Financial Bubble Theory and the Log Periodic Power Law Application to Malaysian Stock Market

Devendran Indiran, Munira Ismail, Zaidi Isa

Abstract: Financial bubbles crashes phenomena has puzzled the economists for decades. The Efficient Market Hypotheses states that the stock market is efficient and all stock prices reflect all information. However, despite the efficient market hypothesis, financial bubbles which lead to financial crashes still persist in the market. This paper attempts to deviate from the efficient market hypothesis, and aimed to explore the causes of financial bubbles. Financial bubbles can be formed as a result of irrational euphoria, heterogeneous beliefs, positive feedback trading, synchronization failure among the traders, level of testosterone of traders and many other factors. Next, we discuss on the methods that has been developed to capture the bubbles and predict the financial crashes. There are numerous evidences that have shown that LPPL model is able to predict the financial crashes. Modifications have been made to this model to increase its efficiency in predicting financial crashes. We will additionally discuss on the implications of the Log Periodic Power Law model and also the changed versions in predicting financial crashes.

Keywords: Financial bubbles, Financial crashes, Log-Periodic Power Law.

I. INTRODUCTION

Financial bubble crashes has crippled economy of many countries in the past decades. The phenomena of financial bubble crashes remains as unsolved problems in standard econometrics and financial economic approaches [1] and [2]. Therefore, a meticulous research is required to understand the causes of financial bubbles. There are numerous ways are developed to capture and predict the financial bubbles crashes. The main intent in this article is to reflect on what were achieved in empirical financial bubble research, the key issues in bubble crash prediction and provide a simple analysis of Malaysia stock market bubble as well where we may be heading.

Financial bubbles are often outlined as a positive acceleration or deviation of costs higher than its basic price [3], [4], [5] and [6]. The value deviations are often classified arbitrarily into three classes like growing bubbles, informational bubbles and fads. Growing bubbles can be appeared within the market even the traders are rational. Its usually constant terms that seem in solutions to distinction equations of equilibrium costs[3] and [7], unless a market is known to be restricted by quality life, or by the wealth or range of traders.

Revised Manuscript Received on February 05 2019.

Devendran Indiran, School of Mathematical Sciences, Universiti Kebangsaan Malaysia, Pekan Bangi, 43600 Bangi, Selangor, Malaysia,

Munira Ismail, School of Mathematical Sciences, Universiti Kebangsaan Malaysia, Pekan Bangi, 43600 Bangi, Selangor, Malaysia

Zaidi Isa, School of Mathematical Sciences, Universiti Kebangsaan Malaysia, Pekan Bangi, 43600 Bangi, Selangor, Malaysia

Info bubbles occur once costs deviate from basic values supported all available information, as a result of data is not absolutely collective by market prices [8], or agents have totally different beliefs regarding however the economy works.Fads are mean-reverting deviations from basic value caused by social or psychological forces like those that cause fashions in politics or consumption product (Shiller, 1984), or like Keynes's ‘animal spirits’. If fads are slowly mean-reverting, they are 'near-rational' since traders would have to be wait a long time to use their data that prices are in a fad.

According to [4], financial bubble can be induced by the irrationality of investors in the market. The two books by [4] “The Great Crash 1929” and by [6] “Manias, Panics and Crash” emphasize that the feelings of great happiness and excitement which may be normal or abnormal triggered by irrational euphoria make the investors to invest in bull market to gain high profit. During this respect, [9] argues that the stock increment because of irrational high spirits caused by an emphatic media. Recent study by [10] argues that the level of testosterone influences the behavior of investors and led to irrational act in market. Approximately 70% of professional traders in the market are male. Testosterone levels trigger a person to respond to social status [11] as well as to competition. High level of testosterone gives the winner effect to a person even in non-sport competition and also increases greed in the ultimatum game. High level testosterone gamer offer less money to others than low level testosterone gamer [12]. [10] proved that the level of testosterone effects the market participant’s behavior. The individual-level analysis showed that high testosterone participants paid more as prices increased that expanded the gap between prices and fundamental values. Momentum created by feedback trading was autocatalytic in that rising prices generated higher prices among participants receiving testosterone but not among those who received a placebo. Recent theories shows that bubbles may be shaped even within the absence of irrational investors, due to regeneration mechanism by noise traders, synchronization failure among rational traders and heterogeneous beliefs with a brief sale restrictions. Positive feedback traders are shopping for winners and marketing losers [13]. [14] model assumes that, the rational speculators trade more when they receive good news and move the costs up these days more than the basic price. The positive deviation of worth directly stimulate the noise traders to exchange response to previous worth will increase so keep costs on top of its fundamentals.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

