International Journal of Economics and Financial Research
ISSN(e): 2411-9407, ISSN(p): 2413-8533
Vol. 2, No. 5, pp: 99-103, 2016
URL: http://arpgweb.com/?ic=journal&journal=5&info=aims

Testing the Existence of Lead-Lag Effects in the Hong-Kong Stock Market

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Abstract: The aim of this paper is to investigate the lead-lag effect between two indices on the HONG-KONG stock market. This analysis is applied to daily data from 14/04/2003 to 10/10/2014. The results show that the more liquid index leads the less liquid. These results are consistent with those shown by the impulse response function. These results concluded that the predictability of less liquid index by more liquid index returns. In these studies, we can conclude that the lead-lag effect can generate a predictability of returns of the two indices of Hong-Kong stock exchange in the case of daily data.

Keywords: HKEx large cap liquid index; HKExGEM less liquid index; Lead-lag effect; Impulse-Response function.

1. Introduction

Several studies have investigated the lead-lag effect on the predictability i.e. Lo and Mackinlay (1990), Camilleri and Green (2004). All the studies conclude that the predictability is attributed to the lead-lag effect. Thus study aims to examine the lead-lag effect and its impact on predictability of returns of Hong-Kong stock market. The lead lag effect is perceived when there is a relationship between the price movements of two distinct markets, when one of them leads and the other follows with some lag time when this effect is identified, there is a rupture of the Efficient Market Hypothesis (EMH) in consequent the predictability of returns.

The aim study of Tonin *et al.* (2013) is to examine the lead lag effect between the stock market of the BRIC member countries from March 2009 until to March 2013. The result emphasizes that the Brazilian market leading others stock exchange analyzed in periods before and after the financial crises. The existence of lead-lag effects between U.S stock market (NYSE) and the Brazilian stock market (Bovespa) are examined by Oliveira and Mederos (2009). They concluded that the price movement in the NYSE is followed by similar movements in Bovespa which would enable predicting stock prices in the Brazilian market, thus providing arbitrage opportunities.

Camilleri and Green (2004) examined the lead-lag effect on the Indian market using three approaches: Test Pesaran Timmermann, VAR model, Granger-Causality and Impulse-response function on daily and high frequency data. The results imply that lead-lag effect appears to be the main source of the predictability of returns. The co movement and causality to markets in the United States, United Kingdom and six asian markets are studied by Meric *et al.* (2008). The authors used the technique of Principal Analysis to determine if the standards of co movement of the markets of USA, UK, AUSTRALIA, CHINA, RUSSIA, INDIA, JAPAN and SOUTH KOREA have changed with periods before and after September 11th, 2001.

TSE (1995) examined the lead-lag relationship between the Nikkei spot and futures contract about Nikkei index and found that lagged changes in futures prices cause adjustments in the spot price, in the short run, but the reserve is not true. Pena *et al.* (2010) analysed the relationship of Dow Jones index and the Nikkei-225 index with the Bovespa index with daily data of the variation of three indexes in the period of January 2006 to May 2008. The results identified contemporary relations between Dow Jones and Bovespa indexes. The authors also indicate the possibility of lag in the relationship between Bovespa and Nikkei 225 indexes. Nakamura (2009) shows the existence of lead-lag effect between the equity markets and the integration of the Brazilian stock market and their deposits in the American depositary receipt (ADR s). Malliaris and Urrutia (1992) shows that the lead-lag effect for six major stock market indexes, comaparing these indices between the periods before and after the crises of 1987 submitted significant changes between those periods.

In our study we evaluate the impact of lead-lag effect on predictability of returns of Hong-Kong stock market

The rest of the paper is organized as follows: The following section includes the introduction. Section 2 introduces the three methodologies adopted in this analysis. Sections 3and 4 present the data and empirical findings, respectively. The final section provides conclusions how the more liquid index leads the less liquid and the lead-lag effect cause the predictability returns on the Hong-Kong.

