Rational Speculative Bubble Size in Gold, Hang Seng, S&P 500 and Nikkei 225 Index During Year 2008 to 2016

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Abstract. A rational speculative bubble is a surge in asset prices that exceed its intrinsic value. Rational speculative bubbles are among the ascription which may lead to the collapse of an economic system. Rational speculative bubble cannot be created but it comes into existence when assets started to be traded. Financial rational speculative bubble and burst have negative effect on the economy and markets. Financial rational speculative bubbles are difficult to detect. This study aims to shows the size of rational speculative bubble in four markets, which are gold, Hang Seng, S&P500 and Nikkei 225 during year 2008 to 2016. In this study, generalized Johansen-Ledoit-Sornette model are used to find the size of the rational speculative bubble. Bubble detection is important for both sides of macro-economic decision makers and to the trader. Especially for a trading system that requires detailed knowledge about the time and the stage of the bubble burst.

1. Introduction
Rational speculative bubble refers to a situation where the price of an asset that exceed its fundamental price. This bubble is a catalyst for the collapse of the economic system of a country. It can not be created but it comes into existence when assets started to be traded. Rational speculative bubble act like a virus in economic system. The larger it size the larger the impact it give to the economic system when it burst. It is important to know the existence and the size of the bubble so a precaution can be take when the bubble is burst. From the studies that have been done, the history of bubbles that occur in developed countries like the United States and China had a negative impact on economic growth. This shows that the study of rational speculative bubble is important to ensure the economic system of a country is in a good and stable condition.

[1], said that the housing bubble in the United States is growing with the stock bubble in the middle of 1990. The growth of the bubble is due to investor wealth that has increased substantially in short periods of time compared to the share price. Investors spend all their money to invest. This has led to the consumption boom in 1990 with a savings rate of disposable
income of 5% in the middle of the decade to 2% by 2000. The bursting of bubble make the economy declined. This also happen in Holland when tulip stock price collapse.

According [2], the tulip mania is the first recorded financial bubble in 1630 in Holland. Tulip stock price has been speculated by the broker. Shares are purchased when prices are low and sell when prices are rise causing the shareholders start to obtain profits. When some shareholders started to sell and freeze benefits, this caused many shareholders start to sell when there is nobody wishing to buy. This causes the tulip stock price to be lower and this situation makes the shareholders panicked and lead to sales, regardless of losses. This situation continued until the collapse of the tulip market in February 1637 as shown in Figure 1.

![Figure 1. Downfall of Price Index of Tulipmania Stock Company.](image)

Also, the collapse of South Sea company that happen when the company’s shares exceed the benefits. When all the investors realized that the company’s management began to sell the company’s shares, they also start to sell their shares until at one time, the company’s shares are no longer worth and cause destruction. The collapse of these share prices should be a guideline to other country especially to the developing countries like Malaysia so that the same mistake not recur.

2. Methodology

In this study, the generalized Johansen-Ledoit-Sornette(GJLS) model is used to find the rational speculative bubble size in gold, Hang Seng, S&P 500 and Nikkei 225 index market during year 2008 to 2016. This model was built by A. Johansen, O. Ledoit and D. Sornette to explain about the dynamic of financial bubble and crashes. GJLS model is the best model to find the size of the rational speculative bubble. This can be shown by a study by [3]. [3] conduct an analysis of the difference between GJLS model and Standard Johansen-Ledoit-Sornette(SJLS) model. This analysis shows that GJLS model is the best model because SJLS model just can detect the financial bubble and forecast the period of the bubble collapse. The GJLS model not only can identify the period of bubble collapse but also can estimate the fundamental value of the bubble collapse.

In other study that was done by [4] who managed to find the size of the rational speculative bubble for Hong Kong market during year 2008. This study shows that GJLS model is the best
model in finding of the size of the rational speculative bubble. The bubble size obtained in line with the economic collapse that occurred in Hong Kong in 2008.