As said by [15], that the key to success in his investment strategy was not beat the opportunity that seems in financial markets, however rather to ride this wave and sell out a lot of later. [16] and [17] introduced the term "noise traders" to describe the behavior of irrational investors. The key purpose is that dealing between rational speculators and regeneration feedback dealers or noise dealers create to bubble-like worth patterns. In their model, rational speculators destabilizes costs as a result of their dealing triggers positive feedback by different investors. Positive feedback dealing reinforced by noise dealers result in a positive auto-correlation of returns at short horizons.

[18], Analyze why the rational dealers ride rather arbitrage bubbles. Arbitrageurs face synchronization failure and as a consequence, delays the arbitrage chance. Arbitrageurs are supposed to notice that the market can eventually crash because the bubbles burst as before long as a sufficient range of rational dealers sold out. However, the scattering about arbitrageur's suppositions around market timing and also succeeding vulnerability on the synchronization for his or her sell-off are delaying this collapse, permitting the bubble to grow. During this structure, bubbles keep within the short and intermediate term because short sellers face synchronization risk, which is, uncertainty relating to the market correction time. As a result, arbitrageurs who conclude which alternative arbitrageurs are yet unbelievable to trade against the bubble realize it optimal to ride the growing bubble for a short duration. [19] extracted hedge fund holdings data from type 13F that is concerning quarterly equity positions of hedge fund with massive holdings within the United State (US) equities within the duration from 1998 to 2000.The studies showed that, over the sample duration 1998 to 2000, hedge fund portfolios were heavily tilted toward extremely priced technology stocks. The extent about their overall stock holdings dedicated with this fragment may have been higher over the relating weight of engineering stocks within the market portfolio. In addition, the hedge funds in their sample skilfully anticipated worth peaks of individual technology stocks. On a stock-by-stock basis, hedge-funds began to crop their holdings before costs folded, shift to technology stocks that encountering rising prices. Subsequently, multifaceted investments directors caught the upturn, yet maintained a strategic distance from a significant part of the downturn. This as represented within the means that mutual funds attained intensive overabundance return in the technology segment of the Nasdaq.

[20], [21], [22], [23] and [24] have claimed that the combined impact of heterogeneous beliefs with trading constraints may be the most reason of financial bubble. Heterogeneous beliefs may be explained as totally different opinion or view of investors towards market price movements in the near future [18]. Limitation to short sale with the heterogeneous beliefs forces the demoralised investors out of the market and leave optimistic investors and therefore inflated quality worth levels. [25]This gives a probable justifications of the Internet or Dot Com bubble that formed in the year between 1998-2000. As archived by [26], around 80% of net-related shares were protected up because of the way that various internet organizations had experienced the latest initial public offerings (IPOs) and rules, in which compels that shares control by insiders and alternative pre-IPO equity holders can't be changed for no less than 6 months after the IPO date. These stocks were expired and the float of the internet area sharply raised and the collapse of internet stock prices coexist with a dramatic growth within the range of Internet companies publicly tradable shares.

Identification of Bubbles

[3] and took after by [7]recommended the variance bound test which is created by [9] to identify the emerges of bubble in the market.[9] and [7] suggested that the infringement of variance bounds is attributed to the existence of bubble. [27], [28], [29] and [30] intensely criticized the proposal because of the fact that the variance certain tests might be failed not provided that bubble exist however conjointly if any of the presumptions of present price model is desecrated. [31]developed an alternate approach by utilizing Euler's condition that could be a two-step verification for the bubble identification in equity prices. Following [34], a huge literature emerged regarding the identification of bubbles, similar to [35], [36], [37], [38] and [39] who incorporated regime switch models for bubble identification. Meanwhile, in an apparently inapplicable approach, [40] utilized Kalman filtering in a plan to test for bubbles, whereas at the same time [41]tried to established a test for bubbles on the residuals primarily based of the cointegrating equation between dividends and stock prices.