2. Methodology

We will analyze the lead-lag effect on the predictability of return using three methodologies VAR, Granger Causality test and Impulse-Response function. In what follows, we present these different methodologies (Camilleri and Green, 2004).

2.1. Granger-Causality Test

The Granger-causality methodology is based on the estimated VAR. Granger (1969) showed that a shock affects a given time series, generates a shock to other time series and then the first series is due to Granger in the second. In this case, the VAR model of a time series appears to be an AR adjusted under other delayed time series and an error term. The VAR model is a means of modeling causal and feedback effects (feedback effect) when two or more time series according to Granger cause the other. The term does not imply causality; it may be the case of inter-relationships between time series caused by an exogenous variable. A bivariate VAR model may be formulated as follows:

$$x_t = \sum_{i=1}^{n} \alpha_{1i} x_{t-i} + \sum_{i=1}^{n} \beta_{1i} y_{t-i} + \mu_{1t} \quad (1)$$

$$y_t = \sum_{i=1}^{n} \alpha_{2i} x_{t-i} + \sum_{i=1}^{n} \beta_{2i} y_{t-i} + \mu_{2t} \quad (2)$$

Where x_t and y_t are two variables assuming to Granger-cause each other, whilst μ_t is an error term. The system of two equations (1) and (2) is formulated by the following vector:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \alpha_{1i} \ \beta_{1i} \\ \beta_{2i} \ \beta_{2i} \end{bmatrix} \begin{bmatrix} x_{t-i} \\ y_{t-i} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix}$$

The Granger causality implies market inefficiency in the sense that fluctuations generate an index fluctuation leads to a fluctuation in another index. This means that if the first fluctuation was justified by new information, the latter fluctuation should have occurred at the same time, ruling out lead-lag effects. Therefore when testing for Granger-Causality using daily data, one should expect contemporaneous relationships if the markets are efficient and if there are not non-synchronous trading effects.

2.1.1. Impulse-Response Function

One of the main uses of the VAR process is the analysis of impulse response. The latter represents the effect of a shock on the current and future values of endogenous variables. VAR models can generate the Impulse-Response Functions. The response of each variable in the VAR system to a shock affecting a given variable: either a shock on a variable x_t, can directly affect the following achievements of the same variable, but it is also transmitted to all other variables through dynamic structure of the VAR. The impulse response function (IRF) of the variable y_t to a shock on the variable x_t, occurring in time t, can be viewed as the difference between the two time series:

- ♣ The realisations of the time series y_t after the shock in x_t has occurred; and
- ♣ The realisations of the series y_t during the same period but in absence of the shock in x_t.

This can be formulated in mathematical notation as follows:

$$IRF_y(n,\delta,\omega_{t-1}) = E[y_{t+n} / \varepsilon_t = \delta, \varepsilon_{t+1} = ... = \varepsilon_{t+n} = 0, \omega_{t-1}] - E[y_{t+n} / \varepsilon_t = 0, \varepsilon_{t+1} = ... = \varepsilon_{t+n} = 0, \omega_{t-1}] \quad ..... (3)$$

Where:

δ, is a shock at time t;

ω_{t-1} is the historical time series

ε is an innovation

IRF is generated from t to t + n.

3. Data

The analysis of the lead-lag effect on the predictability of returns is applied on the daily data of Hon-Kong stock exchange. The daily set constitutes of the closing observations of the HKEx large cap the main liquid index and the HKExGEM the less liquid index. The daily data period ranges from 14/04/2003 to 10/10/2014. In the first step we by the unit root test (ADF).

4. Empirical Findings

This section reports the results of the analysis of a lead-lag effect on the predictability of returns of Hong-Kong stock market. The ADF test results show that the two indices are no stationary in level. However, in first differences, the logarithmic price indices are stationary I (1). To clarify this idea of stationarity of the series, we turn to study the autocorrelation of HKEx (LHKL) and HKExGEM (LHKG) series at different delays. The autocorrelation coefficients are high and decline slowly indicating the existence of a unit root and the logarithmic series of two indices are I (1).

