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Predicting Crash-Time of Rational Speculative Bubbles of Malaysian Stock Market during the Year 2008

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Abstract- Rational speculative bubble can be defined as transient upward movements of stock prices above fundamental value due to speculative investors. The Generalised Johansen-Ledoit-Sornette (GJLS) model have been developed as a flexible tool to identify the size of rational speculative bubble. This model is combines the economic theory of rational expectation bubbles with finite-time singular crash hazard rates, behavioral finance on imitation and herding of investors and traders as well as mathematical statistical physics of bifurcations and phase transitions. It has been employed successfully to a large variety of stock bubbles in many different markets. The purpose of this study is to predict crash-time, intrinsic value and size of rational speculative bubble of Malaysian stock market during global economic crisis 2008. The predicted crash-time by employing GJLS model is exactly same as empirical date of crash during 2008.

Index Terms- bubbles, intrinsic value, GJLS, economic crises

I. Introduction

A positive acceleration of prices above intrinsic value is said to be a rational speculative bubbles (J. Galbraith, 1997 & D. Sornette, 2003). An unexpected rise in the price of a continuous process also can be named as rational speculative bubble. Rational speculative bubbles are one of the severe issue that give negative consequences to the growth of country's economy. This is because of economic bubble development and dramatic bursts in financial markets (Statman, 1998). Many recent concepts describes that economic bubbles can be produced because of positive feedback trading by noise traders, heterogeneous beliefs of investors together with a limitation on arbitrage and synchronization failures among rational traders. Researches done by Linter & John, 1969, E.Miller, 1977, M.Harisson & D.Kreps, 1978 proved that the combined effects of heterogeneous beliefs and short-sales constrained may lead large movements in asset. In this kind of models which assume heterogeneous beliefs and short-sales, the asset prices are determined at equilibrium to the extent that they reflect the heterogeneous beliefs about payoffs, but short sales boundaries force the pessimistic investors disappear from the market, leaving only optimistic investors and thus magnified asset price levels. However, when short sales limitations no longer tie investors, then prices fall back downwards.

In another class of models, the role of "noise traders" in fostering positive feedback trading has been highlighted. The term "noise trader" was proposed first by Kyle & Albert, 1985 and Black & Fischer, 1986 to show irrational investors. These noise positive feedback traders purchase securities when prices increases and sell when prices drop. Due to this positive feedback mechanism, the deviation between the market price and the intrinsic value has been bloated (Shleifer et al., 1990) . The empirical evidences on this theory are mainly from the studies on momentum trading strategies. Stocks which performed poorly in the past will perform better in a long-term perspective (over the next three to five years) than stocks which performed well in the past. In contrast, at intermediate horizon (three to twelve months), the stocks which performed well previously will still perform better (N. Jegadeesh & S. Titman, 2001)

However, predicting the burst of economic bubbles remains an unsolved problem in standard econometric and financial economic methods (Brunnermeier et al., 2004).This is due to the fact that the fundamental value is in general poorly constrained and it is impossible to differentiate between exponentially growing bubble prices. Detecting the bubble ex-ante could help to take some actions to stop from bubble bursting. But none of the theories mentioned above can diagnose bubble ex-ante. This may be due to the fact that all these theories cannot differentiate between intrinsic and bubble price and cannot give a price dynamics which leads to a crash. The Standard Johansen-Ledoit-Sornette (SJLS) model or Johansen-Ledoit-Sornette Model was developed by Sornette and his colleagues. It also has the ability to predict the most probable crash time after a bubble ex-ante. Generalized Johansen-Ledoit-Sornette (GJLS) Models have been developed as flexible tools to predict bursting of rational speculative bubble (W. Yan, 2011). This study specially conducted to predict probable crash time of speculative rational bubble Malaysian stock market for the year 2008.

