium section, is estimated through VECM.

<Table 4-5> shows that there are 3 co-integration relations at 5% significant level at least in the sample 1. And there are 3 co-integration relations at 5% significant level at least in the sample 2. Lastly, there are 4 co-integration relations at 1% significant level at least in the sample 3. It means that there is long term relation between KOSPI and macroeconomic variables. The result of the Johansen test for variables in the sample 1,2 and 3 are as follows:

TABLE 4-5
THE JOHANSEN COINTEGRATION TEST OF CLASSIFIED SAMPLES

Sample 1. (2000.10 ~ 2015. 08)				
Eigenvalue	Trace Statistic	0.05 Critical Value	0.01 Critical Value	Hypothesized No. of CE(s)
0.353345	207.7295	103.8473	113.4194	None **
0.320068	131.0037	76.97277	85.33651	At most 1 **
0.182556	63.10940	54.07904	61.26692	At most 2*
0.083962	27.63259	35.19275	41.19504	At most 3
0.047329	12.19778	20.26184	25.07811	At most 4
0.020605	3.664387	9.164546	12.76076	At most 5

Sample 2. (2000.10 ~ 2008. 09)				
Eigenvalue	Trace Statistic	0.05 Critical Value	0.01 Critical Value	Hypothesized No. of CE(s)
0.515886	171.6543	103.8473	113.4194	None **
0.374032	104.1880	76.97277	85.33651	At most 1 **
0.247522	60.62160	54.07904	61.26692	At most 2 *
0.190338	34.17391	35.19275	41.19504	At most 3
0.108877	14.53802	20.26184	25.07811	At most 4
0.040219	3.817636	9.164546	12.76076	At most 5

Sample 3. (2008.10 ~ 2008. 09)				
Eigenvalue	Trace Statistic	0.05 Critical Value	0.01 Critical Value	Hypothesized No. of CE(s)
0.453576	182.6769	103.8473	113.4194	None **
0.436791	134.3281	76.97277	85.33651	At most 1 **
0.393413	88.39973	54.07904	61.26692	At most 2 **
0.313660	48.40717	35.19275	41.19504	At most 3 **
0.165950	18.29658	20.26184	25.07811	At most 4
0.046147	3.779637	9.164546	12.76076	At most 5

- * Critical Value 5%, ** Critical Value 1%

The Estimation of Long-run Equilibrium Relationship

In the sample 1, KOSPI and Won per US dollar exchange rate have a negative long-term relation. The coefficient is -1379.283 This shows that if the Won per US dollar exchange rate is increased, KOSPI will be decreased because foreign investors tend to withdraw their money from KOSPI.

Consumer Price Index and KOSPI have a positive long-term relation. CPI is related to commodity price; generally commodity price has a negative long-term relation. This means that if commodity price is increased, and investors required a higher rate to compensate for the purchasing power, then this causes an increase of the risk adjustment rate; as a result, the stock price falls. In this empirical analysis, a stock can be a hedge for inflation. Industrial Product Index and KOSPI have a positive long-term relation. The coefficient is 538.6434. It corresponds with many previous researches in which corporate production activity and stock price have a positive relation. M2 and KOSPI have a positive long-term relation. The coefficient is 838.4430. The long-term relations correspond with the main hypothesis except LTR and EXCH. In the sample 2, the result of the long-term relations is same as sample 1. Lastly, in the sample 3, the long-term relations correspond with the main hypothesis except M2 and EXCH.

TABLE 4-6
LONG RUN EQUILIBRIUM RELATIONSHIP BETWEEN THE KOREAN STOCK PRICES AND MACROECONOMICS VARIABLES

	The Estimation of Long-run Equilibrium Relationship
Sample 1	KOSPI=-9101.062+838.4430M2+1258.265CPI+57.00356LTR+538.6434IP-1379.283EXCH
Sample 2	KOSPI=-7160.312+659.7298M2+1396.127CPI+113.9535LTR+611.5128IP-1485.239EXCH
Sample 3	KOSPI=18465.56-913.9283M2+1921.107CPI-76.99249LTR+328.4538IP-1934.354EXCH

KOSPI-The Korea Composite Stock Price Index, M2-Money Supply, CPI-Consumer price Index, LTR- 3-year AA- return of corporate bond represents the interest rate,, IP-Industrial Product Index, EXCH-Exchange rate

The Estimation of the VECM

As we have seen in the unit root test, because VECM is more appropriate than VAR. This is why we analyze the relation between KOSPI and macroeconomic variables. The error correction model, shows the equilibrium between variables.

