Lead-lag relationship between macroeconomic variables and stock market: evidence from Korea

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Abstract

This study attempts to investigate whether share price index, specifically KOSPI of Korean Exchange, can be considered as a mirror or reflection of economic activities in Korea. The purpose is to make a finer point with respect to the relationship between economic growth and stock market especially in terms of stock prices. The present study proceeds with a single point investigative agenda as to what is the relationship between the health of the real economy and the health of the stock market? Does a rally in share prices reflect better health of the economy or it is the pink economic health that causes share prices to change?

We have examined the causal relationships between the share price index and other crucial macroeconomic variables namely money supply, exchange rate, consumer price index, and money market rate for the reason of right and robust model specification. The standard time series techniques have been employed. The present study reports causality running from economic growth to share price index and not the other way round. It may therefore be stated that the stock markets in Korea are demand driven and industry led which means that demand for greater equity finance is led by higher and improved economic performance. That is, the state of the economy has a bearing on the share prices but the health of the stock market in the sense of a rising share price index is not reflective of an improvement in the health of the economy. In other words, a Bull Run or rising prices in the stock market cannot be taken to be a leading indicator of the revival of the economy in Korea.

Keywords: Lead-lag relationship, stock markets, macroeconomic variables, time series techniques, Korea

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1. INTRODUCTION

In modern economy, the role of stock exchange is very important. It can be very helpful to diversify the domestic funds and channels into productive investment. However to perform this important task, it is necessary and critical that stock markets have a significant relationship with the macroeconomic variables. Nowadays capital market became a key element of modern market based economy. They transfer the long term funds from savers to borrowers of capital which is very essential for economic development. Economic growth and prosperity is possible only when capital market works efficiently. After globalization, international capital markets are integrated rapidly. This integration has positive effects on economic growth, reducing the risk and especially contagion impact on financial crises.

Stock market plays a vital role to transfer of funds from capital borrowers to capital investors which is essential for economic growth. In other words the stock market is very significant to speed up economic growth through increasing liquidity of financial assets and diversification of global risk easier for investors to make a wiser investment decision. (Agrawalla 2006). A well performing stock exchange is very helpful for economic activity through growth and saving, efficient allocation of investment and attracting FDI (foreign direct investment). The stock market gives confidence to savers by providing domestic households having investable funds, innovation in financial instruments, which diversify their risk and better sharing in investment projects (Agrawalla 2006).

This paper makes an attempt to explore a previously uncharted territory on the cointegration relationship between the variables in the Korean economy and the Korean Stock Market. There is a dearth of literature on this topic for Asian and especially nonexistent for Korean economic factors, both as the techniques employed are relatively newer and also because of the complexities of the process.

2. LITERATURE REVIEW

Emerging stock markets for a long time in the academic circles have been identified as being at least partially segmented from global capital markets. It has been repeatedly argued and the topic of numerous researches that the local economy factors play the anchor role in the equity returns rather than the global factors.

Under this broader framework Bilson, Brailsford, and Hooper (1999) made an attempt to address this question "Whether macroeconomic variables may proxy for local risk sources". They found moderate evidence to support this hypothesis. Furthering their research in search of some commonality patterns in emerging market return, their results found little evidence when the markets were considered collectively. However on the regional level considerable traces of commonality was shown.

Maysami and Sims (2002, 2001a, 2001b) employed the Error-Correction Modeling technique to examine the relationship between macroeconomic variables and stock returns in Hong Kong and Singapore (Maysami and Sims, 2002b), Malaysia and Thailand (Maysami and Sim 2001a), and Japan and Korea (Maysami and Sims 2001b).

Using the Hendry's (1986) approach which allows making inferences to the short-run relationship between macroeconomic variables as well as the long-run adjustment to equilibrium, they were able to analyze the inter-relation and influence of interest rate, inflation, money supply, exchange rate and real activity, to understand the impact 1997 Asian financial crisis. Their findings clearly pointed towards the influence of macroeconomic variables on the stock market indices in each of the six countries under study, though the type and magnitude of the associations differed depending on the country's financial structure.

Ibrahim (1999) investigated the dynamic interactions between the KLSE Composite Index, and seven macroeconomic variables (industrial production index, money supply M1 and M2, consumer price index, foreign reserves, credit aggregates and exchange rate). Under his observations he was able to conclude that Malaysian stock market was informationally inefficient.

Chong and Koh's (2003) in a further study concluded with the same results showing that stock prices, economic activities, real interest rates and real money balances in Malaysia were linked in the long run both in the pre- and post-capital control sub periods.

In a slightly older research of Mukherjee and Naka (1995), with the use of Johansen's (1998) VECM the authors analyzed the relationship between the Japanese Stock Market and exchange rate, inflation, money supply, real economic activity, long-term government bond rate, and call money rate. They concluded that a cointegrating relation indeed existed and that stock prices contributed to this relation. Maysami and Koh (2000) in a similar

attempt concluded that such relationships do exist in Singapore. They found that inflation, money supply growth, changes in short- and long-term interest rate and variations in exchange rate formed a cointegrating relation with changes in Singapore's stock market levels.

Hassan (2003) employed Johansen's (1988, 1991, 1992b) and Johansen and Juselius' (1990) multivariate cointegration techniques to test for the existence of long-term relationships between share prices in the Persian Gulf region. Employing vector-error-correction model, he also investigated the short-term dynamics of prices by testing for the existence and direction of intertemporal Granger-causality. The analysis of weekly price indices in Kuwait, Bahrain, and Oman stock markets showed that: (1) share prices were cointegrated with one cointegrating vector and two common stochastic trends driving the series, which indicates the existence of a stable, long-term equilibrium relationship between them; and (2) prices were not affected by short-term changes but were moving along the trend values of each other. Therefore, information on the price levels would be helpful for predicting their changes.

