Bubble Prediction and Comparative Analysis of Emerging and Mature Markets

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Abstract

Looking back at the history of financial bubbles, every time the bubble burst has caused financial turmoil and severe economic recession. This paper attempts to use the indicators of the technical analysis as the warning condition to predict stock market bubbles. It is expected to find early in the financial bubble burst and reduce the awful impact of the financial storm. The early warning mechanism of technical indicators are applied to the stock market data (1995-2018) of the United States, Japan, Germany, China, Brazil and South Korea to predict the bubble, and then comparing the bubble warning conditions of emerging markets and mature markets. The standard bubble warning conditions are as follows: K value 90, RSI value 90, and Bias 10%. From the empirical results, it is found that the mature market has less volatility, and lowering the warning baseline can improve the accuracy of bubble prediction, and correspondingly, improve the emerging Market warning benchmarks can increase the accuracy of their bubble predictions. In addition, the bubble points captured by the warning conditions of technical indicators, the mature markets generally takes about 6 months to burst, and the emerging markets will only burst within 3 months, showing that the mature market has strong anti-risk ability.

Keywords: Stock Market Bubbles; Technical Indicators; Bias
JEL Classification: G15

1. Introduction

It has been 382 years since the first tulip financial bubble in the Netherlands in 1637. After that, various financial bubbles continued to emerge. Researchers in academia and practice are working hard to find a model or method to effectively predict financial bubbles to reduce the impact of a bubble burst. The research in this paper hopes to use the technical indicators to show the overbought status and the excessive deviation as the conditions for the financial bubble prediction. It is expected to find the financial bubble before they burst, and reduce the impact of the financial turmoil. The early warning conditions of technical analysis are used to predict the stock market bubbles in mature markets (US,
Japan, Germany) and emerging markets (China, Brazil, South Korea), and we try to compare the differences of them.

2. Literature Review

Financial bubble research has always been a hot topic in the field of financial academics. Since the 1980s the international economics community has initiated a research trend on the rational bubble. The rational bubble theory is based on the Market Efficiency Hypothesis, and assumes that participants in the market are rational, so in the case of limited trading, there will be no asset price bubbles. Santos and Woodford (1997) pointed out that the asset price and the present value of the dividend represented by the asset are equal, and the asset price bubble is unlikely to occur, but the conclusion depends on many assumptions. In actual economic life, it is obviously unrealistic to assume that investors have rational predictions. Therefore, rational bubble theory cannot reasonably explain many bubbles in financial markets.

The irrational bubble theory is a supplement to the rational bubble theory to explain the bubble phenomenon caused by irrational factors. The complexity and change of the real financial market is the result of non-linear affection. From the perspective of irrationality, the theory analyzes the individual psychology of traders and explores the causes of bubbles from a microscopic perspective. DeLong et al. (1990) established the DSSW model (noise trader model), showing that the unpredictability of noise trader beliefs brought risks to asset prices. The risk aversion attitude of arbitrageurs limited their ability to correct mispricing, thus enabling stocks. Market prices continue to deviate from the underlying value. Barberis et al. (1998) proposed the BSV model (investor sentiment model), which considers that investors use the public information to predict future cash flow, resulting in systematic errors due to different emotions, and causing the stock price to deviate from the basic value, and then leading to bubbles.

Since the 1990s, many scholars have begun to conduct more in-depth and more general research on financial bubbles based on nonlinear dynamics theory and behavioral finance theory. In terms of nonlinear dynamics theory, the LPPL model (Log Periodic Power Law) is the most representative. The main proponents of the model, Johansen and Sornette (1996), compared the stock market crash with the physical material fracture. The first-order logarithmic periodic power law model was used to study the bubble before the collapse of the United States in 1987, and the bubble in the process of collapsing fits well with the logarithmic periodic oscillations. Johansen and Sornette (2001) used the LPPL model to analyze 21 important bubbles and found that the model can be applied to predict the speculative bubbles and the bubble bursting time in emerging markets. In terms of the behavioral finance theory, Shiller (2001) uses feedback theory to explain the process of generating, amplifying and destroying of the stock market bubble. Past prices have increased investor confidence and expectations, and investors have spurred stock prices to attract more participants. This feedback loop has caused asset price bubbles to expand.