II. Generalised Johansen Ledoit Sornette Model

The GJLS model of economic bubbles and crashes is an extension of the rational expectation bubble model proposed by N. Barberis et al., 1998. A financial bubble is modelled as a regime of accelerating or super-exponential power law growth punctuated by short-lived corrections organized according the symmetry of discrete scale invariance (K. Daniel et al., 1998). The super-exponential power law is argued to result from positive feedback resulting from noise trader decisions that tend to enhance deviations from fundamental valuation in an accelerating spiral.

We firstly consider the purely speculative asset that pays no dividends, so that we do not take into account the interest rate, information asymmetry, risk aversion, and the market clearing condition. The rational expectations are simply corresponding to the familiar martingale hypothesis in (1).

$$E_t\left[p(t')\right] = p(t) \qquad \forall t' > t \qquad (1)$$

where $p(t)$ denotes the price of the asset at time t and $E_t[.]$ indicates the expectation conditional on information revealed up to time t.

Then lets the cumulative distribution function (cdf) of the time of crash is called $Q(t)$, the probability density function (pdf) is $q(t) = \frac{dQ}{dt}$ and the hazard rate is $h(t) = \frac{q(t)}{1-Q(t)}$. The hazard rate is the probability per unit of time that the crash will happen in the next instant if it has not happened yet.

In the JLS model, the stock market dynamics is described as (2).

$$\frac{dp}{p} = \mu(t)dt - \kappa dj \qquad (2)$$

where p is the stock market price and the term dj indicates a discontinuous jump such that $dj = 0$ before the crash and $dj = 1$ after the crash happens. The parameter κ determined the loss amplitude associated with the occurrence of a crash. The time-dependent drift $\mu(t)$ is chosen so that the price process satisfies the martingale condition given as (3) and (4), respectively.

$$E_t[dp] = \mu(t)p(t)dt - \kappa p(t)h(t)dt = 0 \qquad (3)$$

$$\mu(t) = \kappa h(t) \qquad (4)$$

And (5) is corresponding to the price.

$$\log\left[\frac{p(t)}{p(t_0)}\right] = \kappa \int_{t_0}^{t_1} h(t')dt' \qquad (5)$$

This gives the logarithm of the price as the relevant observable. The higher the probability of a crash, the faster the price grow (conditional on having no crash) in order to obey the martingale condition. Intuitively, investors must be remunerated by a higher return in order to be induced to hold an asset that might crash. The sensitivity of the market reaction to news or external influences accelerate on the approach to this transition in a specific way characterized by a power law divergence at the critical time t_c of the form $F(t) = (t_c - t)^{-z}$, where z is called a critical exponent. This form amounts to the following property of (6).

$$\frac{d\ln f}{d\ln(t_c - t)} = -z \qquad (6)$$

(6) is a constant, namely that the behaviors of the observable F become self-similar close to t_c. The symmetry of self-similarity in the present context refers to the fact that the relative variations $d\ln F = \frac{dF}{F}$ of the observable with respect to relative variations $d\ln(t_c - t) = \frac{d(t_c - t)}{(t_c - t)}$ of the time-to-crash are independent of time t, as expressed by the constancy of the exponent z.

The crash hazard rate follow the same dependence as (7).

$$h(t) = B'(t_c - t)^{m-1} \qquad (7)$$

where B' is a positive constant and t_c is the critical point or theoretical date of the bubble end. The term m must in the range of $0 < m < 1$ for an important economic reason's otherwise; the price would go infinity when approaching t_c (if the bubble has not crashed yet).
The first order expansion for (7) (the hazard rate) is given by (8).

$$h(t) \approx B'(t_c - t)^{m-1} + c'(t_c - t)^{m-1}\cos\left[\omega\ln(t_c - t) + \phi'\right] \qquad (8)$$

The crash hazard rate now displays log-periodic oscillations. This can easily see by taking the exponent z to be complex with a non-zero imaginary part, since the real part of $(t_c - t)^{-z+i\omega}$ is $(t_c - t)^{m-1}\cos[\omega\ln(t_c - t)]$. The evolution of the price before the crash and critical date is then given by (9).

$$\ln E[p(t)] \approx A + B(t_c - t)^m + C(t_c - t)^m\cos(\omega\ln(t_c - t) + \phi) \qquad (9)$$

The generalised Johansen Leodit Sornette Model is formed by inferring fundamental value of stock in eq.(9). Extension of (9) is said to be GJLS Model that proposed by (W.Yan et al., 2011).