Vuyyuri (2005) investigated the cointegrating relationship and the causality between the financial and the real sectors of the Indian economy using monthly observations from 1992 through December 2002. The financial variables used were interest rates, inflation rate, exchange rate, stock return, and real sector was proxied by industrial productivity. Johansen (1988) multivariate cointegration test supported the long-run equilibrium relationship between the financial sector and the real sector, and the Granger test showed unidirectional Granger causality between the financial sector and real sector of the economy.

Gunasekarage, Pisedtasalasai and Power (2004) examined the influence of macroeconomic variables on stock market equity values in Sri Lanka, using the Colombo All Share price index to represent the stock market and (1) the money supply, (2) the treasury bill rate (as a measure of interest rates), (3) the consumer price index (as a measure of inflation), and (4) the exchange rate as macroeconomic variables. With monthly data for the 17-year period from January 1985 to December 2001 and using unit root tests, cointegration, and VECM, they examined both long-run and short-run relationships between the stock market index and the economic variables The VECM analysis provided support for the argument that the lagged values of macroeconomic variables such as the consumer price index, the money supply and the Treasury bill rate have a significant influence on the stock market.

3. THEORIES

Economic theory postulates that interest rates, inflation, price level, and money supply and market capitalization and other factors are important variables in developing a comprehensive understanding of the behavior of stock prices and index movements.

Gross Domestic Product (GDP) - The most popular measure of real economic activities is the gross domestic product (GDP). The GDP is an economic number that indicate the total value of all the final goods and services produced by resources located in a country during a period. The GDP become one of the most important economic numbers because it gives economists and investor a rough idea of how fast the economy is growing. In the other hand, stock market usually is used as mirrors for growth of economic. When a nation's economy is doing well, the growth of GDP will be reflected in the increasing value of stock in the market. But the effect of GDP growth on stock prices is difficult to predict in part because there are two potentially offsetting effects. Stronger than expected GDP growth implies potentially stronger dividend growth and higher equity prices, however, the accompanying inflation and interest rate concerns tend to have a negative effect on equity prices.

Several studies in the macroeconomics and finance literature have examined the effect of the surprise component of various macroeconomic releases (i.e. actual less consensus or survey estimates) on asset price movements on that day, or intraday around the time of the release (Bernanke and Kutter (2003), Fair (2003), and others). In general, these studies tend not to find a significant effect of the GDP release news and equity price movements due to the offsetting effects and difficulty measuring the true “news” contained in the data release. Nevertheless, the disconnect between equity prices and GDP release surprises remains a puzzle. A study by Rigobon and Sack (2006) tries to address some of these problems. Using data from 1994 to 2006, they find no significant effect from advance GDP release surprises on equity prices using a standard OLS regression. However, they do find a slightly positive effect that is statistically significant when they use a more advanced econometric method which controls for censoring effects. The coefficient was tiny, so it would take a large surprise to generate even a small movement in stock prices according to their findings.

Inflation - Another variable of interest is inflation. There are two opinions which explain the relationship between inflation and stock price (Reilly, 1992: 44). The first opinion said that there is positive relationship between inflation and stock price. Increasing the inflation rate will have positive effect to the stock price. The

follower of this opinion assumes that the inflation occurred is caused demand pull inflation. The inflation condition in the company, producer, can impact increasing more consumer cost. Therefore, the profit margin increases, so it will be positive perspective to stock price in stock market, so on. The same opinions are said by Donald E. Vaugh:"...a growing assets base should support sales and earnings per share. Lastly, during an inflationary economics, sales prices per unit of output are likewise usually rising, thus providing higher dollar per share and hopefully larger reported earnings per share figure…" (Vaugh, 1984: 195). The second opinion explains that increasing inflation rate will result in decreasing stock price. Arising this opinion assumes that happened inflation is cost push inflation. The inflation existence results raw material cost and labor wages, so at this condition, the producer do not dare to increase its product price. This matter causes decreasing profit margin, so expected return and dividend follow it downhill. This condition causes downhill share price. Meanwhile, Kolb express in its book, investment, that high inflation rate whether anticipated or unanticipated seems to occur with low stock price (Kolb, 1988: 268). The increasing of accelerating inflation will cause disinclination all investor to invest its fund in the stock form, investor tend to choose investment in the other form like investment in real estate or gold (Winger, 1992: 475).

Money Supply (M1) - In economics, money supply or money stock is defined as the total amount of money available in an economy at a particular point in time (Johnson, 1994). There are several ways to calculate, but standard measures usually include currency in circulation and demand deposits (M1). Money supply data are recorded and published, usually by the government or the central bank of the country. Public and private-sector analysts have long monitored changes in money supply because of its possible effects on the price level, inflation and the business cycle. That relation between money and prices is historically associated with the quantity theory of money. There is strong empirical evidence of a direct relation between long-term price inflation and money-supply growth. These underlie the current reliance on monetary policy as a means of controlling inflation. This causal chain is however contentious, with heterodox economists arguing that the money supply is endogenous and that the sources of inflation must be found in the distributional structure of the economy. Mukherjee and Naka (1995) advanced a view that the relationship between the two is ambiguous and may be positive or negative, an explanation for the observed findings need to be made. Indeed, based on a diagrammatic model, Bulmash and Trivoli (1991) argued that the increase in money supply has immediate positive liquidity effects and long-run negative effects on the stock market. Provided that rational expectations on consequences of monetary expansion are formed with delay, monetary expansion generates first the wealth effect, which leads to an increase in aggregate spending on both real goods and services and on financial assets

such as stocks and bonds. In the long-run, various factors such as inflation uncertainty and anticipation of depreciation and monetary contractions may set in and result in negative responses by the stock market.

