

The Ripple of Bubble Dynamics

From Influencing Factors of Sectoral Bubbles to Market-Wide Contagion in Chinese Stocks

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1 Introduction

2 Methodology

3 Results

4 Summary

A Tale of Two Musicians



(a) George Frideric Handel



(b) Shane Filan

Question: Who will you be? The fortunate Handel, who exists at just the right moment, or the poor Filan, caught in the downturn?

List of Historical Bubbles

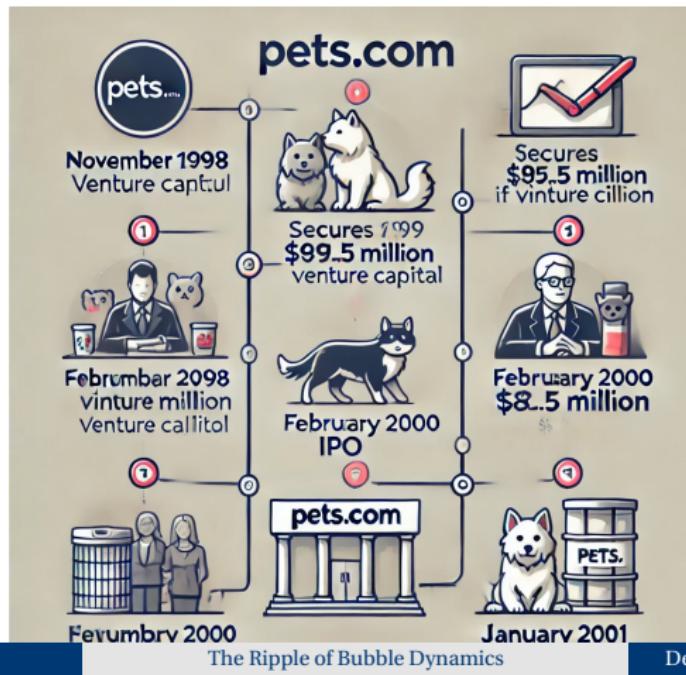
Bubble: "An upward price movement over an extended range that then implodes."

Bubble	Country	Years	Asset	Post-bubble financial crisis
Mississippi Bubble	France	1719–20	Mississippi Company stocks	No
South Sea Bubble	UK	1719–20	Company stocks (including stocks of the South Sea Company)	No
Windhandel Bubble	Netherlands	1720	Company stocks	No
First emerging market bubble	UK	1824–6	Company and mining stocks	Yes
Railway Mania	UK	1844–6	Railway stocks	Yes
Australian Land Boom	Australia	1886–93	Company stocks and real estate	Yes
Bicycle Mania	UK	1895–8	Stocks of bicycle companies	No
Roaring Twenties	USA	1920–31	Stocks of new technology companies	Yes
Japanese Bubble	Japan	1985–92	Company stocks and real estate	Yes
Dot-Com Bubble	USA	1995–2001	New technology stocks	No
Subprime Bubble	USA, UK, Ireland, Spain,	2003–10	Real estate and houses	Yes
Chinese bubbles	China	2007, 2015	Stocks	No

Case Studies: The Dot-com Bubble

The Rise and Fall of Pets.com

The Pets.com went from IPO to liquidation in just 268 days, with \$300 million of investment capital vanishing



Case Studies: The Dot-com Bubble

Hyperactive Trading

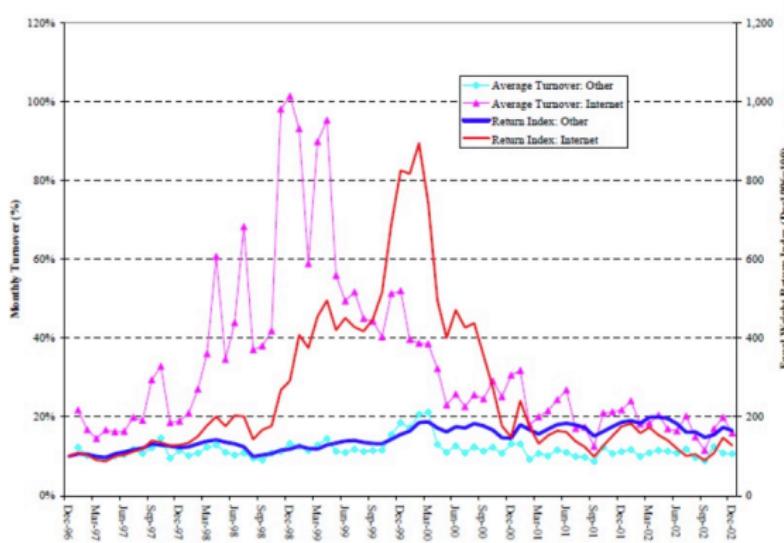
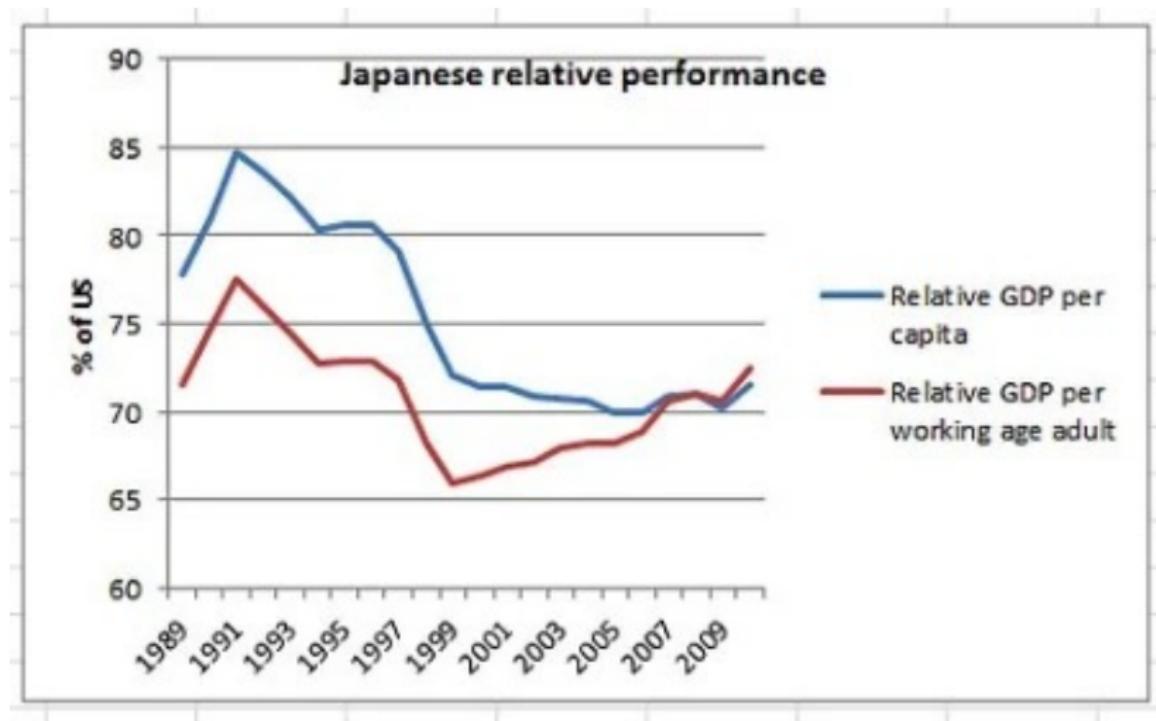


