E C O N O M I C S B U L L E T I N

Non−linear Market Behavior: Events Detection in the Malaysian Stock Market

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Abstract

This paper advocates a reverse from of event studies that is data−dependent to determine endogeneously the events that trigger non−linear market behavior. Using the Malaysian stock market as our case study, coupled with the 'windowing' approach proposed by Hinich and Patterson (1995), the present study is able to identify major political and economic events that contributed to the short bursts of non−linear behavior. The present framework can be extended to individual firm to examine the adjustment of its stock price to firm−specific events, which will provide deeper insight into issues on corporate finance.

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1. Introduction

Over the past three decades, there has been growing interest among researchers in exploring the non-linear behavior of financial time series data. This line of research inquiry has produced encouraging results, with more and more empirical evidence emerged to suggest that non-linearity is a universal phenomenon (for a review of the literature, refer to Lim and Hinich, 2005). Though evidence of non-linearity abounds, Hinich and Patterson (1995) conjectured that the behavior of the non-linear dependency structures is at best episodic in nature. Their conjecture received wide empirical support across different financial markets. Among them are Brooks and Hinich (1998) on 10 major foreign exchange rates, Ammermann and Patterson (2003) on 6 major stock market indices and 247 individual stocks traded on the Taiwan Stock Exchange, Lim *et al*. (2003) on 4 Southeast Asian foreign exchange rates, Lim and Hinich (2005) on 13 Asian stock market indices and Romero-Meza *et al*. (2005) on 7 Latin American stock market indices. In all these aforementioned studies, the detected non-linear behavior is episodic in that there were long periods of pure noise process, only to be interspersed with relatively few brief episodes of highly significant non-linearity. In a parallel literature, Ramsey and Zhang (1997) found that activities in financial markets are relatively short-lived and surrounded by longer periods of apparent randomness.

This paper attempts to shed further light into the widely observed episodic features of financial time series. In this context, those long periods of randomness in asset price series are consistent with the weak form efficient markets hypothesis, resulting from instantaneous market response to the arrival of new information. However, when surprises or unexpected shocks hit the market, the adjustment process generally generates a pattern of non-linear price movements relative to previous movements since investors are cautious and unsure of how to react, resulted in a delay or slow response (Antoniou *et al*., 1997; Brooks *et al*., 2000). Hence, as highlighted by Ramsey and Zhang (1997: 370), one can view the dominant market reaction to isolated shocks as a sequence of 'short bursts of intense activity that are represented by narrow bands of frequencies'. In fact, the authors are optimistic that tying those localized frequency bursts to news events might be enlightening, which is the main objective of the present study.

To accomplish that, this paper utilizes the 'windowing' approach proposed by Hinich and Patterson (1995) to detect major political and economic events that have contributed to the short burst of non-linear dependencies in the Malaysian stock market, our case study. In those event studies pioneered by Fama *et al*. (1969) that are now an important part of corporate finance, researchers hypothesize about an event *a priori* and gauge the resulting market response as reflected in stock prices. The present study, in contrast, advocates a reverse from of event studies that is data-dependent to determine endogeneously those events that trigger non-linear market reactions. This can be achieved in the 'windowing' approach of Hinich and Patterson (1995) since the procedure breaks the full sample period into shorter windows of time to allow closer examination of the precise time periods during which non-linear dependencies are occurring, detected via the bicorrelation test statistic (denoted as H statistic).

2. Methodology

This section provides a brief description of the 'windowing' approach and the bicorrelation test statistic (denoted as *H* statistic). Let the sequence $\{y(t)\}$ denote the sampled data process, where the time unit, t, is an integer. The test procedure employs non-overlapped data window, thus if n is the window length, then k-th window is $\{y(t_k), y(t_k+1),\ldots.., y(t_k+n-1)\}$. The next non-overlapped window is $\{y(t_{k+1}), y(t_{k+1}+1),\ldots.. y(t_{k+1}+n-1)\}$, where $t_{k+1} = t_k+n$. The null hypothesis for each window is that $y\{t\}$ are realizations of a stationary pure noise process that has zero bicovariance. The alternative hypothesis is that the process in the window is random with some non-zero bicorrelations $C_{yyy}(r, s) = E[y(t)y(t+r)y(t+s)]$ in the set $0 < r < s < L$, where L is the number of lags.

We state without proof and derivation that the *H* statistic[1] is defined as:

$$H = \sum_{s=2}^{L}\sum_{r=1}^{s-1} G^2(r,s) \quad \sim \chi^2_{(L-1)(L/2)} \tag{1}$$

where $G(r,s) = (n-s)^{\frac{1}{2}} C_{ZZZ}(r,s)$, and $C_{ZZZ}(r,s) = (n-s)^{-1}\sum_{t=1}^{n-s} Z(t)Z(t+r)Z(t+s)$ for $0 \le r \le s$. $Z(t)$ are the standardized observations, obtained by subtracting the sample mean of the window and dividing by its standard deviation. The number of lags L is specified as $L= n^b$ with $0 < b < 0.5$, where b is a parameter under the choice of the user. Based on the results of Monte Carlo simulations, Hinich and Patterson (1995) recommended the use of b=0.4 in order to maximize the power of the test while ensuring a valid approximation to the asymptotic theory even when n is small. In this test procedure, a window is significant if the *H* statistic rejects the null of pure noise at the specified threshold level.