In a outstanding paper, [42] presented a algorithmic regression approach so as to analyze the bubble characteristics of different financial statistics throughout the subprime crisis. [43] broadened [42]'s plan by presenting a relevant econometric structure wherever in excess quite one bubble may exist in a similar sample. [43]provided the recognizable conditions with relevancy the explosive behavior of bubbles based on the unit root behaviour of relevant financial time series. [44] explored the facility properties of rational bubbles considering a huge type of testing alternatives, whereas[45] incontestible that structural break Chow-type tests have extended power for the identification of bubbles. Again, [46] described their projected bubble specification algorithm program utilizing information from S&P500 series, while [47]provided the asymptotic properties of the connected bubbles detection conditions. Finally, in two seminal works, [48]the only structure, thus far, within the existing literature, below that an early watching mechanism is established for the detection of multiple bubble episodes.

From a technical perspective, presumably the foremost important element of bubbles is that they're characterized by explosive growth pattern, in spite of the approach that speculative movements are often assumed to follow a random walk process [3] and [49].What's more, it is exactly this, the foremost widely recognized approach to find the bubble, by applying test for associate structural modification from a random walk regime to an explosive one. Such test have been created by [43], [42], [44] and [47].

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Notwithstanding, the crash time of bubbles is a most inconspicuous subject which is difficult to recognize in real financial world. [50] proposed a basic power law model to anticipate the most likely crash time of bubbles in financial markets.Inspired by the physics of self-organized criticality and magnetic phase transitions, [50] developed simple power law models of market prices or stock indices as they approach the moment of a crash. [50] has claimed that the crash would be caused by the cooperative behavior of a network of investors. In this theory, the moment of a stock market crash is equivalent to a critical point in the time dimension. Thus, the dynamics of a stock market index is expected to discontinuously change at the essential time of the crash. The foremost basic power law model proposed by [50] has the subsequent form,

$$P(t) = A + B(t_c - t)^{\alpha} \quad (1)$$

where,

$P(t)$	=	Stock market index	$(t_c - t)$	=	Time to the critical point
A, B	=	Scaling parameters	t_c	=	Time at the critical point
α	=	power law exponent			

[50] takes these ideas further and suggests that the investors' network system gives rise to discrete scale invariance, which calls as complex power law model. Separate scale invariance is a weaker scale invariance that involves a most well-liked scaling ratio λ or a power of the scaling ratio λ^n, wherever *n* could be a positive number. The result is that the statistic is anticipated to oscillate with an increasing frequency so that the stock exchange index oscillates at higher and better rates as the crucial time of the crash is approached. The result's a model [50] consisting of a complex power law as shown in Eq (2).

$$P\left(\frac{t}{T}\right) = A + B\left(\frac{t_c - t}{T}\right)^{\alpha}\left[1 + C\cos\left(\beta\ln\left(\frac{t_c - t}{T}\right) - \varphi\right)\right] \quad (2)$$

where,

C	=	Amplitude of the log-periodicity oscillations	T	=	Time scale
φ	=	Relative phase	β	=	log frequency with scaling factor $\lambda = e^{\frac{2\pi}{\beta}}$

The parameter A should be positive since the value of a stock index is always positive. The $(t_c - t)$ is that the governing parameter of the stock market index that indicates the time to the critical point. Eq (2) is the power law model with log-periodic oscillation. The model in Eq(2), indicates that the stock indices are singular at $t = t_c$, which implies $\ln(t_c - t)$ in the model is discontinues when $t_c = t$. In practice, however stock indices cannot reach a singularity so a small constant is often added to the governing parameter $t_c - t$ to ensure that the price changes, $\frac{dP(t)}{dt}$ at the given time is discontinuous at $t = t_c$ while $P(t)$ is continuous at $t = t_c$. D. Sornette successfully found the evidence of log-periodic pattern in S&P 500 market which paralleling previous similar observations on earthquake. Later in 1997, [51] studied the behavior of daily S&P 500 Index from 1994 to 1998 by using a specialized method which appears to be exponentially growing with a log-periodic oscillatory structure. They studied by identifying the troughs of the apparent log-periodic fluctuations. [51] argue that the time period between troughs decreases as the moments of crash is approached. [52], modified the model shown in Eq.2 together with the primary non-linear correction that is from renormalization group approach and obtained the following model in Eq(3). This model successfully modified to point out that the precursors can be identified over a much longer interval.