Figure 2: Prices and Turnover for the Internet and Non-Internet Stocks, 1997-2002

Case Studies: the "Lost Decades" of Japan



Motivation

Stylized Facts

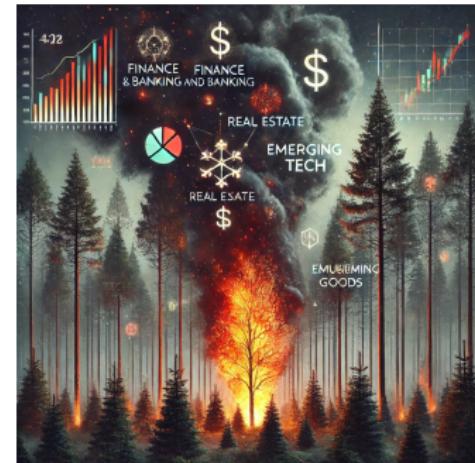
- ① *Financial markets are periodically marked by phases where asset prices substantially exceed their fundamental valuations, phenomena widely recognized as bubbles.*
- ② *Bubble often can have severe economic consequences.*
 - *During their expansion phase, bubble often lead to inefficient capital allocation and hyperactive trading.*
 - *Upon their collapse, they can trigger profound financial crisis and extended economic downturns.*

Questions

- When do bubbles occur?
- How are bubbles formed?
- Will a bubble in one sector start affecting the entire market?
- What happens when that comes true?
- Can we predict or control this spread?

Will a bubble in one sector start affecting the entire market?

- As financial systems evolve, sector-specific bubbles increasingly show the potential to spread across industries, posing risks to overall economic stability.
- Financial bubbles can be analogously described as fires.
- Much like a fire that quickly escalates from a single spark into a full-blown inferno, financial bubbles can start in one sector and then spread, distorting entire markets.



Research Gap

- The contagion effect of financial bubbles is well-documented across various asset classes.
 - Different cryptocurrencies (Enoksen et al., 2020; Chen et al., 2024)
 - Oil and gold markets (Gharib et al., 2021)
 - Oil and stock markets (Zhao et al., 2021)
 - Oil, gold, and stock markets (Bei et al., 2024)
 - Housing markets (Gomez-Gonzalez et al., 2018)
- The contagion dynamics **within stock market sectors** remain less understood
 - Sector-specific analysis can reveal **unique patterns and risks** not apparent in broader market-level analyses
 - Stocks within the same sector often share **similar risk factors** and are subject to **comparable technological changes**

Why China?

- Many studies have detected the presence of bubbles in **well- developed equity markets**
- The **fast expansion of emerging economy** tends to result in **explosive pricing dynamics**, thereby culminating the risk of bubbles.



- The second largest equity market
- A suitable experimental ground
 - Prevalence of Retail Investors → Speculative trading behaviors
 - Developing Regulatory Institution → susceptible to the formation of bubbles
 - Unique Setup of Economic System → Sectoral heterogeneity of stock market bubbles
 - Banking, industrial, and utilities sectors, mostly controlled by SOEs, have stable profitability and are tightly regulated, unlike high-growth sectors like Consumer Discretionary and Healthcare.

Research Questions

- During which periods have market- or sector-level bubbles occurred in China's stock market?
- Which factors better explain the evolution of these bubble dynamics: investor behaviors or financial performance?
- Is there sectoral heterogeneity in the formation and contagion of bubbles?

Sketch of this Research

Bubble Detection Techniques:

- **Modified Backward Sup Augmented Dickey-Fuller Method:** Utilized to identify instances of market- and sector-level bubbles within the Chinese stock market

Driving Factors:

- **Complementary Log-Log Model:** Employed to evaluate the correlation between the likelihood of bubble formation and the driving factors:
 - Investor Behaviors, Corporate Governance Indicators, Macroeconomic Conditions

Contagion Effects Analysis:

- **Time-Varying Granger Causality Test:** Applied to explore dynamic contagion effects between sectors and the whole market, identifying the initial sectors that potentially trigger broader market bubbles.

Main Results

Bubble Detection:

- **2015:** Broad-based bubble behavior observed across all sectors.
- **2018 and 2020:** Bubbles localized to specific sectors, indicating structural bubbles.

Key Drivers of Bubbles:

- Investor behavior significantly influences sector-level bubbles, overshadowing corporate governance and macroeconomic factors.
- **High Vulnerability Sectors:** Consumer Discretionary, Healthcare, and Materials.
- **Resilient Sectors:** Financials, Energy, and Utilities.

Causality Effects:

- **2015 Bubble:** No discernible causality between sectoral bubbles and overall market impact.
- **2018 and 2020 Bubbles:** Specific sectors triggered broader market reactions.
- **Contagion Dynamics:** Initiation of contagion effects preceded observable market-wide bubbles.