2.1. Generalized Johansen-Ledoit-Sornette

The GJLS model can be shown as equation 1

\[ p_t = p_1 + \exp(A + B(t_c - t)\beta)1 + C\cos(\omega \log(t_c - t) + \phi) \]  

Equation 1 is used to forecast the size of the rational speculative bubble for a particular time. Where \( p_t \) is the price for the time \( t \). \( p_1 \) as the intrinsic value and \( \exp(A + B(t_c - t)\beta)1 + C\cos(\omega \log(t_c - t) + \phi) \) refers to the size of rational speculative bubble or also known as \( \exp(F(t)_{LPPL}) \). In this study, only the \( \exp(F(t)_{LPPL}) \) is used because this study aims to shows the rational speculative bubble size for major world markets which are Hang Seng, S&P 500 and Nikkei 225 Index including Gold Index.

Equation 2 shows that the equation of the size of rational speculative bubble that referred to as \( h(t) \).

\[ h(t) = \exp(A + B(t_c - t)\beta)1 + C\cos(\omega \log(t_c - t) + \phi) \]  

In equation 2, the parameter that must be found are \( A, B, C, t_c, \beta, \omega, \phi \) where \( A, B \) and \( C \) are the linear parameters while \( t_c, \beta, \omega, \phi \) are nonlinear parameters. According to [5], the value of \( \omega \) can be found by using three consecutive peaks which is \( h, n \) and \( f \) where \( h < n < f \). The value of \( \omega \) can be calculate as \( \omega = 2\Pi/\ln(\rho) \) where \( \rho = (n - h)/(f - n) \) and the value of \( \phi \) as \( \phi = \Pi - \omega \ln(t_c) - t \). The value of the linear parameters can be estimates by using ordinary least squares(OLS) method as shown below.

\[
\sum_{t=t_1}^{t_n} \begin{pmatrix}
\ln p_t \\
f_t \ln p_t \\
g_t \ln p_t
\end{pmatrix} = \sum_{t=t_1}^{t_n} \begin{pmatrix}
1 & f_t & g_t \\
f_t & f_t^2 & f_t g_t \\
g_t & f_t g_t & g_t^2
\end{pmatrix} \begin{pmatrix}
A \\
B \\
C
\end{pmatrix}
\]

The system of the equations above are rewrite in the matrix form as \( X^T y = (X^T X)\beta \), where

\[
X = \begin{pmatrix}
1 & f_1 & g_1 \\
. & . & . \\
. & . & . \\
1 & f_n & g_n
\end{pmatrix}, \quad y = \begin{pmatrix}
\ln p_1 \\
. \\
. \\
\ln p_n
\end{pmatrix} \quad \text{and} \quad \beta = \begin{pmatrix}
A \\
B \\
C
\end{pmatrix}
\]

Then, the solution of \( \hat{\beta} \) is given by \( (X^T X)^{-1}X^Ty \). The linear parameter which are \( A, B \) and \( C \) are solved by using \( \hat{\beta} \) formula.

3. Result

The below table shows the values of the rational speculative bubble during 2008 to 2016 in three stock market including gold index. The fundamental values shows that the market values diverges about 30% to 39% according to the stock market shown in table 1. In conclusion, this study estimates the value and size of the rational speculative bubble during year 2008 to 2016. The GJLS model successfully applied to the data and achieve the study aim.
### Table 1. The Bubble Size of Stock Markets.

| Stock Market | Time Interval       | Market Value | Fundamental Value | Bubble Size       |
|--------------|---------------------|--------------|-------------------|-------------------|
| S&P 500      | 24/6/2013-13/12/2016| 2271.72      | 1573.09           | 698.63, 30.75     |
| Nikkei 225   | 17/10/2014-24/6/2015| 20868.03     | 14532.51          | 6335.52, 30.36    |
| Hang Seng    | 8/2/2010-28/4/2015  | 28442.75     | 19550.9           | 8891.85, 31.26    |
| Gold         | 27/7/2010-5/9/2011  | 1901.34      | 1161.55           | 739.79, 38.91     |

### 4. Conclusion

In this study, the size of the rational speculative bubble in Gold, Hang Seng, S&P 500 and Nikkei 225 Index During Year 2008 to 2016 acquired by using Generalized Johansen-Ledoit-Sornette. Future study can be done by identifying the trend of the bubble size from one cycle to another cycle. So, with the identified trend we can estimate the next fundamental value of the bubble collapse.

### Acknowledgements

We would like to acknowledge Postgraduate Center of Universiti Malaysia Terengganu for contributing a part of the participation fee for this conference. We would also like to thanks the helpful comments from the editor and reviewers.

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