TABLE 4-7
THE RESULTS OF COEFFICIENT ESTIMATION OF VECM

	Sample 1	**Sample 2**	**Sample 3**
Independent Variable	D(KOSPI)	D(KOSPI)	D(KOSPI)
CointEq1	-0.067197 [-1.51026]*	0.044806 [0.48336]	-0.289202 [-3.42599]***
CointEq2		296.8891 [1.10382]	133.5765 [0.51193]
CointEq3			-1168.148 [-1.86316]**
CointEq4			
D(KOSPI(-1))	0.303698 [3.15218]***	0.201855 [1.52497]*	0.231321 [1.53667]*

D(KOSPI(-2))	-0.070371 [-0.76025]	-0.074490 [-0.55908]	-0.077279 [-0.56765]
D(M2(-1))	-460.9405 [-0.34946]	-549.4411 [-0.37780]	-1754.316 [-0.61083]
D(M2(-2))	-2332.579 [-1.72824]**	-2372.341 [-1.61869]*	-7074.691 [-2.40354]***
D(CPI(-1))	-271.4175 [-0.17324]	-1064.178 [-0.58435]	-104.7557 [-0.03757]
D(CPI(-2))	375.5507 [0.21865]	-3539.355 [-1.68293]**	1031.546 [0.33397]
D(LTR(-1))	-23.65670 [-0.98356]	4.598511 [0.16655]	-42.88403 [-0.96609]
D(LTR(-2))	-0.868356 [-0.03559]	19.90697 [0.65642]	58.26911 [1.32917]*
D(IP(-1))	97.66838 [0.53257]	355.6073 [1.48103]*	238.5838 [0.70769]
D(IP(-2))	-89.41244 [-0.67244]	235.4014 [1.25904]	-154.1355 [-0.71104]
D(EXCH(-1))	89.02298 [0.31189]	859.0687 [2.05296]	108.6370 [0.22721]
D(EXCH(-2))	53.06660 [0.18498]	95.95353 [0.24279]	413.5980 [0.90963]
C	23.07067 [1.81047]**	42.06556 [2.57225]**	56.98800 [2.21562]**
R-squared	0.137362	0.262856	0.354177
Adj. R-squared	0.050556	0.107667	0.190158

KOSPI=The Korea Composite Stock Price Index, M2=Money Supply, CPI=Consumer price Index, LTR= 3-year AA- return of corporate bond represents the interest rate., IP=Industrial Prodect Index, EXCH=Exchange rate

- * Critical Value 10%, ** Critical Value 5%, *** Critical Value 1%
- [t-statistics value]

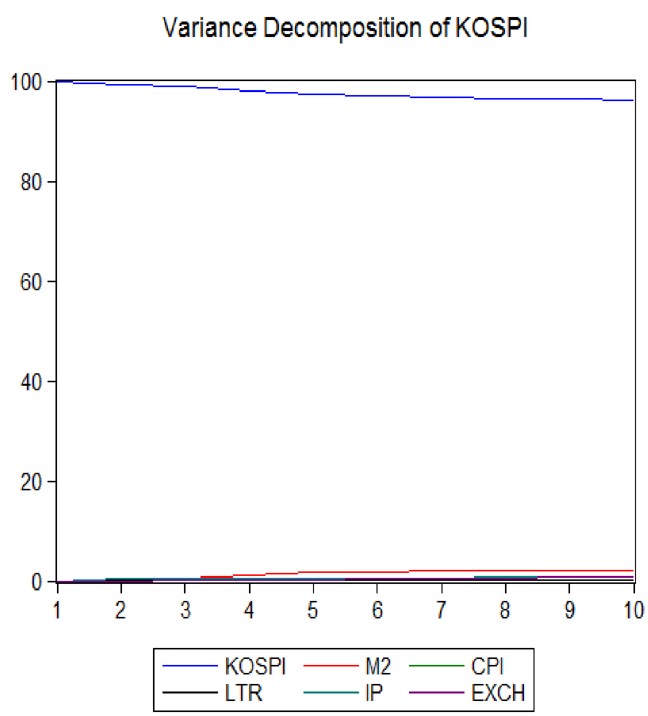
Prediction and Variance Decomposition

Variance decomposition provides a different method of depicting the system dynamics. Variance decomposition decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VECM. The variance decomposition gives information about the relative importance of each random innovation to the variables in the VECM.