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How to Detect Bubbles?

the modified Backward Sup Augmented Dickey-Fuller method (mBSADF).

A price series $\{y_t\}$ under efficient market conditions

$$\gamma_t = dT^{-\eta} + \gamma_{t-1} + u_t, t = 1, 2, \dots, T \quad (1)$$

A price series containing one bubble

$$y_t = \begin{cases} dT^{-\eta} + y_{t-1} + u_t, & t \in N^0 \\ \delta_T y_{t-1} + u_t, & t \in B \\ \gamma_T y_{t-1} + u_t, & t \in C \\ dT^{-\eta} + y_{t-1} + u_t, & t \in N^1 \end{cases}, \quad (2)$$

$B = [Tf_o, Tf_c]$ represent the bubble period. f_o and f_c denote the (fractional) date of the bubble origination and termination, respectively

How to Detect Bubbles?

the modified Backward Sup Augmented Dickey-Fuller method (mBSADF)

Perform the following DF regression on the sub-samples for each observation of interest $t := \lfloor Tf \rfloor$:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{j=1}^k \theta_j \Delta y_{t-j} + u_t, t = \lfloor Tf_1 \rfloor, \dots, \lfloor Tf \rfloor, \quad (3)$$

The *BSADF* statistic:

$$BSADF(f_0, f) = \sup_{f_1 \in [0, f-f_0]} ADF(f_1, f), f \in [f_0, 1]. \quad (4)$$

The *mBSADF* statistic:

$$mBSADF(f_0, f) = \sup_{f_1 \in [0, f-f_0]} ADF(f_1, f) + \frac{C}{K} \sum_{t=\lfloor fT \rfloor - K + 1}^{\lfloor fT \rfloor} m_t, f \in [f_0, 1], \quad (5)$$

where $m_t = \Delta y_t / \sigma_{\Delta y_t}$

How to Detect Bubbles?

the modified Backward Sup Augmented Dickey-Fuller method (mBSADF)

Obtain the estimates of f_o and f_c by comparing $mBSADF(f_0, f)$ and its corresponding right side critical values

$$\hat{f}_o = \inf_{f \in [f_0, 1]} \{f : mBSADF(f_0, f) > mscv^{\theta_T}(f)\}, \quad (6)$$

$$\hat{f}_c = \inf_{f \in [\hat{f}_o + L_b, 1]} \{f : mBSADF(f_0, f) < mscv^{\theta_T}(f)\}, \quad (7)$$

Why mBSADF?

- Improve the differentiation between genuine bubbles and mere data fluctuations
- Minimize the estimated bias

How to Identify the Driving Factors of Bubbles?

Complementary log-log model (clogclog)

Pool the 10 sector indices and construct a panel regression model
→ The overall correlation between the occurrence of bubbles and the potential driving factors

$$\log(-\log(1 - P(bub_{i,t} = 1))) = \beta_1 ATR_{i,t} + \beta_2 QS_{i,t} + \beta_3 Sent_{i,t}^\perp + \beta_4 ATR_{i,t} \times QS_{i,t} + \beta_5 ATR_{i,t} \times Sent_{i,t}^\perp + \beta_6 ROE_{i,t} + \beta_7 Insti_{i,t} + \beta_8 Asset_{i,t} + \beta_9 EPU_t + \beta_{10} rGDP_t + \nu_i + e_{i,t},$$

Establish a time-series model for CSI 300 index and each sector index → The sector heterogeneity of the bubble-factor relationship

$$\log(-\log(1 - P(bub_t = 1))) = \beta_1 ATR_t + \beta_2 QS_t + \beta_3 Sent_t^\perp + \beta_4 ATR_t \times QS_t + \beta_5 ATR_t \times Sent_t^\perp + \beta_6 ROE_t + \beta_7 Insti_t + \beta_8 Asset_t + \beta_9 EPU_t + \beta_{10} rGDP_t + e_t$$

How to Identify the Driving Factors of Bubbles?

Complementary log-log model (clogclog)

The dependent variable $bub_{i,t}$ is defined as

$$bub_{i,t} = \begin{cases} 1, & mBSADF_i(f_0, f) > mscv^{\theta_T}(f) \\ 0, & mBSADF_i(f_0, f) < mscv^{\theta_T}(f), \end{cases} \quad (8)$$

- *ATR*: abnormal turnover rate \Leftrightarrow speculation
- *QS*: the inverse of weighted price spread \Leftrightarrow liquidity
- *Sent*¹: perform a regression on speculation and extracting the residual to filter out the noise
- *ATR* \times *QS* & *ATR* \times *Sent*: the interaction of speculation and liquidity, speculation and sentiment
- *ROE* & *Insti* & *Asset*: return on equity, institutional ownership, the growth rate of total asset
- *EPU*: the uncertainty index of economic policy
- *rGDP*: the growth rate of GDP

How to Identify the Driving Factors of Bubbles?

Complementary log-log model (clogclog)

Why clogclog?

- **Traditional Model Issues:** Probit and logit models face **rare event bias** when dealing with significant uneven binary outcomes.
- **Data Asymmetry:** The occurrence of bubbles display an **asymmetrical distribution**
- **clogclog Advantages:** Uses a **logarithmic transformation** to accurately model skewed data.

How to Evaluate the Bubble Contagion Effects?

Time-varying Granger Causality Test

- For series y_{1t} (CSI 300 index) and y_{2t} (sector index) to be examined, an unrestricted $VAR(p)$ model is considered

$$Y_t = \Pi X_t + \epsilon_t, t = 1, \dots, T, \quad (9)$$

$$Y_t = (y_{1t}, y_{2t})', X_t = (1, Y'_{t-1}, \dots, Y'_{t-p}), \Pi_{2(2p+1)} = [\Psi_0, \Psi_1, \dots, \Psi_p].$$

- $H_0: y_{2t} \not\rightarrow y_{1t}$, i.e. y_{2t} is not a Granger reason for y_{1t}
- the Wald test statistic:

$$\mathcal{W} = [\mathbf{R} \text{vec}(\hat{\Pi})]' \left[\mathbf{R} \left(\hat{\Omega} \otimes (\mathbf{X}' \mathbf{X})^{-1} \right) \mathbf{R}' \right]^{-1} [\mathbf{R} \text{vec}(\hat{\Pi})] \quad (10)$$

- the test statistic:

$$\mathcal{SW}(f_0, f) = \sup_{f_1 \in [0, f-f_0]} \mathcal{W}(f_0, f), \quad (11)$$

How to Evaluate the Bubble Contagion Effects?