In what follows, we analyze the lead-lag effect on the predictability of returns using three methodologies, namely the VAR, Granger causality and impulse response function. According to both AIC and SC criteria we obtain a VAR (1) for the logarithmic daily series of indices LHKL and LHKG. Estimation of individual equations of the VAR systems are reproduced in table 1 (in APPENDIX)

From Table 1 (in the appendix), we can see the coefficients of LHKL (-1) and LHKG (-1) are significant at the 5% and indicating a lead-lag effect and delayed returns of LHKL can explain returns of the dependant variable LHKG.

In order to investigate further the Granger causality tests are applied to the system of two equations. The results obtained for a number of delay equal to one for dailydata are given in Table 2.

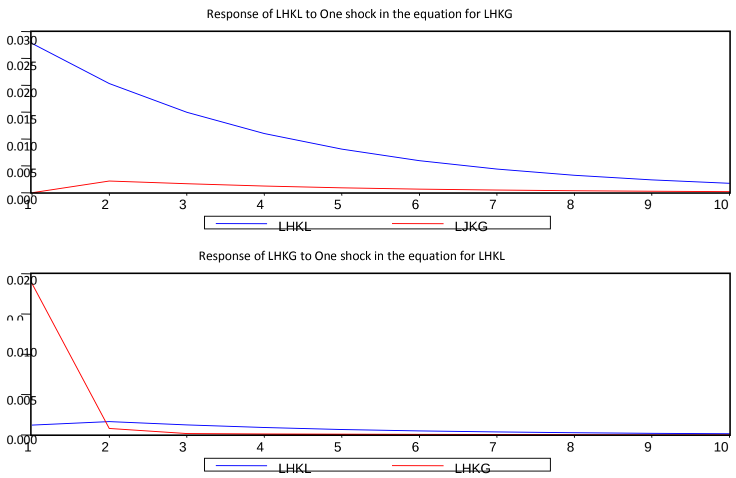
Table-2. Granger-Causlity Test

Null Hypothesis	F-Statistic	Probability
LHKG does not Granger Cause LHKL	7.69771	0.00561
LHKL does not Granger Cause LHKG	19.1828	0.000013

The table indicates the bidirectional causality: The null hypothesis hypothesis that LHKG does not cause LHKL and that LHKL does not cause LHKG is not accepted threshold of 5%.

The analysis of the Impulse-Response function of each indices reveals the following results:

Fig-1. Impulse-Response Function



If data is daily, a LHKG shock had a higher impact on the LHKL index. similarity a LHKL shock generates a higher impact on the LHKG index. This is attributed to a lead-lag relationship.

This study, based on impulse response functions, can be supplemented by an analysis of variance decomposition of forecast error. The objective is to calculate the contribution of each of the innovations in the variance of the error. The results for the study of the variance decomposition are reported in a Table 3. The variance of the forecast error is due to LHKL for about 99.35% to its own innovations and to 0.65% with those of LHKG. The variance of the forecast error is due to LHKG 2.08% to the innovations of LHKL and 97.92% to its own innovations.

We can deduce that the impact of a LHKL shock on LHKG is important but there is almost lower than the impact of a LHKG shock on LHKL.

Table-3. Decomposition of the variance of the LK and LKM series

Variance Decomposition of LHKL:			
Period	S.E.	LHKL	LHKG
1	2.78E-09	100.0000	0.000000
2	3.45E-09	99.60018	0.399818
3	3.76E-09	99.46579	0.534207
4	3.92E-09	99.40914	0.590858
5	4.01E-09	99.38206	0.617938
6	4.05E-09	99.36831	0.631693
7	4.08E-09	99.36111	0.638895
8	4.09 E-09	99.35727	0.642726
9	4.10 E-09	99.35522	0.644781
10	4.10 E-09	99.35411	0.645888
Variance Decomposition of LHKG:			
Period	S.E.	LHKL	LHKG
1	1.88 E-09	0.416309	99.58369
2	1.89 E-09	1.169895	98.83011
3	1.89 E-09	1.589977	98.41002
4	1.90 E-09	1.816430	98.18357
5	1.90 E-09	1.938670	98.06133
6	1.90 E-09	2.004760	97.99524
7	1.90 E-09	2.040523	97.95948
8	1.90 E-09	2.059885	97.94012
9	1.90 E-09	2.070370	97.92963
10	1.90 E-09	2.076049	97.92395
Ordering:LKHL LHKG			