When a certain variable has a power of influence, the portion is big or becoming increased; in contrast, when certain variables do not have a power of influence, the portion is small or becoming decreased. <Table 4-8> represents the variance portion of KOSPI forecasting error for each variable in VECM in the sample 1. After 10 periods, KOSPI explains 96% of its own variance, M2 explains 2.08% of the KOSPI variance, then other variables have a very small influence on KOSPI. And <Table 4-9> represents the variance portion of KOSPI forecasting error for each variable in VECM in the sample 2. After 10 periods, KOSPI explains 82% of its own variance. M2 explains 6.28% of the KOSPI variance, LTR explains 7.31% of the KOSPI and EXCH explains 2.27% of the KOSPI variance, Then other variables have a very small influence on KOSPI. Lastly, <Table 4-10> represents the variance portion of KOSPI forecasting error for each variable in VECM in the sample 3. After 10 periods, KOSPI explains 72% of its own variance. EXCH explains 10.37 of the KOSPI variance, M2 explains 8.39% of the KOSPI and LTR explains 7.64% of the KOSPI. Then other variables have a very small influence on KOSPI.

TABLE 4-8
THE RESULT OF VARIANCE DECOMPOSITION OF THE WHOLE PERIOD

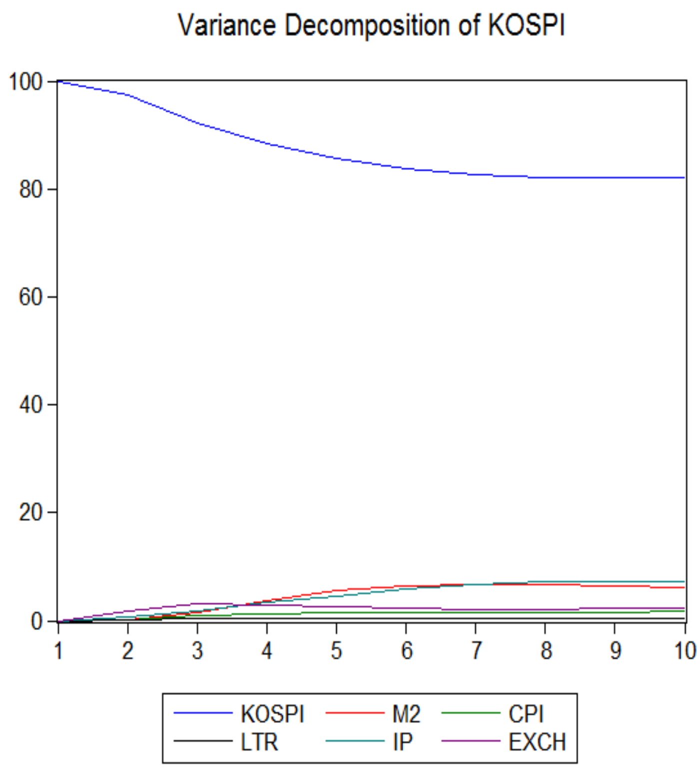
Variance Decomposition of KOSPI						
Period	KOSPI	M2	CPI	LTR	IP	EXCH
1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	99.29629	0.018746	0.036601	0.121433	0.526927	6.35E-08
3	98.82828	0.416456	0.101572	0.235070	0.396662	0.021957
4	98.04275	1.156955	0.077613	0.258495	0.352251	0.111935
5	97.34714	1.649480	0.074421	0.220918	0.463010	0.245029
6	97.01174	1.851390	0.064608	0.192033	0.521604	0.358622
7	96.75951	1.981619	0.058039	0.174416	0.580783	0.445632
8	96.50020	2.056318	0.056368	0.162716	0.679671	0.544725
9	96.29832	2.077954	0.056929	0.153720	0.749345	0.663729
10	96.11217	2.083346	0.063429	0.147750	0.809911	0.783391