$$P\left(\frac{t}{T}\right) = A + B\frac{\left(\frac{t_c - t}{\phi}\right)^{\alpha}}{\sqrt{1 + \left(\frac{t_c - t}{\Delta t}\right)^{2\alpha}}}\left[1 + C\cos\left(\beta\log\left(\frac{t_c - t}{\phi}\right) + \frac{\Delta\beta}{2\alpha}\log\left(1 + \left(\frac{t_c - t}{\Delta t}\right)^{2\alpha}\right)\right)\right] \quad (3)$$

where,

ϕ = Renormalized group flow map

In the year 1999, [53] modified the LPPL model in Eq(3) to predict the decelerating of log periodic oscillation in order to prove that the imitation between dealers and their herding behavior not only cause speculative bubble with increase speed over-valuation of financial markets probably followed by crashes, however to "anti-bubbles" with decelerating market devaluations.

*Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication*

During this same year, [53], studied about the lowest necessities for a model of stock market fluctuations that should contains time asymmetry, robustness with respect to connectivity between agents, rationality and a probabilistic description. This study intentionally aimed to compare the results with the model which is suggested by [55]. [55] suggested to remove the power law exponent α from the model in Eq(6). [54] proved that [55] model significantly over-estimates the moments of the crash and model in Eq(2) better fit to the data. In the year 2000 and 2001, [54] applied model as shown in Eq(10) to predict financial bubble crash in Latin-America, Asian and Western stock markets. The model shown in Eq(4) is the simplest version of Eq(2). as the time scale is has been removed to reduce the complexity of the model.

$$P(t) = A + B(t_c - t)^{\alpha}\left[1 + C\cos(\beta\ln(t_c - t) - \varphi)\right] \quad (4)$$

In the year 2006 [56] given a scientific algorithm, that was enforced on the Dow Jones Industrial Average index (DJIA) and on the Hong Kong Hang Seng composite index (HSI) to find earlier important drops or changes of regimes. [57] analyzed the 2006-2008 oil prices run-up by utilizing LPPL methodology and proved that oil costs displayed a bubble-like dynamics. In this year 2010, [58] enforced the LPPL model to find bubbles and sequent market crashes of Shanghai traditional market combined index and therefore the Shenzhen stock market element index.[59] given a scientific analysis of drawdown outliers and showed that they're either preceded by a (super-exponential) power law price appreciation adorned by LPPLS signatures or by exogenous shocks. [60], utilizing the LPPL model, developed an alarm index supported a complicated pattern recognition technique with the aim of detection bubbles and performed forecasts of market crashes and rebounds. Testing their methodology on 10 major world equity markets, they showed quantitatively that their alarm technique performs much better than chance in prediction market crashes and rebounds. [61] projected a modification of the LPPL formulation convenient for a lot of stable calibrations by increasing the cosine function $C\cos(\beta\ln(t_c - t) - \varphi)$ into two terms, $C\cos(\beta\ln(t_c - t))\cos(\varphi)$ and $C\cos(\beta\ln(t_c - t))\sin(\varphi)$ and the LPPL model becomes,

$$P(t) = A + B(t_c - t)^{\alpha} + C_1(t_c - t)^{\alpha}\cos(\beta\ln(t_c - t)) + C_2(t_c - t)^{\alpha}\sin(\beta\ln(t_c - t)) \quad (5)$$

Where there are three nonlinear parameters (β, α, t_c) and four linear parameters. This modification considerably minimize the problem of the fitting procedure and improves its stability. In additionally they developed an extra subordination that permits one to find the essential time, the end of the bubble and therefore the most probable time for a crash to occur. [61] utilized the Shanghai Composite index (SSE) from January 2007 to March 2008 to check the changed LPPL model. Moreover, the analysis team at ETH Zurich developed an LPPL based mostly bubble detection system into three indicators particularly, Bubble Status, the End-of-Bubble signal and therefore the confidence which is described in [62] and [63]. The following section shows a simple analysis of Malaysia stock market bubble crash time during the 2008 with the help of Eq. (4).