Exchange Rate - The impact of exchange rate can be positive or negative to stock price. Based on "exchange rate channel" of monetary policy transmission as in Pan et al (2007), a depreciation of the local currency makes exporting goods less expensive and may lead to increase in foreign demand and sales for the exporting firms. As a result, the value of exporting (importing) firm would increase (decrease). This, however, is only true if the demand for exports and imports are elastic. If the demand for imports is inelastic, the benefit of increased export would be absorbed by higher prices paid for import. Thus, the impact of exchange rate on stock price can be positive or negative depends on the importance of a nation's international trade in its economy as well as the degree of the trade balance (net value of export and import activities)

4. SOUTH KOREA STOCK EXCHANGE (KOREA EXCHANGE)

South Korea's first stock market was created in 1956, only three years after the ceasefire ending the Korean War. The first year of the stock market featured 12 domestic companies dealing in government bonds. In the 1970s, the South Korean government introduced the Korean Securities Depository (1974) and the Korean Securities Computer Corporation (1977) to streamline trading and end-of-day reconciliation. The Korean stock market was closed to foreign investors until 1992 when a limited number of major international firms were allowed to trade in Seoul. The exchange has increased in importance since 1997 as limitations on foreign companies listed on the market were lifted.

The Korean stock market is one of several divisions of the Korean Exchange, a financial corporation in charge of the country's domestic and international trade. The Korean Exchange oversees the Stock Market, Futures and Management Strategy Divisions through its board of directors and chairman. The stock market's daily organization has gone from manual trading in the early 1980s to automated orders in 1983 and a fully automated trading platform in 1997. South Korea's modern stock market was created in 2005 when the nation's four markets merged into a single entity. The Korean stock market is located in Yeouido, an island adjacent to Seoul.

The Korea Composite Stock Price Index or KOSPI is the index of all common stocks traded on the Stock Market Division—previously, Korea Stock Exchange—of the Korea Exchange. It's the representative stock market index of South Korea, like the Dow Jones Industrial Average or S&P 500 in the U.S. KOSPI was introduced in

1983 with the base value of 100 as of January 4, 1980. It's calculated based on market capitalization. As of 2007, KOSPI's daily volume is hundreds of millions of shares or (trillions of won).

5. DATA AND METHODOLOGY

i. Data

This research utilizes quarterly data from 1994:Q1 to 2010:Q4 of stock market return and macroeconomics variables of Korea, a total of 68 quarters. The stock return used is the Korea Composite Stock Price Index (KOSPI), while the macroeconomics variables considered the Gross Domestic Product (GDP) as a proxy of real economic activities, the Customer Price Index (CPI) as a proxy of inflation, the exchange rate (FX) is represented by the bilateral Won exchange rate against the US dollar, and the money supply (M1).

All of these data were retrieved from Datastream. All variables were taken in their level form, and for their log form, for running identification tests their difference log forms have been taken in account. The basic statistics of the data are presented in Table 1.

Table 1: Definition of Variables

Acronym	Definition of Variables	Source
LKOSPI	Logarithm of quarterly-end closing index of Korean composite index	Datastream
LGDP	Logarithm of quarterly-end Gross Domestic Product (constant price 1990)	Datastream
LCPI	Logarithm of quarterly-end Consumer Price Index of Korea	Datastream
LFX	Logarithm of quarterly-end real exchange rate of Won to USD	Datastream
LM1	Logarithm of quarterly-end M1 money supply of Korea	Datastream

The variables basic statistical measures are presented in Table 2.

	KOSPI	GDP	CPI	M1	FX (1USD = KRW)
Mean	993.98	191059.00	91.34	233711.30	1080.60
Standard Deviation	422.51	42590.90	14.75	105574.20	203.34
Minimum	305.64	120132.10	65.60	75551.50	756.10
Maximum	1962.70	263240.90	117.60	415888.30	1716.30

Table 2. Basic Statistical Measures for Variables

ii. Methodology

In the model for this paper the examination of the dynamic relations between macroeconomic variables related to the KOSPI may be undertaken through either Engle and Granger (1987) or Johansen and Juselius (1990) protocols. While Engle and Granger's (1987) two-step error correction model may be used in a multivariate context, the Johansen's (1990) VECM yields more efficient estimators of cointegrating vectors. This is because the Johansen's (1990) VECM is a full information maximum likelihood estimation model, which allows for testing cointegration in a whole system of equations in one step, without requiring a specific variable to be normalized.

The model in this paper does not finish at the VECM stage but takes it one step further into Variance Decomposition techniques for analyzing the leading and the follower variable with culminating in the Persistence Profiling with system wide shocks and in Impulse response function using Generalized Impulse Response function to further refine the explanation of the linkage.

6. RESULTS and DISCUSSIONS

Unit Root Tests: Time series data are often assumed to be non-stationary and thus it is necessary to perform a pretest to ensure there is a stationary cointegrating relationship among variables to avoid the problem of spurious regression. Based on the error correction mechanism as indicated by Johansen (1990), it is necessary for the variables to be of the same order of integration.