Time-varying Granger Causality Test

- The starting and ending dates of causality are denoted as f_o and f_c :

$$\hat{f}_o = \inf_{f \in [f_0, 1]} \{f : \mathcal{SW}(f_0, f) > scv\}, \hat{f}_c = \inf_{f \in [\hat{f}_o, 1]} \{f : \mathcal{SW}(f_0, f) < scv\}, \quad (12)$$

scv is the critical value of $\mathcal{SW}(f_0, f)$.

Why time-varying Granger Causality Test

Effective when there are multiple structural changes in the causal relationship between series.

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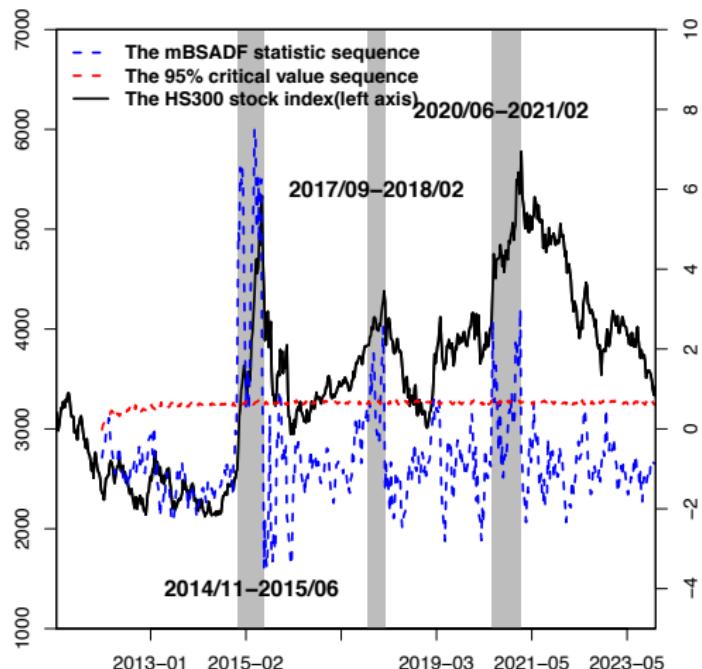
What Periods are Characterized as Bubbles?

Key Findings

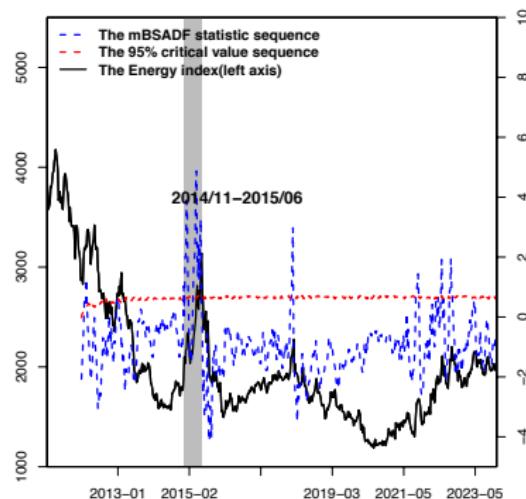
- Chinese stock market has experienced **three bubbles** in recent years: 2014-15, 2017-18, and 2020-21
- The well-known **2015** stock market crash involved **all sectors**
- The **other two** bubbles are **structural**, primarily concentrated in sectors like consumer goods, healthcare, energy, and technology

What Periods are Characterized as Bubbles?

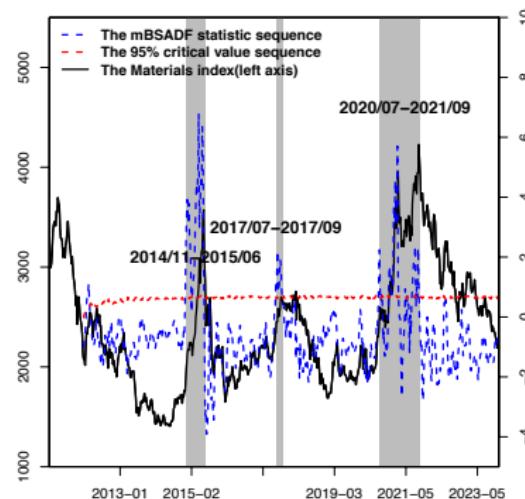
Figure 3: The bubble detection results of CSI300 index



What Periods are Characterized as Bubbles?

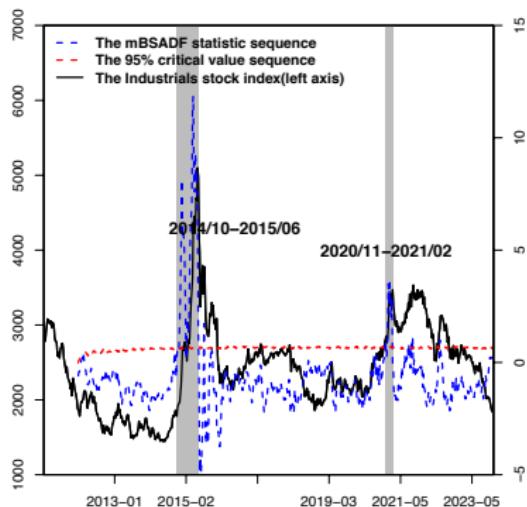


(a) Energy Sector

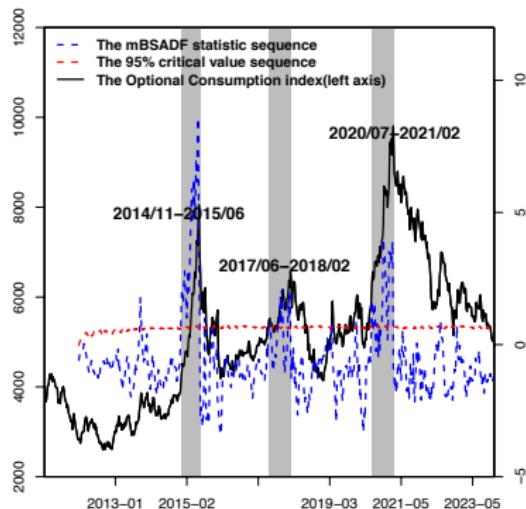


(b) Materials Sector

What Periods are Characterized as Bubbles?