II. ANALYSIS OF MALAYSIAN STOCK MARKET BUBBLE

Malaysia had experienced a major currency shock during the year 1997 which directly affect the stock market and caused financial crises. The last peak date before the stock market crash during 1997/98 was 1994-02-03 with index value 1150.21. An analysis manage to forecast the crash time of Malaysian stock market crash by utilizing LPPL model as shown in Eq.(2). Figure 1, shows the well fitted of real stock market index information with the predicted data of LPPL model. Table 1 and 2 shows the predicted crash time Malaysian stock market during the year 1997/98 by LPPL model and the estimated values of parameters respectively. The chosen time window is based on exponential trend before the crash time which is from 1991-08-19 to the peak date 1994-02-03. The model predicted the crash time with one day different with the real date.

Besides 1997/98 financial crises, Malaysian stock market also faced stock market depression during the year 2008. The impact of financial crash during 2007/8 was not affect the country economic growth directly as experienced in 1997/98 financial crash. The last peak date before the slight crash during 2007/8 was 2008-01-11 with index value 1516.22. The LPPL model used again to predict the 2007/8 the crash date as shown in the Table 3 and 4. Figure 2 portraits the fitted stock index with LPPL model parameters. The exponent trend time interval chosen for the analysis is from 2008-02-24 to 2001-05-18. The model predicted the crash time 10 days after the real crash date.

Table. 1 Predicted Crash Time of Malaysian Stock Market, 1997

Time interval	Market Crash Date	LPPL Crash Predicted Date	error
19/08/1991 - 03/02/1994	1994-02-03	1994-02-02	0.9673

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table. 2 Estimated Parameters of Malaysian Stock Market, 1997

Parameters	Estimated Value	Standard Error
A	2.324	0.3930
B	-4.448	0.5276
C	-2.254	0.5232
β	5.768	0.1696
Ø	15.41	1.0520
α	0.35	0.0303

Table. 3 Predicted Crash Time of Malaysian Stock Market, 2008

Time interval	Market Crash Date	LPPL Crash Predicted Date	error
18/05/2001 - 24/02/2008	2008-01-11	2008-01-21	9.942

Table. 4 Estimated Parameters of Malaysian Stock Market, 1997

Parameters	Estimated Value	Standard Error
A	1.082	0.2830
B	-2.629	0.6876
C	4.712	0.1232
β	18.40	0.7739
Ø	-8.900	0.6660
α	0.152	0.0673

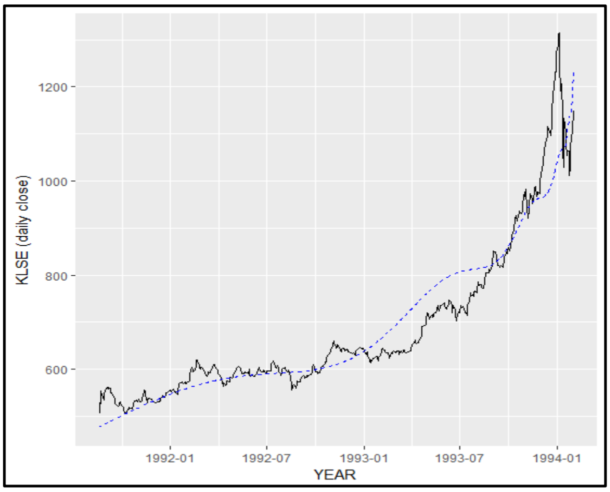

Fig. 1 Fitted Stock Index with LPPL Model (1992-1994)

