

Gauging Stock Price Volatility during the Financial Crisis using a Multivariate Cointegration Analysis

Zuriyati Ahmad, Tuan Nadiah Tuan Razilah

Faculty of Business and Management, Universiti Teknologi MARA cawangan Terengganu Malaysia

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Abstract: The stock price performance can be an indicator to reflect current economic conditions, trends and public trust in economic performance. Macroeconomic variables theoretically affect the stock market as the stability of macroeconomic variables can help to stabilize the stock price. Nonetheless, previous findings show the stock market experienced a little difficulty because the shock event happened in Malaysia. Thus, this study aims to gauge stock price volatility the financial crises. Monthly time series data spanning from 1996 to 2014 is applied to the multivariate model with inclusion of dummy variable of financial crisis. The normal OLS and Johansen cointegration test are applied to examine the changes of stock price. The finding indicates a strong impact of financial crisis is found towards the stock price when it tested using a multivariate analysis. While a cointegration exists in the stock price model. Nonetheless, when checking for the long run equilibrium, the financial crisis is insignificant towards the volatility of stock price in Malaysia.

1 INTRODUCTION

The stock market is a channel for the corporate sector to raise capital for investment and business activities. Malaysia is the potential country for investors to have a new business opportunity due to the economic growth of this country. Maziah, Anisah and Hadhifah (2013), have described the Malaysian stock market is growing in line with the rapid economic development in the past decade. The Malaysian stock market has experienced dramatic changes in the past two decades (Zaherawati, et. al, 2010). The stock market related closely to economic growth and it is also a strong economic growth that increases the stock performance.

The stock market serves as a guide in shaping a country's economic growth. The establishment of the stock market exchange allows government and corporate institutions to raise capital quickly in accelerating economic development (Kyereboah-Coleman & Agyire-Tettey, 2008). Previous researchers indicate that the stock price performance can be an indicator to reflect current economic conditions, trends and public trust in economic performance. Macroeconomic variables theoretically affect the stock market because the stability of macroeconomic variables can help to stabilize stock price too. In fact, Mohamed et. al (2009) state that the

changes in macroeconomic variables can fully reflect the current share price

Nevertheless, the stock market experienced a little difficulty because the natural event of problems in the macroeconomic variables that happen in Malaysia (Aisyah, Zahirah & Fauziah, 2009). For example, a steep decline during 1997 when the financial crisis hit. The Asian financial crisis has made a tremendous outbreak to the Malaysian economy and in turn fluctuate the stock price severely. Before 1996, for example KLCI has reached more than 1200 points and most investors believe that this trend will be maintained. However, it fell to 500 points due to the financial bubble burst (Asmy et al, 2009).

The scenario that Malaysia has facing during the Asian Financial Crisis in 1997 and the global financial crisis in 2008 has led a slowdown in the stock market. Asian countries, including Malaysia suffered heavily as an impact of the financial crisis (Zaherawati et al, 2010). Due to that, Malaysia is having a volatility of stock price due to macroeconomic factors and financial crisis. Thus, this study aims to gauge the volatility of stock price during the financial crises.

The remaining of the paper is organized as follows. Section 2 discusses the literature review. The methodology under consideration will be highlighted

in section 3. Section 4 discusses result and discussion. Lastly, section 5 offers conclusion.

2 LITERATURE REVIEW

Stock price as defined by Mishkin (2007) is a securities claimed on the income and assets of the corporation known as the shares traded. In efficient capital markets, stock prices react quickly to the new information available. Therefore, stock price reflects all stock's information which causing the investors are not allowed to use the information that already available to forecast stock prices movement and make profits from the shares traded. Besides, stock prices also reflect future expectations corporate performance and profitability.

Stock price is a crucial indicator for portfolio management. The investment decision can be affected by volatility and fluctuation of the stock market. Many studies (Adamu, 2010; Rafaqet & Ali, 2012; Sakthivel et al., 2014; Gabriel & Manso, 2014; Lee and Jeong, 2014; Kishor and Singh, 2014) have been conducted in measuring the impact of financial crises and stock market.

Theoretically, the financial crisis led to a great uncertainty in global stock markets (Olusola, 2011). It gives a big impact towards the economic growth of a country. During the financial crisis, many financial institutions have collapsed and the government was forced to come up with other alternatives to save the financial system. Thus, studies on the impact of financial crises on stock price volatility have been carried in many countries and region. For example, in Nigeria, Adamu (2010) studies the stock market volatility before and during the crisis. The period is divided into 24 months each to study the volatility of market returns which are between 2006 – 2007, and 2008 – 2009. Using variance or standard variation to examine the volatility of stock market and the result indicates that during the period 2006 – 2007, the stock market is less volatile than the period 2008 – 2009.