The tests for stationary or unit roots employ the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests performed on the variables in levels and first differences. We have utilized the ADF test for testing the unit root. The ADF test with null hypothesis of existence of unit root, which implies the variable, is non-stationary, whereas the alternative hypothesis is the non-existence of unit root, which implies the variable, is stationary. The summary results for the level form variables are represented in Table 3. The detail results are in Appendix 1A to 1E.

Variable	T-Statistic	95% Critical Value	Null Hypothesis	Implication
Variables in Level Form				
LKOSPI	-2.7016	-3.4824	Accepted	Non-stationary
LGDP	-3.0897	-3.4824	Accepted	Non-stationary
LCPI	-2.8642	-3.4824	Accepted	Non-stationary

LM1	-1.4009	-3.4824	Accepted	Non-stationary
LFX	-2.3365	-3.4824	Accepted	Non-stationary

Table 3: Level log form ADF Output

In the level log form all the variables represent a lower t-statistic than the critical value, thus accepting the null hypothesis, that there is unit root. At 5 % significance level all variables are non-stationary. For the differenced form of the log variables, as represented in Table 4, the t-statistics are larger than the critical value at 5 % significance level, thus the null hypothesis is rejected and the alternate hypothesis of no unit root accepted. The detail results are in Appendix 1F to 1J.

Variable	**Test Statistic**	**95% Critical Value**	**Null Hypothesis**	**Implication**
DKOSPI	-5.0767 (AIC)	-2.9092	Accepted	Stationary
	-5.0713 (SBC)	-2.9092	Accepted	Stationary
DGDP	-4.9355 (AIC)	-2.9092	Accepted	Stationary
	-4.7212 (SBC)	-2.9092	Accepted	Stationary
DCPI	-5.9789	-2.9092	Accepted	Stationary
DM1	-5.1130	-2.9092	Accepted	Stationary
DFX	-6.0080	-2.9092	Accepted	Stationary

Table 4: Differenced log form ADF Output

Relying primarily on the AIC and SBC criteria, the conclusion that can be made from the above results is that all the variables we are using for this analysis are I(1), and thus we may proceed with testing of cointegration.

Order of the VAR: The next empirical result is the determination of the Order of VAR model. The differenced log form of variables is taken in consideration, due to their stationary characteristic. The unrestricted VAR post estimation menu with an arbitrarily high order of 6 for estimation, gives a varying result for Alkaline Information Criterion and Schwarz Bayesian Criterion.

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Test Statistics and Choice Criteria for Selecting the Order of the VAR Model
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 Based on 61 observations from 1995Q4 to 2010Q4. Order of VAR = 6
 List of variables included in the unrestricted VAR:
 DKOSPI          DGDP            DCPI            DM1             DFX
*****************************************************************************
 Order    LL         AIC       SBC             LR test         Adjusted LR test
   6   736.9752  586.9752  428.6597                ------              ------
   5   717.2178  592.2178  460.2882  CHSQ( 25)=  39.5149[.033]   20.0814[.743]
   4   686.9099  586.9099  481.3662  CHSQ( 50)= 100.1307[.000]   50.8861[.439]
   3   651.0765  576.0765  496.9187  CHSQ( 75)= 171.7975[.000]   87.3069[.157]
   2   636.1471  586.1471  533.3753  CHSQ(100)= 201.6562[.000]  102.4810[.413]
   1   613.9514  588.9514  562.5654  CHSQ(125)= 246.0478[.000]  125.0407[.482]
   0   556.6068  556.6068  556.6068  CHSQ(150)= 360.7369[.000]  183.3253[.033]
*****************************************************************************
    AIC=Akaike Information Criterion     SBC=Schwarz Bayesian Criterion
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Table 5. Test Statistics and Choice Criteria for Selecting the Order of the VAR Model

Since there is an apparent conflict between AIC and SBC recommendations, we would address this by checking for the serial correlation for each variable. Please refer to Appendix 2A to 2E for details. The summary results are as follows:

Variable	**Chi-square p-value**	**Implication (at 10%)**
DKOSPI	0.241	There is no serial correlation
DGDP	0.063	There is no serial correlation
DCPI	0.181	There is no serial correlation
DM1	0.000	There is serial correlation
DFX	0.740	There is no serial correlation

From the above table, there exist autocorrelation in 1 out of the 5 variables. Thus, if we adopted a lower order, we may encounter the effects of serial correlation. The disadvantage of taking a higher order is that we risk over-parameterization. However, in our case, given that we have a relatively low number time series (68 observations), this is a serious concern. Considering the trade-off of lower and higher orders, we decided to choose the higher VAR order of 2.

Cointegration Results: Cointegration implies that the relationship among the variables is not spurious i.e. there is a theoretical relationship among the variables and that they are in equilibrium in the long run. Employing the Cointegration LR Test Based on Maximal Eigen value, the results imply that there exists one cointegrating relationship at 10 % significance level between the variables. Please see Appendix 3 for detail results.