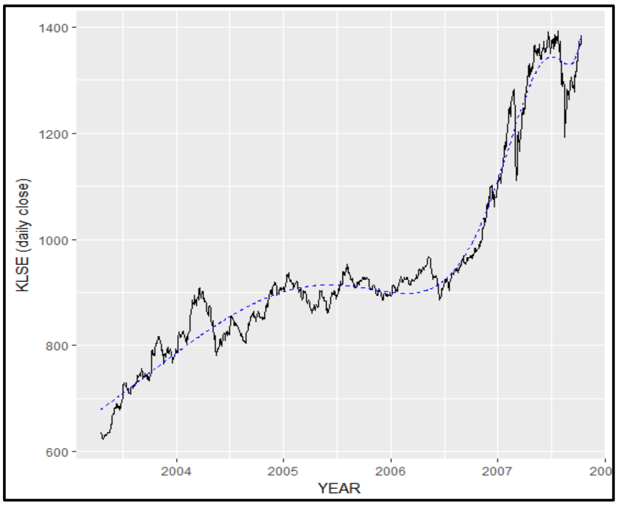

Fig. 2 Fitted Stock Index with LPPL Model (2003-2008)

III. CONCLUSION

The study of financial bubbles should be more precise in order to capture the behavior and to overcome the effects on financial markets. This paper has highlighted few factors of forming and bursting of bubbles in financial markets. Financial bubbles is triggered by irrational euphoria of the investors, heterogeneous beliefs, feedback dealing by noise dealers, synchronization failure among the dealers and therefore the level of testosterone of traders. Besides that, this paper also gave attention to the modifications of LPPL model to underline the contribution in predicting financial bubble crash time to give an insight for researchers to enhance the existing models in predicting the financial bubble crashes. At the end of this paper, we also provided a simple analysis on Malaysian stock market bubble crash time prediction for the year 1997/98 and 2007/08. While this approach has delighted in an extensive perceivability in the expert financial group the world over such as banks, shared assets, speculative stock investments, venture homes however it has not however received the thought from the educational financial association. This is often due the starting point of the hypothesis coming back from agreement with complicated basic frameworks in Physics and also the theory of complicated system. In future, modelling on financial bubble growth should be given more priority as its play crucial role in economic critical time.

ACKNOWLEDGEMENT

We would prefer to acknowledge Universiti Kebangsaan Malaysia for giving fund

REFERENCES

1. T. Lux, D. Sornette, "On rational bubbles and fat tails", Journal of Money, Credit and Banking 34 (3) (2002) 589–610.
2. R. Gurkaynak, "Econometric tests of asset price bubbles: Taking stock", Journal of Economic Surveys 22 (1) (2008) 166–186.
3. O.J. Blanchard and M.W. Watson, 1982, "Bubbles, Rational Expectations and Speculative Markets, in Crisis in Economic and Financial Structure: Bubbles, Bursts, and Shocks", edited by Paul Wachtel. Lexington: Lexington Books.
4. J. Galbraith, "The great crash", 1929, Mariner Books, 1997.
5. Sornette, "Critical market crashes", Physics Reports 378 (2003) 1–98.
6. P. Kindleberger, Manias, Panics and Crashes: A History of Financial Crises. New York: Basic Books, 1978.

7. J. Tirole, 1982, ‘‘On the possibility of speculation under rational expectations’’, Econometrica 50, 1163-1182.
8. M. Friedman and A.J. Schwartz: ‘‘A Monetary History of the United States’’, 1867-1960. Princeton: Princeton University Press, 1963.
9. R. Shiller, 1984, ‘‘Irrational Exuberance’’, Princeton University Press, Princeton, NJ.
10. Nadler, P.Jiao, C. Johnson, V. Alexander, and P.J Zak,. ‘‘Testosterone administration increases size of experimental asset bubble’’, In Press.
11. B. Mazur, (1992). ‘‘Testosterone and chess competition’’, Social Psychology Quarterly, 55(1), 70-77.
12. P.J. Zak, R. Kurzban, S. Ahmadi, S. Swerdloff & J. Park (2009). ‘‘Testosterone Administratiion Decreases Generosity in the Ultimatum Game’’, PLOSone.
13. N. Jegadeesh and S. Titman, 1993, ‘‘Returns to buying winners and selling losers: Implications for stock market’’.