Reviewing the development of financial bubble theory, investor irrationality assumptions are closer to the realistic securities market. Under this premise, behavioral finance plays an important role in the bubble research. Behavioral finance integrates the theory of psychology into finance, and uses micro-individual behavior and the psychological causes of such behavior to explain, study and predict the development of financial markets. Behavioral finance provides a reliable and logical scientific model for understanding the market and provides theoretical support for the effectiveness of technical analysis. Technical analysis is based on the market behavior which includes and digests everything. Price fluctuations can be quantitatively analyzed and predicted. The technical analysis is used to judge market trends and make investment decisions based on the periodicity of trends. The three major assumptions of technical analysis are: the market includes all information, stock prices move along a certain trend and history repeats itself. Yang et al. (2010) discussed the rationality of these three assumptions from the perspective of behavioral finance. Mi (2015) believed that "the effectiveness of technical analysis applied to predict the trend of the securities market cannot be overthrown by the
Effective Market Hypothesis”, and elaborated how the psychology of investors can affect the stock price based on the behavioral financial theory. Thus, the technical analysis can be effectively used in the securities market. Because behavioral finance theory is widely used in irrational bubble research, and the technical analysis has a certain foundation of the behavioral finance, this paper tries to use technical analysis to predict stock market bubbles.

Looking at the current method of studying the stock market bubble, we have not found a literature that uses only technical analysis to predict the stock market bubble. Most of the relevant literature on technical analysis is to verify whether the technical analysis is efficient or to prove the weak-efficiency market hypothesis. Shi (2013) explored the effectiveness of technical analysis in the Mainland China, Hong Kong and Taiwan. Based on the daily chart, the paper used seven technical indicators (KD, MACD, Quarterly Line, Volume, Neckline, Support Line and Pressure Line) to verify the effectiveness of technical analysis in the 1997 Asian financial turmoil, the 2000 Internet bubble and the 2008 Lehman storm, respectively. The academic community detects that the stock market bubble mostly uses the asset pricing model as the entry point. The core of its research is to find out the intrinsic value of the stock, and then judge the gap between the stock price and the intrinsic value, so as to analyze the size of the bubble. There are exist some methods for estimating the intrinsic value of stocks: Campbell and Shiller (1998) used price earnings ratios and dividend-price ratios as forecasting variables for the stock market, Engle and Granger (1987) used co-integration test, West (1988) used Euler equation test, Zhou (1998) used dynamic autoregressive method and White (2000) applied P/E comparison method. In the literature to measure the size of the stock market bubble. Pan (2000) used the past earnings per share as the basis for predicting the future dividend, calculating the intrinsic value of the Chinese stock market, and compared the price with the intrinsic value to detect the size of the stock bubble. Wu et al. (2004) assumed that the dividend payout ratio of China stock market was zero, using the Capital Asset Pricing Model (CAPM) to determine the intrinsic value of the stock market and calculate the size of the bubble.

This paper uses the overbought status of technical indicators and the excessive bias as the bubble warning conditions to predict the bubble and analyze the size of the bubble.

3. Research Method
This paper obtains the weekly frequency index of six countries from January 1, 1995 to December 31, 2018. The six indexes are: American Dow Jones Index (DJI), Japan Nikkei 225 Index (N225), Germany DAX Index (DAX), China Shanghai Composite Index (SHI), Brazil São Paulo Index (IBOVESPA) and Korea Composite Index (KS11).

Three technical indicators are used to determine whether the current market is in a state of overheating, and predict if there is a bubble in the stock price. Applying eight rules of Granville (1960) and based on the 200-day moving average (200MA), we examine the future trend of stock prices. In Figure 3-1, 1B represents the first point of purchase, 1S represents the first selling point, and we can see the bubble point of overheating in the market is a point like 4S (the fourth selling point). At this time, 4S indicates that the stock price deviates from the 200MA largely, and will lead to a large drop in stock prices.
Hu (2009), a Taiwanese investment expert, introduced the gravity line of the stock market in his book. It indicates that the track line consists of three lines, the central track is 51MA, the upper track is 10% of the central track, and the lower track is -10% of the central track. The operating rule is when the stock price rises to the upper track, it means that the stock price is 10% away from the central axis. It is a selling point and the principle of gravity will pull the stock price back to the normal range on the contrary, when the stock price falls to the lower track, it is a buying point and the principle of gravity will make the stock price rebound. This paper is based on the track line indicators, using weekly data instead of daily data to set the parameters of the track line to capture the medium-term trend of the stock market. We set the central track to 13 weeks MA (quarter line), and the upper track (positive bias) changes from +5% to +15% which is a total of 11 upper track lines.