The price dynamics of an asset as

$$dp = \mu(t)pdt + \sigma(t)pdW - \kappa(p - p_1)^{\gamma}dj \qquad (10)$$

where the $\mu(t)pdt + \sigma(t)pdW$ describes the statistical geometrical Brownian motion and the third term is the jump.

When the crash occurs at some time t^* (indicate $\int_{t^*-}^{t^*+} dj = 1$), the price drops abruptly by amplitude $\kappa\left(p\left(t^*\right) - p_1\right)^{\gamma}$.

where $\kappa = \gamma = 1$, the price drops from $p(t^{*-})$ to $p(t^{*+}) = p_1$. The price changes from its value just before crash to a fixed well-defined valuation p_1.

Inferring no-arbitrage condition $E_t[dp] = 0$ to (10) leads to

$$\mu(t)p = k(p - p_1)^{\gamma} h(t) \tag{12}$$

Conditional on the absence of a crash, the dynamics of the expected price obeys the equation

$$dp = \mu(t)pdt = k(p - p_1)^{\gamma} h(t)dt \tag{13}$$

and the fundamental price must obey the condition $p_1 < \min p(t)$. For $\gamma = 1$, the solution is

$$\ln[p(t) - p_1] = F_{LPPL(t)} \tag{14}$$

where $F_{LPPL(t)}$ is given by the (9); For $\gamma \in (1,0)$, the solution is

$$(p - p_1)^{1-\gamma} = F_{LPPL(t)} \tag{15}$$

do not consider the case $\gamma > 1$ which would give an economically non-sensible behaviour, namely the price diverges in finite time before the crash hazard rate itself diverges.

In summary, [26] considered a model as shown below.

$$p_1 + \exp(F_{LPPL}(t)), \gamma = 1 \tag{16}$$

The final model (16) was applied to the Kuala Lumpur Composite Index (KLCI) to identify the the most probable crash-time of rational speculative bubble that appeared during the year 2008. Besides that, this study also to obtain fundamental value of stock price and followed by identification of bubble size as well.

III. RESULTS AND DISCUSSION

As a first step, we test few time intervals to predict the index value at market stopping time in order to choose a most appropriate time window to predict crash-time of rational speculative bubble of KLCI. Table 1 shows the results obtained for index value at market stopping time.

Table 1: Predicted index value at market stopping time

Time interval	Index value at market stopping time	Predicted index value	Differences, %	MSE
01/09/1998-18/02/2008	1516.22	1506.88	0.60	3.16E-07
29/03/1999-18/02/2008	1516.22	1493.87	1.50	2.01E-08
31/05/1999-18/02/2008	1516.22	1477.81	2.50	1.26E-09
27/09/1999-18/02/2008	1516.22	1477.02	2.60	3.56E-08
08/05/2001-18/02/2008	1516.22	1437.27	5.20	3.13E-08
19/12/2002-18/02/2008	1516.22	1400.17	7.70	1.38E-08
10/03/2003-18/02/2008	1516.22	1402.75	7.43	2.36E-08
24/05/2004-18/02/2008	1516.22	1401.70	7.60	9.06E-09
06/03/2007-18/02/2008	1516.22	1430.91	5.63	1.44E-09

There are nine different time intervals selected to predict index value at market stopping time. The most nearest index value obtained is for the time interval 01/09/1998-18/02/2008. This time interval was used to forecast the crash-time of KLCI during year 2008. The crash-time predicted using selected time interval by the model is exactly same as the empirical date that is 18/02/2008. The fitted KLCI index with the GJLS model is shown in figure 1.