Null Hypothesis	Alternate Hypothesis	Statistic	95% Critical Value	90% Critical Value	Conclusion
r= 0	r=1	46.8762	37.8600	35.0400	Reject Null Hypothesis Accept Alternate
r<=1	r=2	23.9112	31.7900	29.1300	Accept Null Hypothesis Reject Alternate

Table 6: Cointegration Test Results based on Test of Maximal Eigenvalue

As depicted in the table below, the Maximal Eigenvalue, Trace and HQC indicate that there is one cointegrating vector whereas according to AIC and SBC, there are 6 and one cointegrating vectors, respectively

Criteria	Number of cointegrating vectors
Maximal Eigenvalue	1
Trace	1
AIC	5
SBC	1
HQC	4

We are inclined to believe that there is one cointegrating vector as intuition based on our familiarity with contemporary equity markets, economic performance and indicators which tells us that the economic performance tends to have an effect on local markets to varying degrees. Based on the above statistical result as well as our insight, for the purpose of this study, we shall assume that there is one cointegrating vector, or relationship.

Statistically, the above results indicate that based on the variables we have chosen, in some combination, result in a stationary error term. The economic interpretation, in our view, is that the 5 variables are theoretically related, in that they tend to move together, in the long term. In other words, the 5 variable are cointegrated, that is, their relationship with one another is not merely spurious or by chance. This conclusion has an important implication for policy makers. By taking action on one economic variable, the policy makers will be aware of the impact on other economic variables on the stock market. In other words, their actions will not be in a silo i.e. it will have an impact on the investors' perceptions thus affecting the stock market and other economic

factors. Also, the policy makers could model the effect of their decisions on the effect of one economic variable to another before making the actual implementation decision.

Long Run Structure Modeling (LRSM): With the confirmation of one cointegrating relationship amongst the variables, verifying the theoretical foundation as earlier discussed of the linkages between the variables of one strong cointegrating relationship. Arising from the theoretical base the Stock Index value is normalized in the Long Run Structuring model. Up till now we have run under the assumption that all variables are endogenous. Normalizing our variable of interest, the KOSPI Index, we initially obtained the results in the following Table 7 (please see Appendix 4A for details). Base on the t-ratios, we found one variables to be significant – FX.

Variable	Coefficient	Standard Error	t-ratio	Implication
LKOSPI	-	-	-	-
LGDP	9.6881	5.4135	1.79	Variable is insignificant
LCPI	-6.1311	8.9753	-0.68	Variable is insignificant
LM1	-1.3334	0.99586	-1.34	Variable is insignificant
LFX	2.5996	1.0591	2.45	Variable is significant

Table 7: T-ratio with exact identifying restriction of A1 = 1

Next step is to normalize KOSPI and over identifying the rest. We did this for all the variables, making one over-identifying restriction at a time. The results in the table below revealed that M1 is now a significant variable, instead of being insignificant from the LRSM tests.

Variable	Chi-sq p-value	Implication
LKOSPI	-	-
LGDP	0.001	Variable is significant
LCPI	0.395	Variable is insignificant
LM1	0.035	Variable is significant
LFX	0.000	Variable is significant

Since the LRSM and over identifying results are different, we would adopt the over identifying results whereby all the variables are significant except for CPI.

From the above analysis, we arrive at the following cointegrating equation (numbers in parentheses are standard deviations):

$$KOSPI + 9.69GDP - 1.33M1 + 2.60FX \rightarrow I(0)$$
$$(5.41) \quad (8.98) \quad (1.06)$$

Vector Error Correction Model (VECM): The Vector Error Correction Model (VECM) allows us to identify which variables are exogenous and endogenous. Information on direction of Granger-causation can be particularly useful for economists and policy makers. By identifying which variable is exogenous and endogenous, economists and policy makers can make better forecasts or predict expected results of their actions on economic variables. Typically, policy makers or the economist would be interested to know which index is the exogenous variable because they would closely monitor the performance of that variable as it would have a significant bearing on the expected movement of other variables.

From the VECM test, we found that there are three exogenous variables, GDP, M1 and FX as depicted in the table below. The other variables were found to be endogenous (please see Appendix 5A to 5F).

Variable	P ratio	Implication
LKOSPI	0.000	Endogenous
LGDP	0.131	Exogenous
LCPI	0.010	Endogenous
LM1	0.353	Exogenous
LFX	0.016	Endogenous

The variables of interest to the economist and policy makers are GDP and M1. These exogenous variables would receive market shocks and transmit the effects of those shocks to other variables. VECM also produces a statistic that may be of interest to economists and policy makers. The coefficient of e_{t-1} tells us how long it will take to get back to long term equilibrium if that variable is shocked. The coefficient represents proportion of imbalance corrected in each period. For instance, in the case of the KOSPI, the coefficient is 0.35. This implies that, when there is a shock applied to this index, it would take, on average, 3.5 quarters for the variable to get back into equilibrium with the other variables. The VECM, however, cannot tell us the relative degree of endogeneity or exogeneity among the variables.

Variance Decompositions (VDC): The Variance Decomposition Method, decomposes the variance of the forecast error of a particular variable into proportions attributable to shocks (or innovations) in each variable in the system including its own. The relative exogeneity/endogeneity of a variable can be determined by the proportion of the variance explained by its own past shocks. The variable which is explained mostly by its own shocks (and not by others) is deemed to be the most exogenous of all.

We started out applying orthogonalized VDCs and obtained the following results (see Appendix 6A to 6E).