3. The Data

In this study, the reaction of the Malaysian stock market[2] as a whole towards major events is proxied by the behavior of the Kuala Lumpur Composite Index (KLCI) returns series. In particular, daily closing prices for this index collected from *Datastream* are transformed into a series of continuously compounded percentage returns, using the following relationship:

$$r_t = 100^* \ln(p_t/p_{t-1}) \tag{2}$$

where p_t is the closing price of the index on day t, and p_{t-1} the price on the previous trading day.

[1] Interested readers can refer Hinich and Patterson (1995) and Hinich (1996) for a full theoretical derivation of the *H* statistic and some Monte Carlo evidence on the good small sample properties of the test. The analysis in this paper is conducted using the T23 program, which is available from the personal website of Melvin J. Hinich at http://www.gov.utexas.edu/hinich/. Instead of reporting the *H* statistic as chi-square variates, this program transforms the computed statistic to a *p*-value based on the appropriate chi square cumulative distribution value.

[2] The Malaysian stock market, formerly known as Kuala Lumpur Stock Exchange was officially renamed as *Bursa Malaysia* on 20 April 2004.

On the other hand, annual reports of Securities Commission[3] from years 1995 through 2004 are our important historical sources with good documentation of the major events affecting the performance of the KLCI over the years. In tandem with the availability of annual reports, the sample period for the KLCI is limited to 1 January 1995 through 31 December 2004.

To apply the bicorrelation test in conjunction with the windowed testing procedure, all the returns series are split into a set of non-overlapping windows of 25 observations in length (approximately 5 trading weeks), so as to reduce the loss of observations at end sample. According to Brooks and Hinich (1998), the window length should be sufficiently long to provide adequate statistical power and yet short enough for the test to be able to detect the events that trigger the nonlinear behavior. In fact, it was found that the choice of the window length does not alter much the results of the significant *H* statistics in this study.

4. Empirical Results

Before proceeding with the bicorrelation test, we first remove linear dependencies from the returns series by fitting an autoregressive model. The bicorrelation test is then applied to the residuals of the fitted AR(*p*) model, so that a rejection of the null of pure noise at the specified threshold level is due to significant non-linearity. Table 1 presents the results of the bicorrelation test using the 'windowing' approach for the KLCI returns series. Clearly, the null of pure noise is rejected by the *H* statistic in only 7 windows, which is equivalent to 6.73%.[4] Consistent with earlier studies, the KLCI returns series are characterized by relatively few brief episodes of highly significant non-linearity surrounded by long periods of pure noise. The interesting question to be answered here is: what events trigger these short bursts of non-linear market behavior? The last column of Table 1 identifies those key events that represent shocks to the Malaysian stock market in which most investors were slow to response as they took time to work out the impact of the events. Uninformed traders were also delaying their response to see how informed market participants behave because they do not have the resources to fully analyze the information (Antoniou *et al*., 1997). Some of the contributing events in this paper are consistent with the findings of Lai *et al*. (2001), who conducted a survey on 77 institutional investors to gauge their responses and reactions to a list of external factors and events in the questionnaire.

[3] The Securities Commission established on 1 March 1993 under the Securities Commission Act 1993, is a self-funding statutory body in Malaysia with investigative and enforcement powers. Apart from discharging its regulatory functions, the Securities Commission is also obliged by statute to encourage and promote the development of the securities and futures markets in Malaysia (Further information on Securities Commission can be obtained from her official website at http://www.sc.com.my/).

[4] In this study, the threshold level was set at 0.01. The level of significance is the bootstrapped thresholds that correspond to 0.01.

Table 1
'Windowing' Test Results for KLCI Returns Series

Fitted AR(p) model	Total number of windows	Significant H windows	Dates of significant H windows	Key Events
AR(1)	104	7 (6.73%)	7/2/95-13/3/95	Baring debacle on 27/2/95.
			14/3/95-17/4/95	Announcement of the general election on 5/4/95.
			27/2/96-1/4/96	A 3% fall on Dow on 8/3/96; Increased tension between China and Taiwan on 23/3/96.
			25/8/98-28/9/98	KLSE announced additional measures to enhance transparency on 31/8/98, including no longer recognizing deals involving KLSE-listed securities traded overseas; On 1/9/98, the government introduced wide-ranging foreign-exchange controls, including the pegging of 3.80 ringgit to 1 US dollar.
			12/1/99-15/2/99	Graduated repatriation levy on foreign portfolio profits was introduced on 15/2/99.
			10/8/99-9/9/99	Announcement of the reinstatement of Malaysian stocks into the MSCI benchmark indices effective Feb 2000 was made on 12/8/99; Lifting of the moratorium on foreign portfolio capital on 1/9/1999.
			27/3/01-30/4//01	Announcement of a drastic fall in net international reserves was made on 9/4/01; Tabling of the Eighth Malaysia Plan on 24/4/01.

5. Conclusion

This paper advocates a reverse from of event studies that is data-dependent to determine endogeneously the events that trigger non-linear market behavior. Using the Malaysian stock market as our case study, coupled with the 'windowing' approach proposed by Hinich and Patterson (1995), the present study found that the KLCI returns series are characterized by long periods of pure noise, only to be interspersed with relatively few brief episodes of highly significant non-linearity. Major political and economic events that contributed to those short bursts of non-linear behavior are identified. The present framework can be extended to individual firm to examine the adjustment of its stock price to firm-specific events, which will provide deeper insight into issues on corporate finance.

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