On this basis, this paper adds common technical indicators: the Relative Strength Index (RSI) and the Stochastics Oscillator (KD) to help the track line capture the crisis warning of the bubble more accurately. In technical analysis, these two technical indicators are the most commonly used by investors and their values change from 0 to 100. They are operated in the following ways: 0 to 20 are oversold areas and it's the best time to buy; 80 to 100 are overbought areas and it's the best time to sell. It's like the thermometer, when the stock price rises to the high point, the value of the RSI and KD indicators will enter the overbought area of 80-100 which like boiling water to 80-100 degrees, the stock price will be pulled back to the correction, that is, the indicator will cool down. Therefore, the method of research uses the RSI and K both greater than 90 as one of the bubble warning conditions.

In sum, the standard bubble warning conditions are: RSI and the K value of KD are both greater than 90. And the stock price touches the 10% upper track, that is, the bias is greater than 10%.

In the technical analysis, the volatilities of global stock markets are not the same, and will vary according to the structural characteristics of different markets. For example, the volatility of mature markets such as Europe and the United States is different from that of emerging markets. The standard bubble warning conditions cannot be applied to six countries. Therefore, based on the structure of different stock markets, this paper will adjust the warning conditions (K value, RSI value and Bias) to make it more suitable for different countries.

Firstly, drawing bubble warning points in red that satisfies the warning conditions (RSI>90, K>90, deviation rate >10%) on the weekly stock price chart to observe the distribution of bubble warning points in six countries. Calculate the maximum drop of each bubble warning point within the next 3 months, and judge the applicability of the standard bubble warning conditions to the country, and then adjust the overheat indicators (K value and RSI value) accordingly. After that, keep the K value and the RSI value unchanged, and the bias gradually increases from 5% to 15%. Under different conditions, the bubble warning point is obtained, and then calculates the maximum drop in the stock price within 1 month, 2 months...6 months after the bubble warning point appear.

We define:

$$\text{Drop}(m) = \frac{\min(m) - \max(m)}{\max(m)},$$
Where:

- \( m \) = observation months,
- \( \text{Drop}(m) \) = the maximum stock price drop down in \( m \) months,
- \( \text{Min}(m) \) = the minimum stock price in \( m \) months,
- \( \text{Max}(m) \) = the maximum stock price in \( m \) months.

And we define the probability of stock price drop among less than 5%, between 5% and 10%, larger than 10% as follows:

\[
P(<5\%) = \frac{n(<5\%)}{N}; \quad P(5\%\sim10\%) = \frac{n(5\%\sim10\%)}{N}; \quad P(>10\%) = \frac{n(>10\%)}{N}
\]

Here:

- \( P \) = the probability of stock price drop,
- \( N \) = the number of points satisfying three bubble conditions,
- \( n(<5\%) \) = the number of drop less than 5% in \( m \) months.

4. Empirical Results

The standard bubble warning conditions are \( K > 90 \), \( \text{RSI} > 90 \) and \( \text{Bias} > 10\% \). This condition is used to capture the bubble warning points of the six stock markets. If the stock price index falls more than 5% within the observation interval after the bubble warning point appears, it indicates that the bubble bursts, and the bubble warning point is an accurate warning. From the perspective of accuracy, the \( K \) value, \( \text{RSI} \) value and \( \text{Bias} \) are appropriately adjusted to seek the best bubble warning conditions for each country.

