Journal of Economic Behavior & Organization 74 (2010) 149–162

Contents lists available at ScienceDirect

Journal of Economic Behavior & Organization

journal homepage: www.elsevier.com/locate/jebo

Bubble diagnosis and prediction of the 2005–2007 and 2008–2009 Chinese stock market bubbles

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ARTICLE INFO

Article history:
Received 7 September 2009
Received in revised form 2 February 2010
Accepted 10 February 2010
Available online 10 March 2010

JEL classification:
G01
G17
O16

Keywords:
Stock market crash
Financial bubble
Chinese markets
Rational expectation bubble
Herding
Log-periodic power law
Lomb spectral analysis
Unit-root test

ABSTRACT

By combining (i) the economic theory of rational expectation bubbles, (ii) behavioral finance on imitation and herding of investors and traders and (iii) the mathematical and statistical physics of bifurcations and phase transitions, the log-periodic power law (LPPL) model has been developed as a flexible tool to detect bubbles. The LPPL model considers the faster-than-exponential (power law with finite-time singularity) increase in asset prices decorated by accelerating oscillations as the main diagnostic of bubbles. It embodies a positive feedback loop of higher return anticipations competing with negative feedback spirals of crash expectations. We use the LPPL model in one of its incarnations to analyze two bubbles and subsequent market crashes in two important indexes in the Chinese stock markets between May 2005 and July 2009. Both the Shanghai stock exchange composite index (US ticker symbol SSEC) and Shenzhen stock exchange component index (SZSC) exhibited such behavior in two distinct time periods: (1) from mid-2005, bursting in October 2007 and (2) from November 2008, bursting in the beginning of August 2009. We successfully predicted time windows for both crashes in advance (Sornette, 2007; Bastiaensen et al., 2009) with the same methods used to successfully predict the peak in mid-2006 of the US housing bubble (Zhou and Sornette, 2006b) and the peak in July 2008 of the global oil bubble (Sornette et al., 2009). The more recent bubble in the Chinese indexes was detected and its end or change of regime was predicted independently by two groups with similar results, showing that the model has been well-documented and can be replicated by industrial practitioners. Here we present a more detailed analysis of the individual Chinese index predictions and of the methods used to make and test them. We complement the detection of log-periodic behavior with Lomb spectral analysis of detrended residuals and (H, q)-derivative of logarithmic indexes for both bubbles. We perform unit-root tests on the residuals from the log-periodic power law model to confirm the Ornstein–Uhlenbeck property of bounded residuals, in agreement with the consistent model of 'explosive' financial bubbles (Lin et al., 2009).

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doi:10.1016/j.jebo.2010.02.007

1. Conceptual framework and the two Chinese bubbles of 2005–2007 and 2008–2009

The present paper contributes to the literature on financial bubbles by presenting two case studies and new empirical tests, in support of the proposal that (i) the presence of a bubble can be diagnosed quantitatively before its demise and (ii) the end of the bubble has a degree of predictability.

These two claims are highly contentious and collide against a large consensus both in the academic literature (Rosser, 2008) and among professionals. For instance, in his recent review of the financial economic literature on bubbles, Gurkaynak (2008) reports that "for each paper that finds evidence of bubbles, there is another one that fits the data equally well without allowing for a bubble. We are still unable to distinguish bubbles from time-varying or regime-switching fundamentals, while many small sample econometrics problems of bubble tests remain unresolved" (page 1). Similarly, the following statement by former Federal Reserve chairman Alan Greenspan (2002), at a summer conference in August 2002 organized by the Fed to try to understand the cause of the ITC bubble and its subsequent crash in 2000 and 2001, summarizes well the state of the art from the point of view of practitioners: "We, at the Federal Reserve recognized that, despite our suspicions, it was very difficult to definitively identify a bubble until after the fact, that is, when its bursting confirmed its existence. Moreover, it was far from obvious that bubbles, even if identified early, could be preempted short of the Central Bank inducing a substantial contraction in economic activity, the very outcome we would be seeking to avoid."