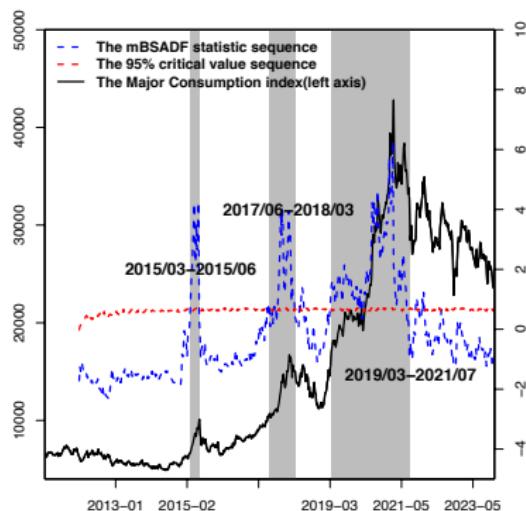


(c) Industrials Sector

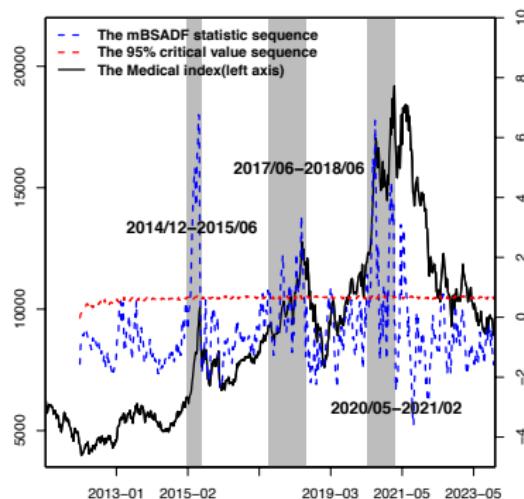


(d) Consumer Discretionary Sector

What Periods are Characterized as Bubbles?

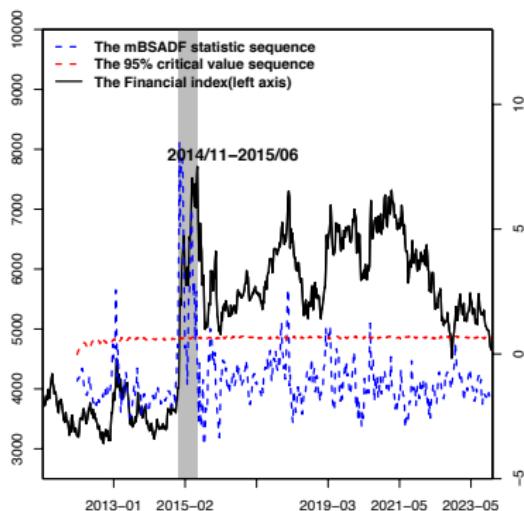


(e) Consumer Staples Sector

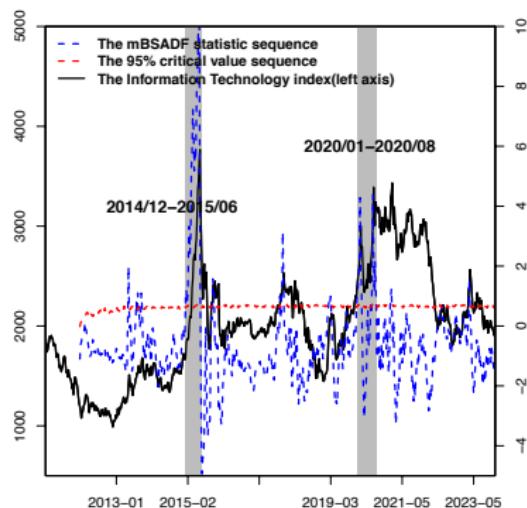


(f) Health Care Sector

What Periods are Characterized as Bubbles?

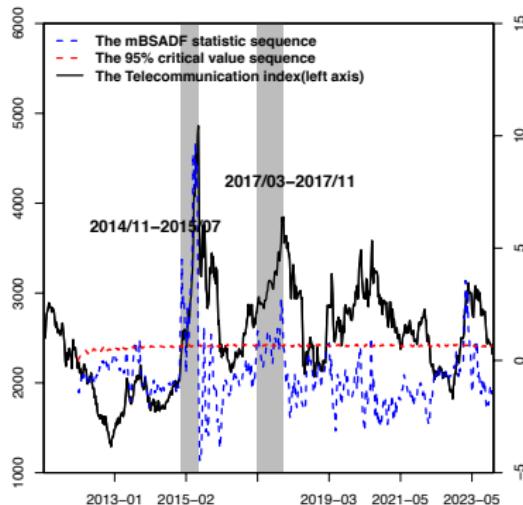


(g) Financials Sector

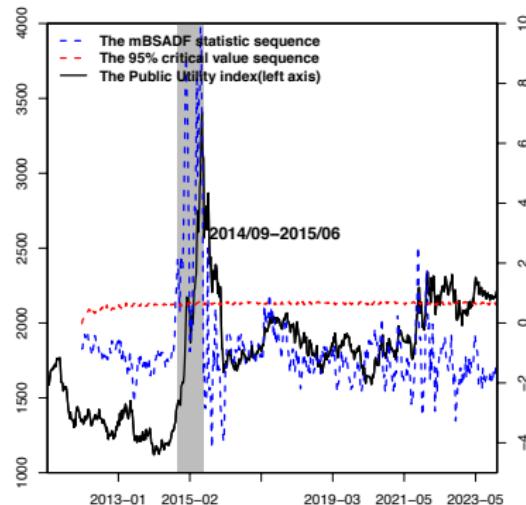


(h) Information Technology Sector

What Periods are Characterized as Bubbles?