These results concluded that the predictability of LHKG index by LHKL returns. These results are consistent with those shown by the impulse response function. In these studies, we can conclude that the lead-lag effect can generate a predictability of returns of the two indices of Hong-Kong stock exchange in the case of daily data.

5. Conclusion

The purpose of this paper is to study the impact of the lead-lag on the predictability of returns Hong-Kong stock exchange via the examination of effect. Three methodologies were adopted on daily data of two indices. These are different levels of liquidity based on bid-ask spread. Specifically, the results show that the more liquid index leads the less liquid. In the conclusion the lead-lag effect cause the predictability returns on the Hong-Kong stock exchange.

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Appendices

Table-1. OLS estimation of VAR equations

OLS estimation of a single equation in the unrestricted VAR				
Dependent Variable: LOG HKEx Largecap(LHKL) Method: Least Squares Sample(adjusted): 14/04/2003 10/10/2014				
Regressor	Coefficient	Std. Error	t-Statistic	Prob.
Constante	0.000114	0.000284	4.004236	0.0001
LHKL(-1)	0.726401	0.019346	37.54800	0.0000
LHKG(-1)	0.116139	0.041860	2.774475	0.0056
R-squared	0.540583	Mean dependent var		6.80E+09
Adjusted R-squared	0.539850	S.D. dependent var		4.10E+09
S.E. of regression	2.78E+09	Akaike info criterion		46.33287
Sum squared resid	9.70E+21	Schwarz criterion		46.34514
Log likelihood	2909.404	Durbin-Watson stat		2.562947
Fstas	73.718 [0.000]	System LogLiklihood		5769.611

Diagnostic tests		
Test Statistics	LM version	F version
A : Serial Corrélation	30.505 [0.0000]	F(1, 1256)= 80.0681 [0.0000]
B : Normality	769.5379 [0.0000]	Not applicable
C : Heteroscedasticity	13.669[0.0000]	F(1, 1256)=38.19544 [0.0000]

A : Lagrange Multiplicateur Test of residual serial correlation
B : Based on a test of skewness and kurtosis of fitted values
C: Based on the regression of squared residuals on squared fitted values.

OLS estimation of a single equation in the unrestricted VAR				
Dependent Variable: LOG HKExGEM(LHKG) Method: Least Squares Sample(adjusted): 14/04/2003 10/10/2014				
Regressor	Coefficient	Std. Error	t-Statistic	Prob.
Constante	0.0000552	0.0000193	28.64634	0.0000
LHKL(-1)	0.057390	0.013103	4.379818	0.0000
LHKG(-1)	0.041983	0.028352	1.480772	0.1389
R-squared	0.018498	Mean dependent var		6.16E+09
Adjusted R-squared	0.016931	S.D. dependent var		1.90E+09
S.E. of regression	1.88E+09	Akaike info criterion		45.55363
Sum squared resid	4.45E+21	Schwarz criterion		45.56590
Log likelihood	286.0468	Durbin-Watson stat		2.003622
Fstas	11.80746[0.0000]	System LogLiklihood		5769.611

Diagnostic tests		
Test Statistics	LM version	F version
A : Serial Corrélation	6.612 [0.2512]	F(1, 1256)= 1.32111[0.25145]
B : Normality	261.61 [0.0000]	Not applicable
C : Heteroscedasticity	3.68333 [0.4505]	F(1, 1256)=0.91987 [0.4514]

A : Lagrange Multiplicateur Test of residual serial correlation
B : Based on a test of skewness and kurtosis of fitted values
C: Based on the regression of squared residuals on squared fitted values.