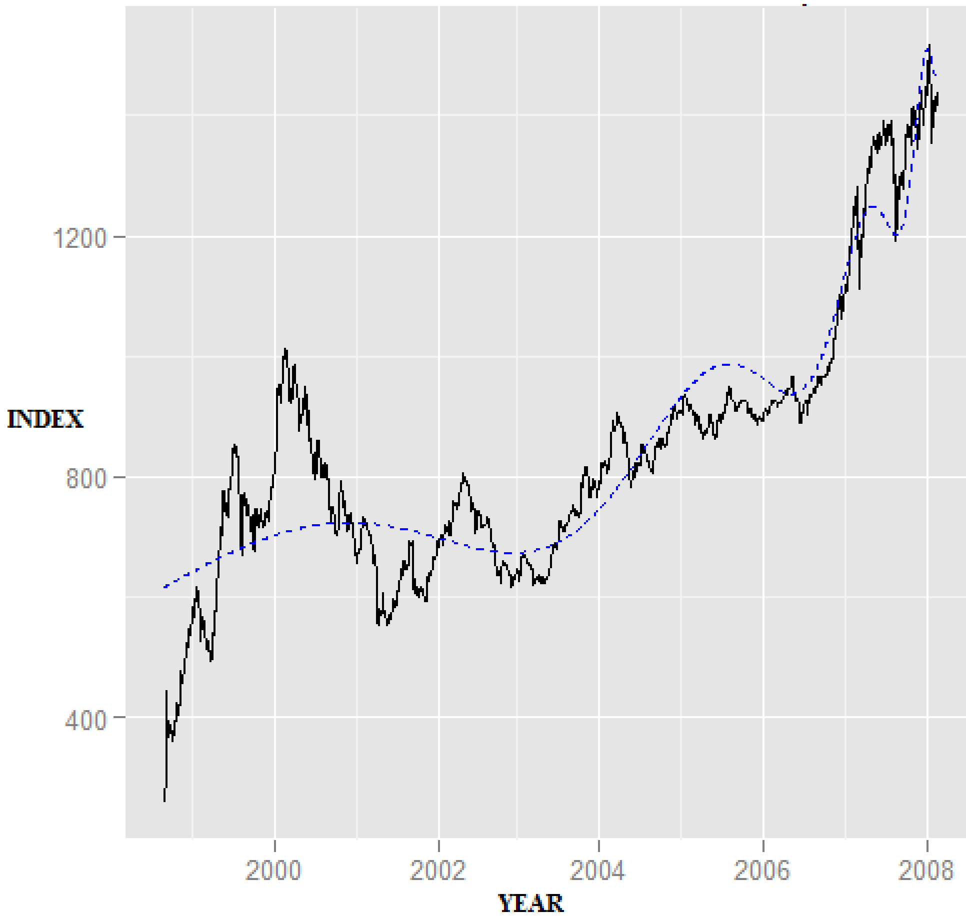

Figure 1: Fitted curve of KLCI, 2008

Table 2: Predicted intrinsic value of KLCI, 2008

Time interval	**Index value at market stopping time**	**Intrinsic value**	**Bubble size**
01/09/1998 - 18/02/2008	1516.22	861.98	654.24, 43.2%

The intrinsic value predicted by using the selected time interval is shown in Table 2. The obtained value is 861.98 which shows that the market value is deviated about 43.2% from its fundamental value. This deviation is called as size of the speculative rational bubble that formed during global economic crisis 2008. By using the predicted intrinsic value, we found that the rational speculative bubble start to form and grow in Malaysian stock market from 12/01/2000 to 18/02/2008. There are eight bubble phases found in the period of selected time interval. The summary of the phases are shown in the Table 3 and illustrated in figure 2.