(i) Telecommunication Service Sector



(j) Utilities Sector

What Periods are Characterized as Bubbles?

Table 1: Bubble detection results of weekly CSI 300 and sector indices

	Period 1	Period 2	Period 3
CSI 300	2014/11-2015/06 8M	2017/09-2018/02 6M	2020/06-2021/02 9M
Energy	2014/11-2015/06 8M	/	/
Materials	2014/11-2015/06 8M	2017/07-2017/09 3M	2020/07-2021/09 15M
Industrials	2014/10-2015/06 9M	/	2020/11-2021/02 4M
Consumer Discretionary	2014/11-2015/06 8M	2017/06-2018/02 9M	2020/07-2021/02 8M
Consumer Staples	2015/03-2015/06 4M	2017/06-2018/03 10M	2019/03-2021/07 29M
Health Care	2014/12-2015/06 7M	2017/06-2018/06 13M	2020/05-2021/02 10M
Financials	2014/11-2015/06 8M	/	/
Information Technology	2014/12-2015/06 7M	/	2020/01-2020/09 9M
Telecommunication	2014/11-2015/07 9M	2017/03-2017/11 9M	/
Public Utility	2014/09-2015/06 10M	/	/

What Periods are Characterized as Bubbles?

Plausible explanations

First Bubble: 2015 Chinese Stock Market Crash

- Cannot be attributed to any specific sector
 - ① "China Dream" → Sustained rise
 - ② Loose monetary policy
 - ③ The relaxed leverage trading regulations & a massive influx of retail investors

Second Bubble: key market reforms

- Government's aim at mitigating systemic financial risks & Government support for certain emerging industries → Structural optimism
- Success of mid-2017 supply-side reforms → optimism about upstream products, e.g. consumer and tech sectors
- Inclusion of Chinese A-shares in the MSCI & establishment of Shanghai -Shenzhen -Hong Kong Stock Connect.

Third Bubble: the early stage of the COVID-19 pandemic

- PBC's strategic liquidity injections
- Attractive valuations of Chinese stocks & Perception of effective pandemic management → A surge in foreign investments
- General economic activities began to resume fully → a surge in demand for production materials and consumer goods.

What are the Driving Factors of Bubbles?

Key Findings

Primary Driver: Investor Behaviors: namely, speculation, liquidity, and investor sentiment

Weak Influences: Corporate Governance and Macroeconomic Conditions

- Stock prices often **diverge from underlying values and broad economic indicators.**
- Financial performance and economic conditions is not the driver to the explosive behaviors of stock prices

Sector Heterogeneity in Bubble Dynamics

- **High Risk Sectors:** Consumer, pharmaceuticals, and materials sectors exhibit higher susceptibility to bubbles, influenced by intense investor sentiment and speculative investment.
- **Low Risk Sectors:** Financials, energy, and utilities sectors which are characterized by stringent regulatory constraints and inherent profit stability show resilience, reducing their bubble formation risk.
- Structural preference of speculative capital

What are the Driving Factors of Bubbles

Table 2: Regression Results - time series regression for CSI 300 index and panel regression for pooled sector indices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>ATR</i>	0.376*** (0.055)	0.401*** (0.054)	0.411*** (0.056)	0.426*** (0.057)	1.013*** (0.035)	0.998*** (0.042)	0.968*** (0.043)	0.988*** (0.044)
<i>QS</i>	0.171*** (0.045)	0.178*** (0.045)	0.194*** (0.061)	0.197*** (0.061)	1.449*** (0.072)	1.275*** (0.077)	1.303*** (0.079)	1.380*** (0.082)
<i>Sent[⊥]</i>	0.288*** (0.064)	0.315*** (0.068)	0.310*** (0.069)	0.305*** (0.074)	0.751*** (0.049)	0.894*** (0.066)	0.865*** (0.068)	0.831*** (0.071)
<i>ATR * QS</i>		0.135** (0.067)	0.177** (0.070)	0.185*** (0.070)		0.195*** (0.049)	0.222*** (0.049)	0.175*** (0.049)
<i>ATR * Sent[⊥]</i>		-0.102 (0.078)	-0.115 (0.080)	-0.137* (0.083)		-0.092** (0.039)	-0.110*** (0.040)	-0.135*** (0.043)
<i>ROE</i>		0.040 (0.053)	0.032 (0.055)			0.044 (0.046)	-0.115** (0.050)	
<i>Insti</i>		0.023 (0.062)	0.014 (0.062)			-0.300*** (0.048)	-0.267*** (0.049)	
<i>Asset</i>		0.103* (0.054)	0.094* (0.055)			-0.050 (0.037)	0.001 (0.037)	
<i>EPU</i>			-0.001 (0.051)				-0.433*** (0.051)	
<i>rGDP</i>				0.088** (0.043)			0.246*** (0.048)	
Observations	580	580	580	580	580	580	580	580