Forecast at Horizon = 6 (Quarters)

	LKOSPI	LGDP	LCPI	LM1	LFX
LKOSPI	54.90%	4.08%	8.10%	6.31%	26.61%
LGDP	40.08%	50.72%	4.57%	2.97%	1.66%
LCPI	5.79%	1.70%	82.69%	1.48%	8.34%
LM1	22.29%	6.32%	11.27%	59.98%	0.14%
LFX	23.46%	19.44%	19.62%	0.27%	37.22%

Forecast at Horizon = 12 (Quarters)

	LKOSPI	LGDP	LCPI	LM1	LFX
LKOSPI	29.43%	4.14%	10.23%	4.63%	51.58%
LGDP	35.74%	50.01%	6.44%	3.29%	45.18%
LCPI	3.13%	1.02%	80.37%	1.06%	14.42%
LM1	21.22%	5.89%	12.07%	60.72%	0.10%
LFX	15.99%	15.31%	21.27%	0.15%	47.28%

For the above two tables, rows read as the percentage of the variance of forecast error of each variable into proportions attributable to shocks from other variables (in columns), including its own. The columns read as the percentage in which that variable contributes to other variables in explaining observed changes. The diagonal line of the matrix (highlighted) represents the relative exogeneity. According to these results, the ranking of indices by degree of exogeneity (extent to which variation is explained by its own past variations) is as per the table below:

No	Variable Relative Exogeneity	
	At Horizon = 6	At Horizon = 12
1	CPI	CPI
2	M1	M1
3	KOSPI	GDP
4	GDP	FX
5	FX	KOSPI

The orthogonalized VDC result shows that CPI has the highest degree of exogeneity followed by M1. However, this result contradicted with the results of Vector Error Correction Model (VECM) where CPI is an endogenous variable. In order to make sense of this result, we need to recognize two important limitations of orthogonalized VDCs. Firstly it assumes that when a particular variable is shocked, all other variables are "switched off". Secondly, orthogonalized VDCs do not produce a unique solution. The generated numbers are dependent upon the ordering of variables in the VAR. Typically, the first variable would report the highest percentage and thus would likely to be specified as the most exogenous variable.

Following this discovery, we decided to rely on Generalized VDCs instead, which are invariant to the ordering of variables. We obtained results as per Appendix 6F to 6J. To interpret the results, additional computations are needed. This is due the fact that numbers do not add up to 1.0 as with the case of orthogonalized VDCs. For a given variable, at a specified horizon, we total up the numbers of the given row and we then divide the number for that variable (representing magnitude of variance explained by its own past) by the computed total. In this way, the numbers in a row will now add up to 1.0 or 100%. The tables below show the result.

Forecast at Horizon = 6 (Quarters)

	KOSPI	GDP	CPI	M1	FX
KOSPI	28.49%	18.81%	10.65%	14.83%	27.21%
GDP	15.16%	34.32%	11.72%	14.88%	23.92%
CPI	3.52%	3.93%	51.26%	13.55%	27.74%
M1	11.07%	12.24%	13.58%	48.65%	14.46%
FX	10.37%	18.59%	19.29%	8.54%	43.21%

Forecast at Horizon = 12 (Quarters)

	KOSPI	GDP	CPI	M1	FX
KOSPI	22.80%	15.34%	11.88%	13.49%	36.48%
GDP	13.42%	32.16%	12.67%	15.16%	26.59%
CPI	2.35%	2.72%	53.70%	11.58%	29.66%
M1	10.58%	11.63%	13.89%	48.98%	14.92%
FX	8.20%	15.82%	20.67%	7.80%	47.51%

We can now more reliably rank the indices by relative exogeneity, as depicted in the table below.

No	Variable Relative Exogeneity	
	At Horizon = 6	At Horizon = 12
1	CPI	CPI
2	M1	M1
3	FX	FX
4	GDP	GDP
5	KOSPI	KOSPI

From the above results, we can make the following key observations:

- Even though CPI is the most exogenous in this Generalized VDC, CPI has been identified LRSM and the over identifying tests as an endogenous variable. Therefore CPI cannot be the most exogenous variable. The next most exogenous variable in the Generalized VDC is M1. Since M1 is identified as exogenous in the LRSM and the over identifying tests, we conclude that by the Generalized VDC test that M1 is the most exogenous variable, the second most exogenous variable is FX.

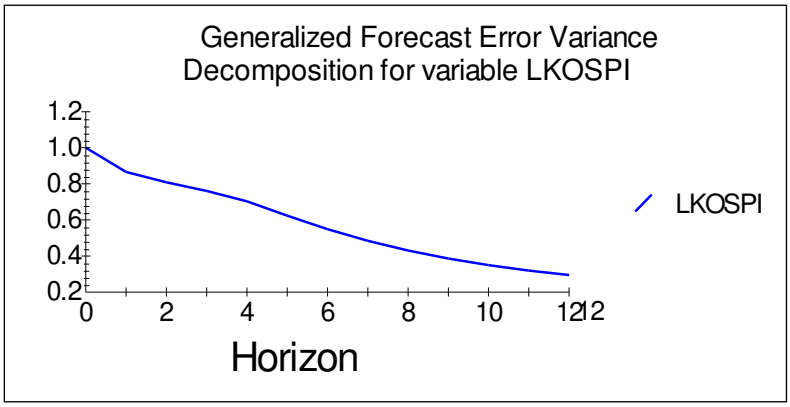
- KOSPI is confirmed as the follower i.e. KOSPI is an endogenous variable. Changes in the exogenous variables i.e. GDP and M1, will influence KOSPI.

- The relative rank in exogeneity is quite stable as time passes. Between 6 quarters and 12 quarters, the exogeneity remains the same.