4.1. America (DJI)

**Figure 4-1-1:** the bubble warning points of America

In Figure 4-1-1, the solid line represents the stock price index (left axis), and the dots distributed on the solid line represent the bubble warning point. At this time, the \( K \) and the \( \text{RSI} \) are both greater than 90, and the \( \text{Bias} \) is greater than 10%. The vertical line of the “\( x \)” mark in the figure represents the maximum drop (right axis) of the corresponding bubble warning point within 3 months. From Figure 4-1-1, it can be seen that only one bubble warning point is captured under the standard bubble warning condition. The value of the "\( x \)” vertical line of this warning point is about 5, showing the maximum drop of this bubble warning point is about 5% within the next 3 months. As the US stock market volatility is relatively small, the standard bubble warning conditions are too strict. We try to lower the \( K \) value and \( \text{RSI} \) value to 85, and observe the drop distribution of the bubble warning points under different \( \text{Bias} \).
The meaning of each small histogram in Figure 4-1-2: the first number in brackets presents observation time, which changes from 1 month to 3 months in the vertical direction; the second number represents the Bias, which change from 5% to 15% in the horizontal direction; the third number represents the number of bubble warning points. The three columns in the small histogram indicate the drop distribution of the bubble warning point in the observation interval. They shows respectively the drop of bubbles is less than 5%, 5%~10%, and greater than 10%. The small figure at the left is “0, 0.5, 1” means that the probability of drop distribution from 0% to 100%.

As can be seen from Figure 4-1-2, even if the bubble warning condition is relaxed, still only a few captured bubble warning points will burst within 3 months (the maximum drop falls more than 5%). We try to extend the observation interval to 6 months, as shown in Figure 4-1-3. It can be seen from the histogram that when the Bias is 8% (K value and RSI value is 85), the eight bubble warning points captured will all burst in the 6 months. Therefore, for the US stock market, the bubble warning points will take a long time to burst, and its optimal bubble warning condition is K value 85, RSI value 85, and Bias 8%.
4.2. Japan (N225)

Figure 4-2-1: the bubble warning points of Japan

Figure 4-2-1 shows that under the standard bubble warning condition, there are 12 bubble warning points in the Japanese stock market, and most of the bubble warning points have not broken within 3 months (the maximum drop less than 5%). Because increasing the limit of the K value and the RSI value will greatly reduces the number of bubble warning points and lack practical references. Therefore, this paper tries to lower the K value and the RSI value to 85, and observe the bursting of the bubble warning point under different Bias values.

Figure 4-2-2: the drop distribution of bubbles in Japan (3 months)

Figure 4-2-3: the drop distribution of bubbles in Japan (6 months)
Figure 4-2-2 shows that when the K value and the RSI value are lowered to 85 and the Bias is 14%, the two bubble warning points captured will burst within 1 month. However, because the number of warning points captured is too small, the reference value for practice is relatively low. Therefore, the observation time is extended to 6 months, and the drop distribution of bubble warning points is shown in Figure 4-2-3. When the observation time is 6 months, the Bias is 11%, the 17 bubble warning points captured will all burst, and the drops of them are greater than 10%. Therefore, for the Japanese stock market, the bubble warning point will take a long time to burst, and its optimal bubble warning condition is K value 85, RSI value 85, and the Bias 11%.

4.3. Germany (DAX)

Figure 4-3-1: the bubble warning points of Germany

As can be seen from Figure 4-3-1, the Germany stock market has 12 bubble warning points under the standard bubble warning condition. Many of them have not broken (the maximum drop less than 5%) in 3 months, so the prediction effect is not accurate enough. Because the German stock market is relatively mature, the standard bubble warning condition is too strict for it, so try to lower the K value and RSI value to 85, and observe the drop distribution of the bubble warning points captured under different Bias values.

Figure 4-3-2: the drop distribution of bubbles in Germany (3 months)
Figure 4-3-3: the drop distribution of bubbles in Germany (6 months)

Figure 4-3-2 reveals the fact when the K value and the RSI value are lowered to 85, the bubble prediction accuracy under different Bias values cannot reach 100% within 3 months (the first column in the small histogram not disappeared), so the observation time is extended to 6 months, and the bubble point drop distribution is shown in Figure 4-3-3. It is shown that when the observation time is 6 months, the Bias is 8%, then the 30 bubble warning points captured are all bursting, and the drops of them are mostly greater than 10%. Therefore, for the Germany stock market, the bubble warning point will take a long time to burst, and its optimal bubble warning condition is K value 85, RSI value 85, and Bias 8%.