What are the Driving Factors of Bubbles

Table 3: Univariate time series regression for 10 CSI sector indices

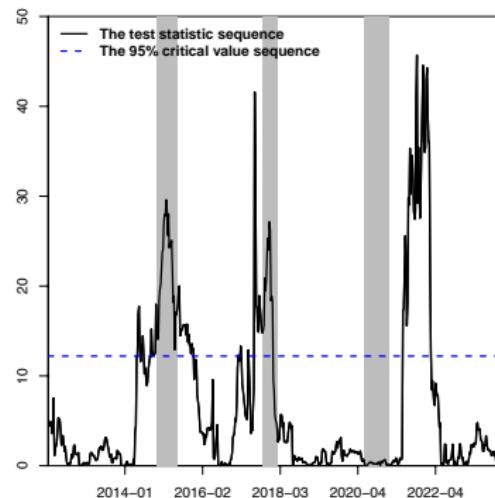
	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Health Care	Financials	Information Technology	Tele-communication	Utilities
<i>ATR</i>	0.195*** (0.052)	0.520*** (0.059)	0.320*** (0.050)	0.440*** (0.056)	0.466*** (0.061)	0.238*** (0.057)	0.186*** (0.058)	0.149*** (0.043)	0.290*** (0.053)	0.415*** (0.056)
<i>QS</i>	0.098** (0.049)	0.468*** (0.073)	0.131*** (0.050)	0.254*** (0.065)	0.650*** (0.076)	0.231*** (0.052)	0.088* (0.049)	0.154*** (0.051)	0.149*** (0.054)	0.099* (0.054)
<i>Sent⁺</i>	0.061 (0.062)	0.160** (0.065)	0.118* (0.066)	0.370*** (0.067)	0.209*** (0.073)	0.148** (0.068)	0.033 (0.064)	0.052 (0.058)	0.107** (0.054)	-0.071 (0.063)
<i>ATR * QS</i>	0.137** (0.058)	0.472*** (0.072)	0.137** (0.069)	0.309*** (0.059)	0.445*** (0.072)	0.167*** (0.057)	-0.122** (0.056)	0.111* (0.057)	-0.051 (0.055)	-0.191*** (0.069)
<i>ATR * Sent⁺</i>	0.105* (0.060)	0.106 (0.073)	-0.026 (0.068)	0.294*** (0.074)	-0.068 (0.067)	0.052 (0.060)	-0.106 (0.079)	0.274*** (0.047)	0.390*** (0.062)	0.192*** (0.055)
<i>ROE</i>	-0.083 (0.051)	-0.051 (0.064)	-0.004 (0.048)	0.125** (0.059)	-0.035 (0.067)	-0.081 (0.052)	0.051 (0.052)	-0.112** (0.054)	-0.020 (0.049)	0.046 (0.048)
<i>Insti</i>	-0.040 (0.051)	0.049 (0.055)	-0.047 (0.047)	-0.149** (0.069)	-0.126* (0.071)	-0.232*** (0.049)	-0.012 (0.048)	0.011 (0.049)	-0.003 (0.054)	-0.128** (0.051)
<i>Asset</i>	-0.092* (0.049)	0.055 (0.062)	-0.117** (0.056)	0.096* (0.059)	0.093 (0.057)	-0.083* (0.050)	0.260*** (0.054)	-0.009 (0.059)	-0.071 (0.049)	-0.015 (0.049)
<i>EPU</i>	0.005 (0.047)	-0.074 (0.054)	0.006 (0.051)	0.010 (0.058)	-0.182*** (0.056)	-0.062 (0.054)	0.023 (0.049)	0.023 (0.048)	-0.082* (0.049)	-0.081* (0.049)
<i>rGDP</i>	-0.004 (0.044)	0.035 (0.048)	0.032 (0.043)	0.003 (0.052)	0.090 (0.067)	0.206*** (0.048)	0.038 (0.042)	0.010 (0.064)	0.022 (0.044)	0.006 (0.052)
Observations	580	580	580	580	580	580	580	580	580	580

What are the Patterns of Bubble Contagion in Chinese Stock Market?

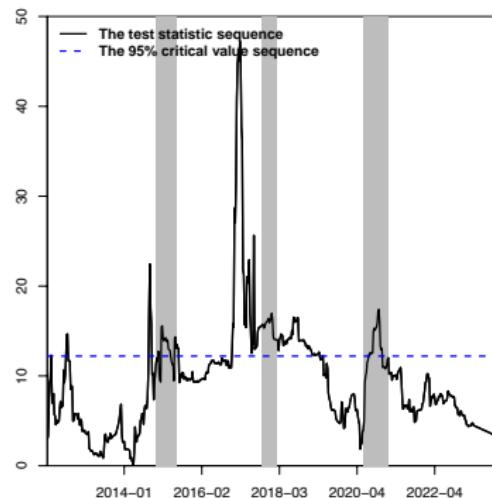
Key Findings

- **Time-varying Causality Patterns:**
 - **2014-2015:** Only detected in Energy and Materials sectors; Driven by systemic risks, not sector-specific contagion
 - **2017-2018:** Most sectors show significant causality
 - **2020-2021:** Materials, **Consumer Discretionary, Consumer Staples**
- **Precedence of Sectoral Contagion:**
 - Contagion effects typically precede broader market bubbles.
 - Early detection can help maintain market stability.
- **Limited Sector Impact:**
 - Minimal contagion from Industrials, Financials, and Utilities.

What are the Patterns of Bubble Contagion in Chinese Stock Market?

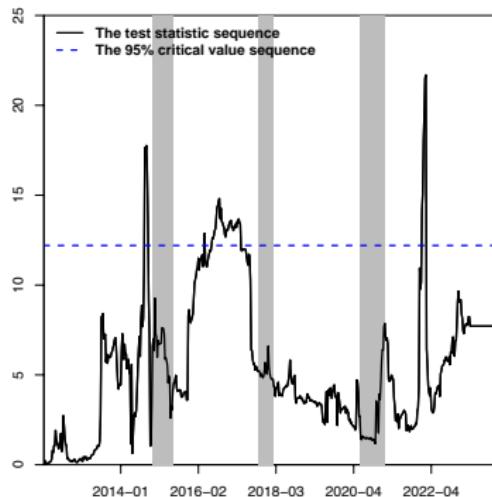


(k) Energy Sector

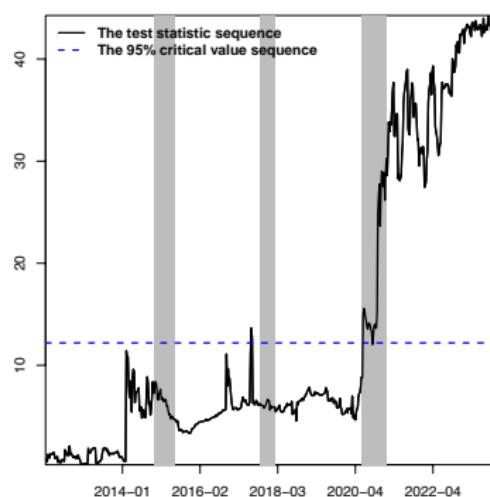


(l) Materials Sector

What are the Patterns of Bubble Contagion in Chinese Stock Market?