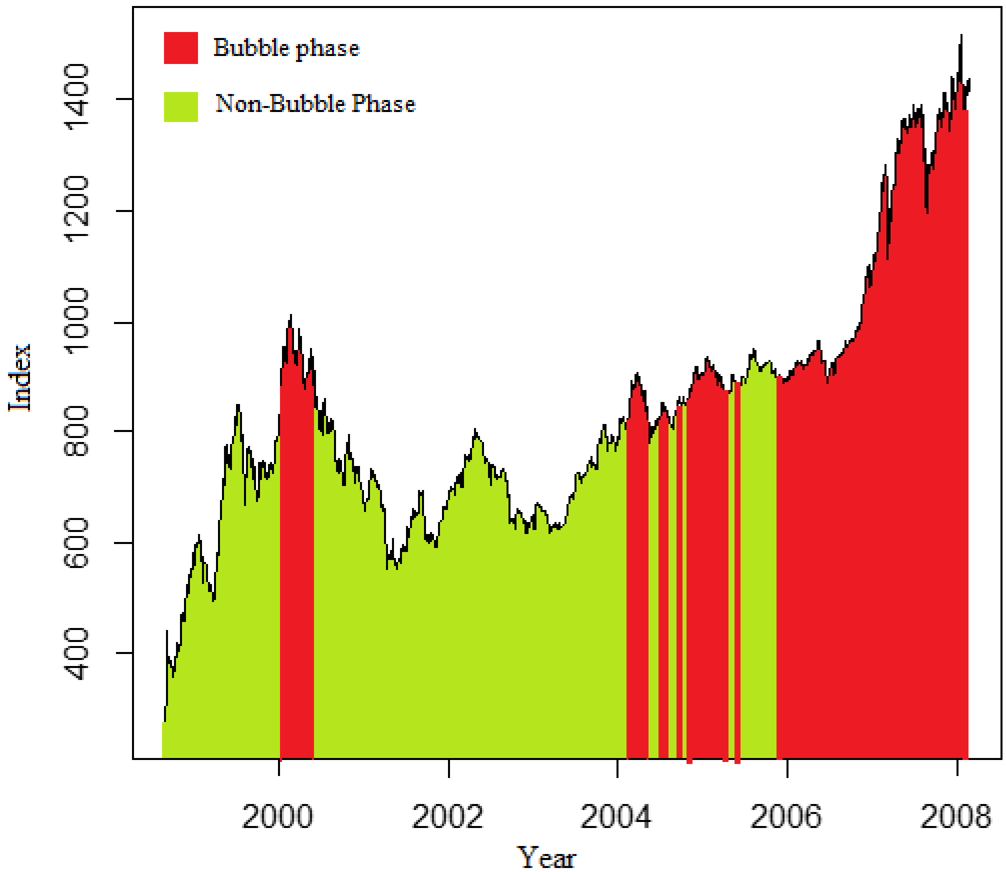

Figure 2: Bubble Phase of Malaysian Stock Market, 2008

Table 3: Bubble Phase and Size of the Bubble Formed in Malaysian Stock Market, 2008

Bubble Phase					Size of the Bubble Formed	
Starts		Ends		Duration		
Date	Market Index Value	Date	Market Index Value		Min %	Max %
12/01/2000	869.62	14/06/2000	862.12	155	0.9	17.55
24/02/2004	874.82	14/04/2004	866.29	51	1.5	5.45
20/04/2004	864.02	27/04/2004	868.32	8	0.2	1.57
20/09/2004	865.34	21/09/2004	865.31	2	0.4	0.93
04/10/2004	865.07	07/10/2004	864.16	4	0.4	0.36
01/11/2004	864.04	05/04/2005	869.81	156	0.2	8.77
08/04/2005	864.02	30/05/2005	869.96	53	0.2	4.88
02/06/2005	862.40	18/02/2008	855.39	992	0.1	75.87

The maximum size of rational speculative bubble formed in Malaysian stock market is 75.87% and appeared about 992 days before crash. According to the Table 3, we can summarize that the longer the duration the bigger the size of the bubble formed.

IV. CONCLUSION

In a conclusion, this paper examines the possible crash-time of rational speculative bubble of KLCI stock market during the year 2008. The GJLS model was successfully employed to the data to achieve our goal of study. It is essential needs for researcher to study on financial bubbles. It is because the economic bubbles are one of the serious issue that give negative implications to the development of economy which is the factor leads to an economy crisis.

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