To break this stalemate, Sornette, Anders Johansen (from 1995 to 2002), Wei-Xing Zhou (since 2002 (now Professor at ECUST in Shanghai)) and the FCO group at ETH Zurich (since 2008, www.er.ethz.ch/fco/) have developed a series of models and techniques at the boundaries between financial economics, behavioral finance and statistical physics. Our purpose here is not to summarize the corresponding papers, which explore many different options, including rational expectation bubble models with noise traders, agent-based models of herding traders with Bayesian updates of their beliefs, models with mixtures of non-linear trend followers and non-linear value investors, and so on (see Sornette (2003b) and references therein for the period 2002 and the two recent reviews in Kaizoji and Sornette (in press), Sornette and Woodard (2009 and references therein). In a nutshell, bubbles are identified as "super-exponential" price processes, punctuated by bursts of negative feedback spirals of crash expectations. These works have been translated into an operational methodology to calibrate price time series and diagnose bubbles as they develop. Many cases are reported in Chapter 9 of the book (Sornette, 2003b) and more recently successful applications have been presented with ex-ante public announcements posted on the scientific international database http://www.arXiv.org and then published in the referred literature, which include the diagnostic and identification of the peak time of the bubble for the UK real-estate bubble in mid-2004 (Zhou and Sornette, 2003a), the U.S. real-estate bubble in mid-2006 (Zhou and Sornette, 2006b), and the oil price peak in July 2008 (Sornette et al., 2009).

Kindleberger (2000) and Sornette (2003b) have identified the following generic scenario developing in five acts, which is common to all historical bubbles: displacement, take-off, exuberance, critical stage and crash. For the Chinese bubble starting in 2005, the "displacement" and "take-off" can be associated with the split share structure reform of listed companies in 2005. Before the reform, only about one-third of the shares of any listed company in the Chinese stock market were tradable. The other two-third shares were non-tradable (not allowed to be exchanged and to circulate between investors), and were owned by the state and by legal entities. The tradable stocks acquired therefore a significant liquidity premium, and were valued much higher than their non-tradable siblings, notwithstanding the fact that both gave the same privilege to their owners in terms of voting rights and dividends. In 2001, the Chinese stock market entered an anti-bubble phase (Zhou and Sornette, 2004) with the Shanghai stock exchange composite index falling from its then historical high 2245 on 24 June 2001 to the historical low on 6 June 2005. On 29 April 2005, the China Securities Regulatory Commission launched the pilot reform of the split share structure. The split share structure reform is defined as the process to eliminate the discrepancies in the A-share transfer system via a negotiation mechanism to balance the interests of non-tradable shareholders and tradable shareholders. On 4 September 2005, the China Securities Regulatory Commission enacted the *Administrative Measures on the Split Share Structure Reform of Listed Companies*,[1] which took effect immediately. It is widely accepted that the split share structure reform was a turning point which triggered and catalyzed the recovery of the Chinese stock market from its previous bearish regime. For the Chinese bubble starting in November 2008, the "take-off" can be associated with China's policy reaction on the global financial crisis, with a huge RMB 4 trillion stimulus plan and aggressive loan growth by financial institutions.

Here, we present an ex-post analysis of what we identified earlier in their respective epochs as being two significant bubbles developing in the major Chinese stock markets, the first one from 2005 to 2007 and the second one from 2008 to 2009. The organized stock market in mainland China is composed of two stock exchanges, the Shanghai stock exchange (SHSE) and the Shenzhen stock exchange (SZSE). The most important indices for A-shares in SHSE and SZSE are the Shanghai stock exchange composite index (SSEC) and the Shenzhen stock exchange component index (SZSC). The SSEC and SZSC indexes have suffered a more than 70% drop from their historical high during the period from October 2007 to October 2008. From November 2008 until the end of July 2009, the Chinese stock markets had been rising dramatically. By calibrating the recent market index price time series to our LPPL model, we infer that, in both cases, a bubble had formed in the Chinese

[1] Available at http://www.csrc.gov.cn/n575458/n4001948/n4002120/4069846.html, accessed on 30 August 2009.