While in India, Sakthivel et al (2014) using JGR GARCH model to examine the pre and post crises. Sakthivel et. al (2014) conclude that global financial crisis gives a negative impact to the stock returns and increases the volatility in the Indian stock markets. Using almost similar method of E GARCH, Rafaqet and Ali (2012) examine the volatility of stock market during the financial crisis in Pakistan and also India. Results reveal that crisis negatively contributes to volatility in stock price for both markets, but the effect is slightly weak. Nonetheless, crisis gives stronger impact towards the Indian market, represents by Bombay stock exchange compared to Pakistan stock market (Karachi stock exchange). The

difference might be due to the fact that India has a bigger economy and its stock market is more open than Pakistan.

Kishor and Singh (2014) investigate the stock return volatility relationship of emerging economies from 2007 to 2013 which also includes the financial crisis of 2008 and its impact on emerging economies of the world. GARCH model is used to examine the impact of news coming from US which is affecting the returns of global index S&P 500 as well as the returns generated by the indices of the BRICS countries. The result indicates there is impact of the global financial crisis on stock returns BRICS. Except the market share of Brazil and China, the volatility of the stock market of Russia, India and South Africa is slightly affected by the global crisis.

Gabriel and Manso (2014) investigate interdependencies and the linkages between international stock markets in the short run in European during the global financial crisis and the Dot-Com crisis. Using a Granger causality test, a causation is found from financial crisis to the European stock market showing the financial crisis led to volatility of stock market.

Studying on North America and Europe, Lee and Jeong (2014) examine the effects of the global financial crisis on the stock market of these two regional equity markets from the period January 2000 and December 2012. It is found that the Northeast Asian equity markets remain independent from European and global stock market movements in the analyzed period. The volatility of the stock market has increased temporally during the global financial crisis in European.

3 METHOD

This study will be benefitted from monthly data set of 19 years covering from 1996 to 2014 with the total number of observations is 228. The observation is adequate for the method chosen. Sample is restricted to this time span in order to get uniformness of the data set and considering the availability of the data. Data is obtained from International Financial Statistic and Bank Negara Malaysia statistical bulletin.

For modelling framework, the impact of financial crisis which is the dummy variable of financial crises is included. The dummy variable (FC) indicates the period of financial crises. In its original form, it is set 1 if financial crisis occurred. Otherwise it is set 0, yielding a sequence isolated 1s, surrounded by 0s.

The goal of the study is to gauge stock price during the financial crisis. Stock price however can also be influenced by various macroeconomic factors such as exchange rates, inflation, economic condition

and interest rate. In order for a linear regression model to be more realistic, these macroeconomic factors which work as controlling variables are added in gauging the impact of financial crisis on stock price volatility. Hence, the estimated linear regression model is as follows;

$$SP = \alpha + \beta_1CPI+ \beta_2IR - \beta_3ER + \beta_4IPI - \beta_5FC + \varepsilon$$

- SP = stock price
- CPI = consumer price index
- IR = interest rate
- ER = exchange rate
- IPI = industrial production index
- FC = dummy of financial crisis
- α = constant
- β = coefficient
- ε = Error term

Since most macroeconomic time series are subjected to some type of trend, it is important to confirm stationary or non stationary properties of variables chosen. Thus, it is imperative to test for the presence of the unit root test. The ADF unit root test is based on the null hypothesis H_0 : each variable chosen is not $I(0)$. If the calculated ADF statistics is less than the critical value the null hypothesis is rejected, otherwise accepted.

The ADF unit root test can be performed by estimating the regression;

$$Y_t = \rho y_{t-1} + \alpha_1 \Delta y_{t1} + \dots + \alpha_{p-1} \Delta y_{t-p+1} + \varepsilon_t$$

As ordinary least square (OLS) is subjected to spurious problem, cointegration analysis will be used by taking the Johansen cointegration test. Cointegration aims at explicitly dealing with the relationship between non stationary time series and spurious result can be avoided. This test is applied to check whether the long run equilibrium relationship exists between the variables. The cointegration test will be based on two tests; trace test statistics and the maximum eigenvalue test statistics.

Johansen cointegration test (Johansen, 1988 and Johansen and Juselius, 1990) is used for testing cointegration. Johansen cointegration test can be also applied to check whether the long run equilibrium exists between the variables to achieve the objective.