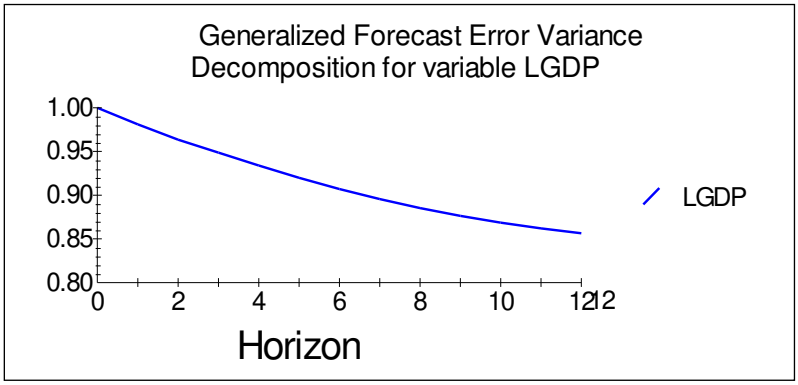
The above results would have plausible implications to economists and policy makers. It shows that any action taken or policies made by the government on the money supply (M1) and foreign exchange (FX) influenced the other

variables the most. That is, the shocks on either M1 or FX will influence the market index (KOSPI) the most, followed by gross domestic product (GDP).

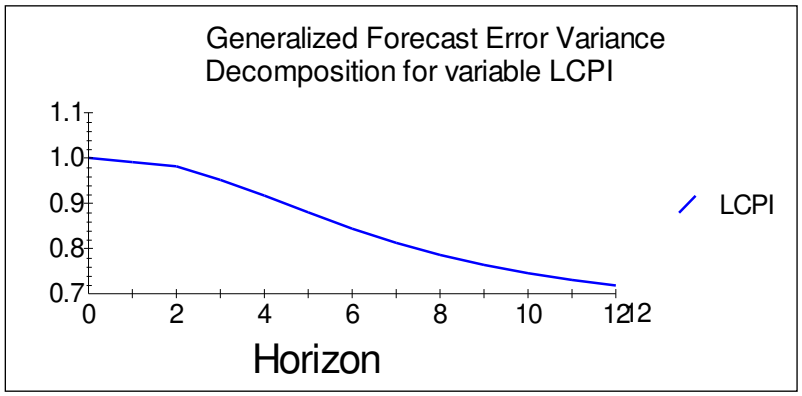
Impulse Response Function (IRF): The information that has been tabulated in VDC can be equivalently represented by Impulse Response Functions. IRFs essentially map out the dynamic response path of a variable owing to a one-period standard deviation shock to another variable. The IRFs are normalized such that zero represents the steady-state value of the response variable. In our model we test it against KOSPI index.



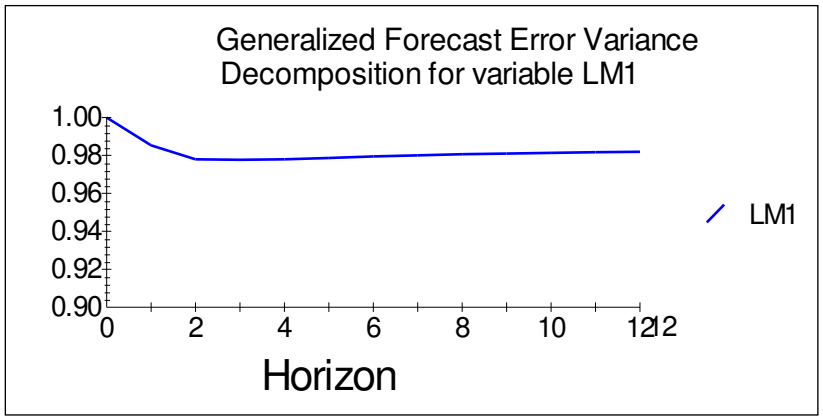
The IRF for KOSPI clearly shows a steady consistent dying out pattern once it is disturbed by one standard deviation.



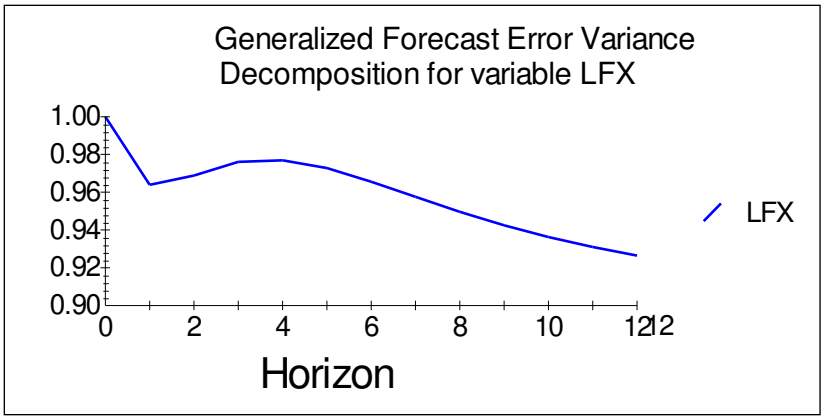
The IRF for GDP too clearly shows a steady consistent dying out pattern once it is disturbed by one standard deviation.