4.4. China (SHI)

Figure 4-4-1: the bubble warning points of China

A Figure 4-1-1 shows a total of 35 bubble warning points were captured under the standard bubble warning conditions, and in the interval between 2006 to 2007 and 2015 to 2016, many bubbles' maximum drop are less than 5% (the value of the "x" perpendicular less than 5). The main reason is that Chinese stock market was the bull market at that time, thus, using 90 as the limits for the K value and the RSI value is not enough to measure, therefore we increase the value to 95 to observe the maximum drop distribution of bubble warning points under this condition.
Figure 4-4-2: the drop distribution of bubbles in China (3 months)

It can be seen from the small graph (2, 5, 5) in Figure 4-4-2 that the K value and the RSI value are increased to 95, and the Bias is 5%, which accurately capture the bubble warning point, that is, when bubble warning points appear under the warning conditions, the stock price index will fall by more than 5% in the next two months, it is necessary to be alert to the stock market. Therefore, for the Chinese stock market, the bubble burst will occur in a short period of time after the bubble warning point appears. The optimal bubble warning condition is K value 95, RSI value 95, and Bias 5%.

4.5. Brazil (IBOVESPA)

Figure 4-5-1: the bubble warning points of Brazil

Figure 4-5-1 shows that under the standard bubble warning conditions, the Brazilian stock market has a total of 27 bubble warning points, but there are many warning points that have not broken within the next 3 months, and the bubble warning efficiency is relatively low. Because the Brazil stock market is an emerging market, its volatility is large, so we try to increase the K value and the RSI value to 95 to observe the distribution of the maximum drop in the bubble warning point under different Bias values.

Figure 4-5-2: the drop distribution of bubbles in Brazil (3 months)
As can be seen from Figure 4-5-2, when the K value is 95, the RSI value is 95, and the Bias is 5%, the 3 bubble warning points captured will burst within the next month. Therefore, for the Brazil stock market, the bubble burst occurs in a short period of time after the bubble warning point appears. The optimal bubble warning condition is K value 95, RSI value 95, and Bias 5%.

4.6. Korea (KS11)

**Figure 4-6-1:** the bubble warning points of Korea

From Figure 4-6-1, the South Korea stock market can capture 9 bubble warning points under the standard bubble warning condition, and the maximum drop of all bubble warning points in three months exceeds 5%. Therefore, the standard bubble warning conditions (K=90, RSI=90, BIAS=10) are suitable to apply to the bubble prediction of the South Korea stock market. On this basis, we observe the drop distribution of the bubble warning points captured by different Bias values seeking the best bubble warning conditions.

**Figure 4-6-2:** the drop distribution of bubbles in Korea (3 months)

From Figure 4-6-2, it can be seen that when the Bias is 5%, the 17 bubble warning points captured at this time have their maximum drop of more than 5 in the following 3 months observation time. And half of the warning points drops more than 10%. Therefore, in the South Korea stock market, the bubble bursts in a short period of time after the bubble warning point appears. The optimal bubble warning condition is K value 90, RSI value 90, and Bias 5%.

5. Conclusion

From the observation time, the bubbles captured in the mature markets of the United States, Japan and Germany all take 6 months to burst, while the bubbles captured in emerging markets of China, Brazil and South Korea will burst in three months. It can be seen that emerging markets are more sensitive to bubbles and weaker in risk resistance. When the bubble warning points appear, it means that the bubble
is about to burst for the emerging markets, which also indicates that the bubble warning mechanism is more valuable for emerging countries.

In terms of the optimal bubble warning conditions, the mature and emerging markets have different volatilities, and their optimal bubble warning conditions need to be adjusted according to the volatility, which make it more suitable for its own market characteristics.

In this paper, when looking for the optimal bubble warning conditions, the adjusted interval of K value and RSI value is 5 (from 90 to 95). In the future, we can try to reduce the adjustment range and test the bubble warning conditions (K and RSI) of 91, 92...95, respectively to find more accurate bubble warning conditions.

References