4 RESULTS AND DISCUSSION

Table 1 presents the result of estimation for coefficient and the significance of the model. In the multivariate regression, all the controlling variables

can reject the hypotheses where there are no relationships between the controlling variables and the volatility of stock price

Table 1: Results multivariate model

<i>Variable</i>	<i>Coefficient</i>	<i>Standard</i>	<i>T statistics</i>
<i>e</i>	<i>t</i>	<i>d</i>	
		<i>error</i>	
C	65.5883	0.4318	151.8915
CPI	25.06204	13.1311	1.9086*
IR	25.1234	3.6946	6.8001***
IPI	1.7837	1.3261	1.3451
ER	421.4466	17.0108	24.7752**
			*
FC	72.4184	3.2484	22.2936**
			*

Notes: *** 1% level of significance
 **5% level of significance
 *10% level of significance

As stated earlier the OLS is subjected to spurious problem thus the Augmented Dickey-Fuller (ADF) model is used to test the time series data correlated each other. This test is conducted in order to check whether the series of the data is stationary or non-stationary. Table 1 provides the summary of stationary test. Using 5% significance level, all variables fail to reject the null hypothesis of non stationary at the level form. Conversely, all variables are stationary at their first difference form, since the null hypothesis of non stationary can be rejected. All variables are $I(1)$ or integrated of order 1. The dummy variable Financial Crisis is not included in the Stationary Test as it was argued in Glynn and Perera (2007) that dummy variable is an exception in this test.

Table 2: Stationary Test

Variable	Level I(0)	First differences I(1)	ADF Value
SP	0.959	21.218	3.457***
CPI	0.712	5.952	3.458***
IR	2.544	3.892	3.459***
IPI	0.906	3.394	2.874**
FC	2.829	4.398	3.458***

All the variables in Table 2 are significant at 1 % significance level except for industrial production index, which is significant at the 5 % level. The result shows that all the variables are non-stationary in level, but are stationary after first differencing. Since the result from ADF has confirmed a series at first

differences stationarity, the test of unit root strongly suggest that all variables are integrated of order one or I (1) by adjusting the maximum lag to 16. Since all the variables are in the same order of integration then it will continue to apply the technique of co-integration.

Once the order of integration is established for each variable, this paper continues to evaluate the cointegration test for the data series. The cointegration test is used to determine whether a linear combination of the series has a long run equilibrium.

Table 3: Johansen Cointegration Test Result

Unrestricted Cointegration Rank Test (Trace)			
Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	0.05 Critical Value
None *	0.1850	105.0128	95.7536
At most 1	0.0887	57.3468	69.8188
At most 2	0.0598	35.6852	47.8561
At most 3	0.0483	21.3014	29.7970
At most 4	0.0288	9.74921	15.4947
At most 5	0.0125	2.9362	3.8141

Unrestricted Cointegration Rank Test (maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max eigen Statistic	0.05 Critical Value
None *	0.1850	47.6659	40.0775
At most 1	0.0887	21.6615	33.8768
At most 2	0.0598	14.3837	27.5843
At most 3	0.0483	11.5522	21.1316
At most 4	0.0288	6.81293	14.2646
At most 5	0.0125	2.9362	3.8414

Result from the Johansen cointegration test is demonstrated in Table 3. From the analysis of the maximum eigenvalue, the model shows the presence of one cointegrating equation since these statistics exceed their critical value at the 5% significance level. Since there is a cointegrating relationship between independent variable, the null hypothesis of no cointegration can be rejected.

Based on the Johansen co-integration test, the trace test (105.0128) are higher than the critical value (95.7536) whereas the max-eigen value (47.6659) is also higher than the critical value (40.0775). Since the trace test and max-eigen is higher than critical value it shows there is a long run equilibrium. The test suggests that null hypothesis is rejected at the 5 % significance level, which means there is at least one co-integration equation.

The existence of cointegration implies variables are cointegrated and there is a meaningful long run relationship. Testing with provision of four lags, the model exhibits no serial correlation and no normality

problem. Thus, the study has proceeded to the next step to find out the magnitude of the long run relationship. Estimated long run equilibrium model is as follows;

Table 4: Results of long run equilibrium

Variable	Coefficient	Standard error	T statistics
CPI	55.4430	13.2603	4.1811***
IR	306.5999	54.0475	5.6727***
IPI	0.2200	9.5646	0.0230
ER	285.27	183.851	1.5516
FC	244.7160	145.126	1.6862