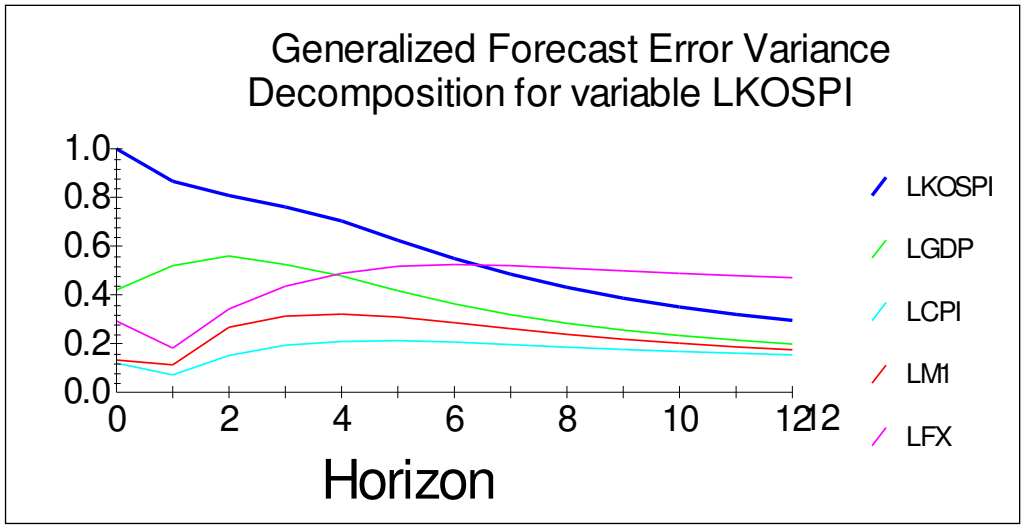
The IRF for CPI shows that once the CPI is disturbed by one standard deviation, there is initially a slight decrease in disturbance but after period 2, the decrease in disturbance is more in a dying out pattern.



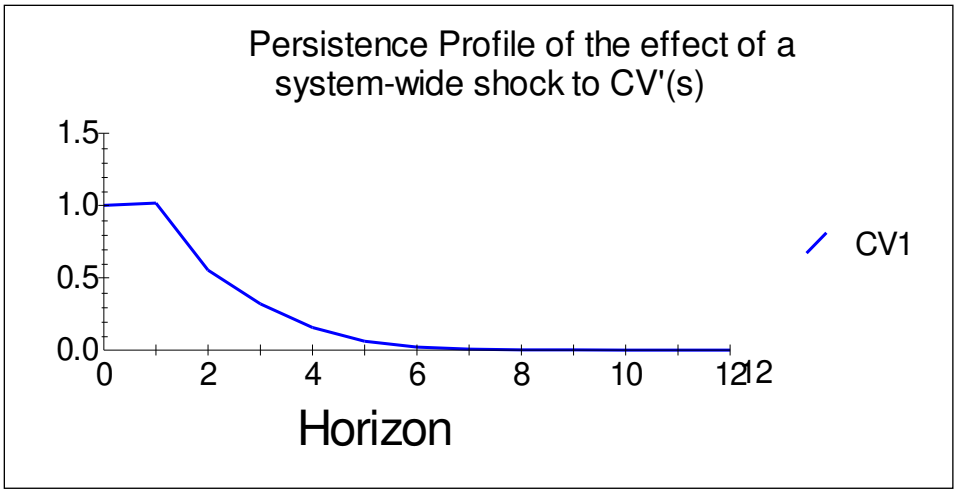
The IRF for M1 shows that once the M1 is disturbed by one standard deviation, there is initially a decrease in disturbance but after period 2, there is an increased disturbance and it does not die out over a time horizon of 12.



The IRF for M1 shows that once it is disturbed by one standard deviation, there is a sharp decrease in disturbance initially and then a sharp increase but overtime it shows a steady decline toward nil.



7. **Persistence Profile:** Unlike the IRF which traces out the effects of a variable-specific shock on the long run relationship, the above graph shows the persistence profile from a system wide shock. We see that when a system-wide shock is applied, there is some sideways persistence during the first quarter but then the system comes back to equilibrium after just over 6 quarters.



8.CONCLUSION

This study attempts to investigate whether share price index, specifically KOSPI of Korean Exchange, can be considered as a mirror or reflection of economic activities in Korea. The purpose is to make a finer point with respect to the relationship between economic growth and stock market especially in terms of stock prices. The present study thus proceeds with a single point investigative agenda in that what is the relationship between the health of the real economy and the health of the stock market? Does a rally in share prices reflect better health of the economy or it is the pink economic health that causes share prices to change?

We have examined the causal relationships between the share price index and other crucial macroeconomic variables namely money supply, exchange rate, consumer price index, and money market rate for the reason of right and robust model specification. The present study reports causality running from economic growth to share price index and not the other way round. It may therefore be stated that the stock markets in Korea are demand driven and industry led which means that demand for greater equity finance is led by higher and improved economic performance. That is, the state of the economy has a bearing on the share prices but the health of the stock market in the sense of a rising share price index is not reflective of an improvement in the health of the economy. In other words, a Bull Run or rising prices in the stock market cannot be taken to be a leading indicator of the revival of the economy in Korea.

It should be noted that there are limitations of this study and hence presents opportunities for future research. The choice of macroeconomic variables is arbitrary. Many other available macroeconomic variables could have been considered and may have produced additional or even different results. The other variables could be the total exports or imports, real interest rates, industrial production indices, employment or unemployment rates and real wage. Also, one aspect that this study did not address was the fact that based on several studies based on the Efficient Market Hypothesis (EMH) has shown that the Korean Exchange has been regarded as an inefficient market. It would be interesting to see in future research what Korean government policies will influence the Korean stock performance.

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