Graph 4-1. The graph of Variance Decomposition of the whole period

TABLE 4-9
THE RESULT OF VARIANCE DECOMPOSITION BEDORE THE GLOBAL FINANCIAL DEBACLE

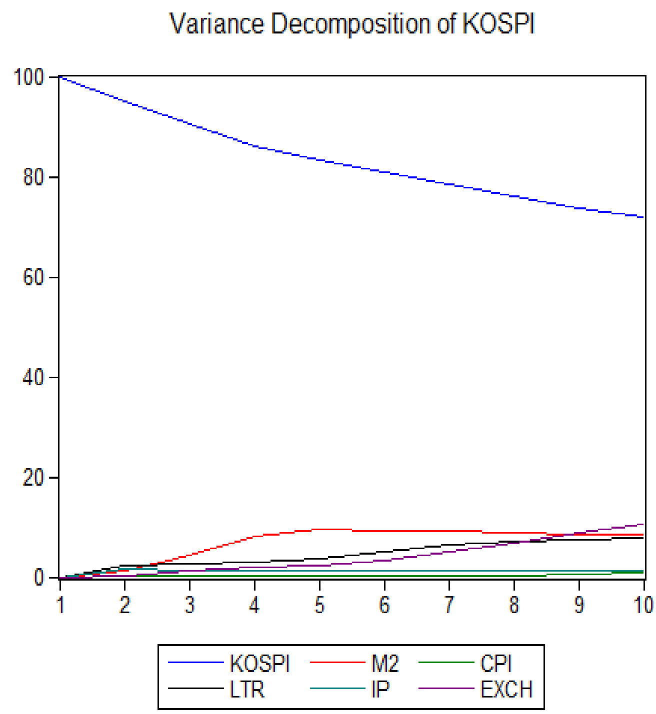
Variance Decomposition of KOSPI						
	KOSPI	M2	CPI	LTR	IP	EXCH
1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	97.29027	0.064498	0.006005	0.195206	0.694605	1.749416
3	92.29162	1.515794	0.822110	0.428410	1.777620	3.164442
4	88.25811	3.740382	1.326304	0.365724	3.321552	2.987927
5	85.64734	5.586998	1.368319	0.336827	4.496383	2.564135
6	83.74561	6.470885	1.374596	0.376230	5.747865	2.284812
7	82.55802	6.728781	1.379818	0.433488	6.746576	2.153315
8	82.19621	6.652895	1.423797	0.442126	7.137998	2.146977
9	82.08234	6.465533	1.554690	0.428346	7.261262	2.207828
10	82.00243	6.281742	1.723271	0.414480	7.312788	2.265291



Graph 4-2. The graph of Variance Decomposition before the Global Financial Debacle

TABLE 4-10
THE RESULT OF VARIANCE DECOMPOSITION AFTER THE GLOBAL FINANCIAL DEBACLE

Variance Decomposition of KOSPI						
	KOSPI	M2	CPI	LTR	IP	EXCH
1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	94.98438	1.096733	0.106227	2.204523	1.457260	0.150873
3	90.40299	4.403094	0.106148	2.720591	1.236110	1.131071
4	85.96641	8.103938	0.119374	2.964144	1.089193	1.756942
5	83.20837	9.429759	0.173286	3.540412	1.314437	2.333736
6	81.00726	9.254233	0.182955	4.923109	1.265529	3.366914
7	78.32526	8.998468	0.218694	6.288005	1.200180	4.969395
8	75.88765	8.812428	0.280217	6.993655	1.147299	6.878747
9	73.72947	8.576444	0.546087	7.385383	1.106578	8.656044
10	71.80862	8.389027	0.701090	7.643378	1.085620	10.37227



GRAPH 4-3. The Graph of Variance Decomposition before the Global Financial Debacle

As the result of the Variance Decomposition of KOSPI, the importance of macroeconomic variables are changed from M2 and IP before the Global financial crisis to LTR and EXCH after the Global financial crisis. We can know that the relation between Korean stock market and macroeconomic variables are not fixed but changing.

CONCLUSION

The purpose of this study is to figure out the econometric relation between KOSPI and macroeconomic variables. Based on the results of this empirical study, we can conclude as follows: First, by the long-term equilibrium for KOSPI and macroeconomic variables using a co-integration vector we can know that KOSPI has a negative relation with EXCH in all of the samples, a positive relation with LTR in the sample 1,2 but a negative relation in the sample 3, a positive relation with CPI and IP in all of the samples, a positive relation with M2 in the sample 1,2 but a negative relation in the sample 3,

Second, through Granger Causality, in the sample 1, KOSPI does granger-cause M2, CPI, LTR and IP. Especially there are two-way granger-causalities between LTR, IP and KOSPI. And EXCH does granger-cause KOSPI. Next, in the sample 2, KOSPI does granger-cause M2, CPI, IP, EXCH and there are two-way granger-causalities between M2, EXCH and KOSPI. Lastly, in the sample 3, KOSPI does granger-cause M2, LTR, IP and there is two-way grager-causality between IP and KOSPI.

Third, as the result of the Johansen co-integration, there are long-term relations between KOSPI and macroeconomic variables. And it is more important result that there exist more co-integration relations after the Global financial crisis than before the Global financial crisis, that is, the correlations are stronger between variables.

Fourth, as the result of the Variance Decomposition of KOSPI, the importance of macroeconomic variables are changed from M2 and IP before the Global financial crisis to LTR and EXCH after the Global financial crisis. We can know that Korean capital market is more affected by foreign capital market after the Global financial crisis.

There are many macroeconomic variables which are related to KOSPI. Thus, we left the finding that the more macroeconomic variables which are related to KOSPI, then the more precise the forecasting, for further study.

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