Notes: *** 1% level of significance

In multivariate regression result (Table 1), consumer price index is found to be positively and statistically significant in affecting the stock price in Malaysia. The result in the long run (Table 4) also shows the consumer price index the magnitude of positive relationship and significantly affects the stock price. The stock price will increase if the consumer price index responds to increase in economy as founded by Yahya et al (2012), Priyanka and Kumar (2012), Sikalao-Lekobane and Lekobane (2014), Seyed, Zamri and Lai (2011), Mahmoud, Sara and Khaled (2016), and Asmy et al (2009). When inflation increases because of an increase in demand that exceeds the current supply, the firm income will increase along with their dividends, which will make the stock more attractive and more people are willing to invest in market share, hence, the stock price will increase. Moreover, stock prices are a good hedge against inflation. It is because equity as value protection from threat of inflation and has a claim on a real asset to prove that the higher the inflation rate, the higher the demand for a particular share.

From the results, interest rate shows a positive magnitude and highly significant relationship between stock price in both OLS and long run equilibrium. When the interest rate is increasing, the stock price will increase. The finding is parallel with Ray (2012), Garza-Garcia and Yue (2010), Sikalao-Lekobane and Lekobane (2014) and Yogaswari, Nugroho and Astuti (2011). When interest rate increase, demand on the deposit will increase rather than going for investment because the cost of borrowing is costly. Therefore, the return on the deposit may increase. The interest rate will also directly affect the rate of discount in valuation model of stock price, in another word, future cash flow and current cash flow receive by the investor would be affected.

For industrial production index, the findings from multivariate analysis in OLS and long run equilibrium

show there are positive relationships but insignificant impact towards stock price. Yahya et al. (2012), Naik and Padhi (2012), Garza-Garcia and Yue (2010), Ray (2012), Seyed, Zamri and Lai (2011) and Aamir, Muhammad, Rehan and Hamza (2014) indicate the positive relationship between industrial production index and stock price. When the industrial production has produced more products, it shows that the firms provide more profit or return on shareholders who are investing in those firms. When shareholders can get high returns, the demand of stock is increasing and stock prices will be higher.

The result from OLS shows that exchange rate has negative and significant relationship with stock price. Nonetheless, in the long run it shows that exchange rate stock price has positive and insignificant relationship towards stock price. The finding from OLS is consistent with Yahya et al (2012), Ray (2012), Naik and Padhi (2012), Sikalao-Lekobane and Lekobane (2014) and Aamir et al. (2014). As the exchange rate is depreciated, the share price will rise, while if the exchange rate is appreciated, the stock price will decline. The reason is the status of the country is depending on the value of exports (international trade). The declining in value of currency will encourage more exports. Therefore, when there is a lot of export occurs for that product, the sales and revenue will increase which lead to increase in the stock price.

Lastly, the major focus of the study is the financial crisis. Finding from multivariate analysis reveals that financial crisis has a negative and statistically significant relationship with the volatility of stock price. T statistics is found to be at 22.2936 with significance level of 1%. A negative magnitude indicates when financial crisis happens stock price will decrease. It creates an impact and instability to the stock market. Finding obtained is parallel with Adamu (2010), Sakthivel et al (2014), Gabriel and Manso (2014), Lee and Jeong (2014), Rafaqet and Ali (2012), Kishor and Singh (2014). Financial crisis creates instable volatility of stock price as people will tend to sell the stock that can give a loss to them and the price of that particular stock will be decreased.

In the long run equilibrium, a magnitude of positive relationship is found which is not compatible with the theory. This finding however can be rejected as the financial crisis does not statistically significant with stock price. Even though there is a cointegration in the model, in the long run equilibrium financial crisis does not show the impact to the stock price. The impact of shock event might occur instantly on stock price has been covered by many researchers (Rafaqet & Ali, 2012; Sakthivel et. al, 2014) using EGARCH

and GARCH method. The impact of financial crisis is seemed not to be delayed or lagged after periods of time.

5 CONCLUSIONS

The purpose of the study is to gauge the volatility of stock price during the financial crises. This study has developed a framework to be tested using the OLS method and cointegration analysis. The robustness of the result was tested under various aspects. It was found that the financial crisis does influence the volatility of stock price using the OLS method. While all the macroeconomic variables which work as control variables are significant with the expected signs as found in the previous research. These macroeconomic factors are really important in influencing the volatility of stock price in Malaysia. Nonetheless, contrary result is found when testing with a more dynamic cointegration method. In the long run equilibrium is insignificant relationship is revealed. In conclusion the finding of the study supports the claim that stock price is affected during the financial crisis. Nonetheless, when testing using the long run equilibrium the insignificant result is found showing the impact does not exist in the long run equilibrium.

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