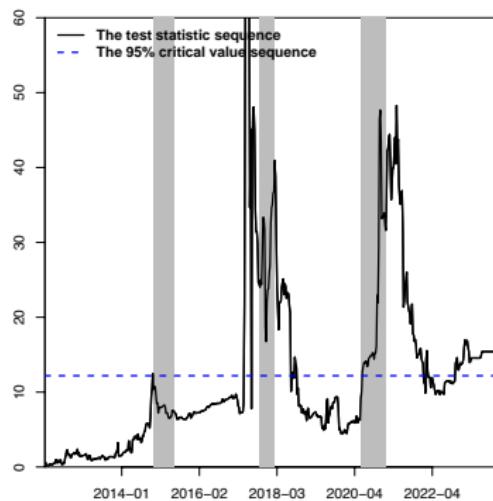


(m) Industrials Sector

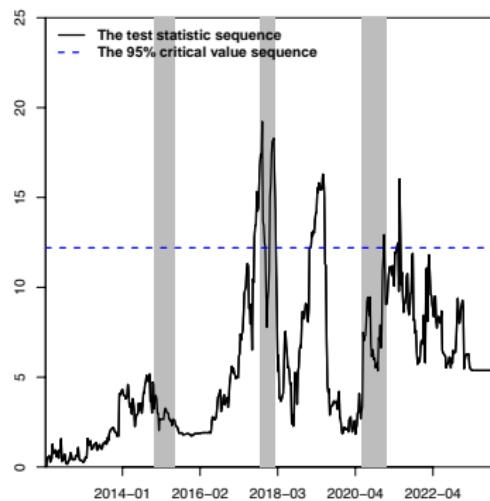


(n) Consumer Discretionary Sector

What are the Patterns of Bubble Contagion in Chinese Stock Market?

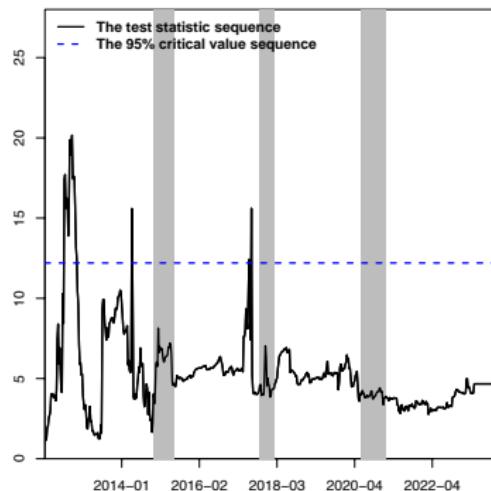


(o) Consumer Staples Sector

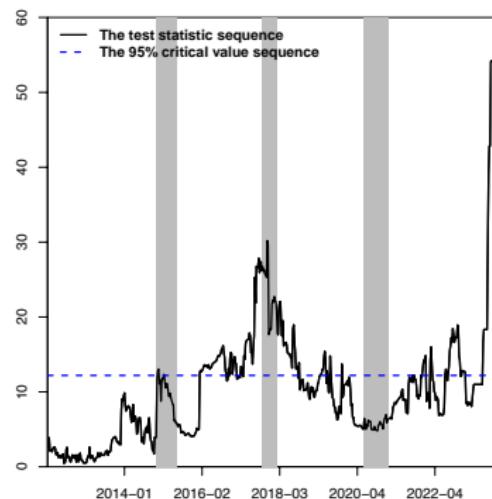


(p) Health Care Sector

What are the Patterns of Bubble Contagion in Chinese Stock Market?

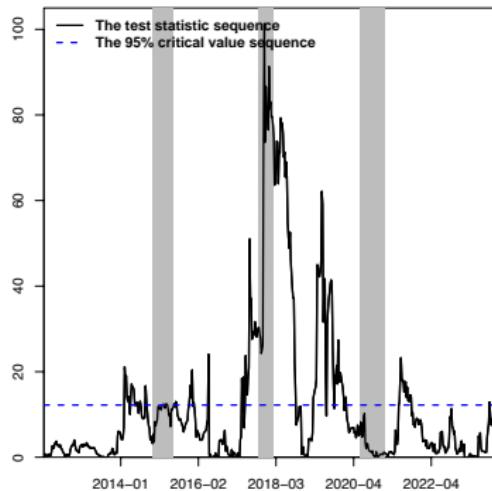


(q) Financials Sector

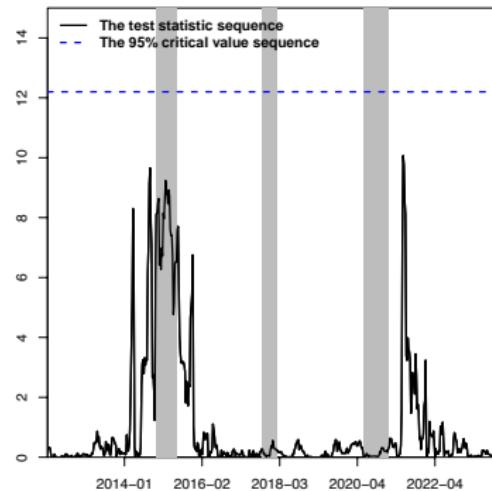


(r) Information Technology Sector

What are the Patterns of Bubble Contagion in Chinese Stock Market?



(s) Telecommunication Service Sector



(t) Utilities Sector

1 Introduction

2 Methodology

3 Results

4 Summary

Key Takeaways

Overview of Bubble Periods:

- Three significant bubbles identified: **2014-2015, 2017-2018, and 2020-2021**.
- **2015** crash was market-wide; **2017-2018** and **2020-2021** were structural, triggered by specific sectors like consumer goods and technology.

Driving Factors of Bubbles:

- **Primary Driver:** Investor behaviors such as speculation and hyperactive trading behaviors.
- Traditional metrics such as corporate governance and macroeconomic conditions show weaker correlation with bubble dynamics.

Patterns of Bubble Contagion:

- Significant causality observed in most sectors during **2017-2018** and **2020-2021**.
- Contagion effects often start before broader market indicators become apparent, underscoring the importance of early detection.

Implications:

- Early monitoring and targeted regulatory interventions can mitigate the

Thank you for listening !