



Critical Transitions in Markets and Societies

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Systems Analysis 2015 | 11-13 Nov 2015 | Laxenburg, Austria



Outline

- Critical Transitions in Socioeconomic Systems
- US Housing Market
- Singapore Housing Market
- Singapore 2011 General Election
- Fusion-Fission Dynamics & Forecasting



CRITICAL TRANSITIONS IN SOCIOECONOMIC SYSTEMS

Regime Shifts in Markets

A Week In Chinese Stocks

Shanghai Stock Exchange Com

In the last year

5,000.000

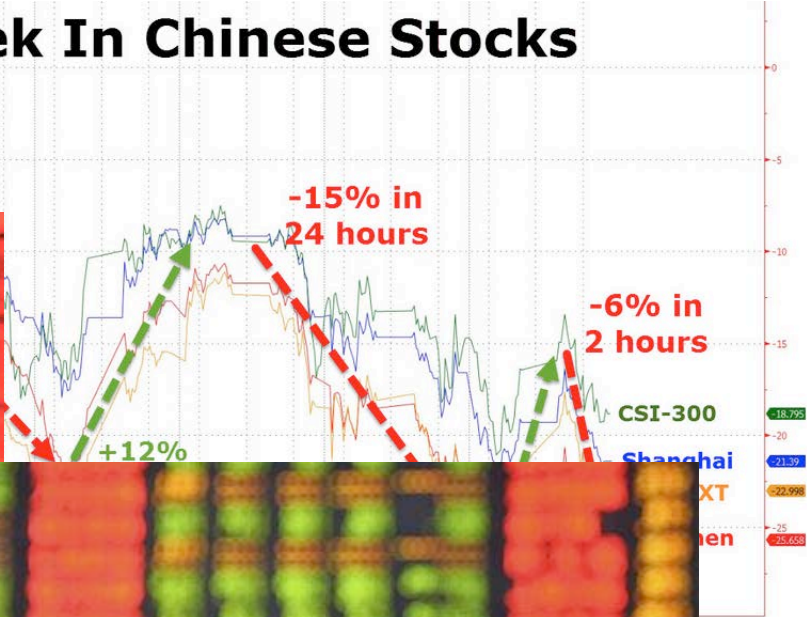
4,000.00

3,000.00

2,000.00

2014

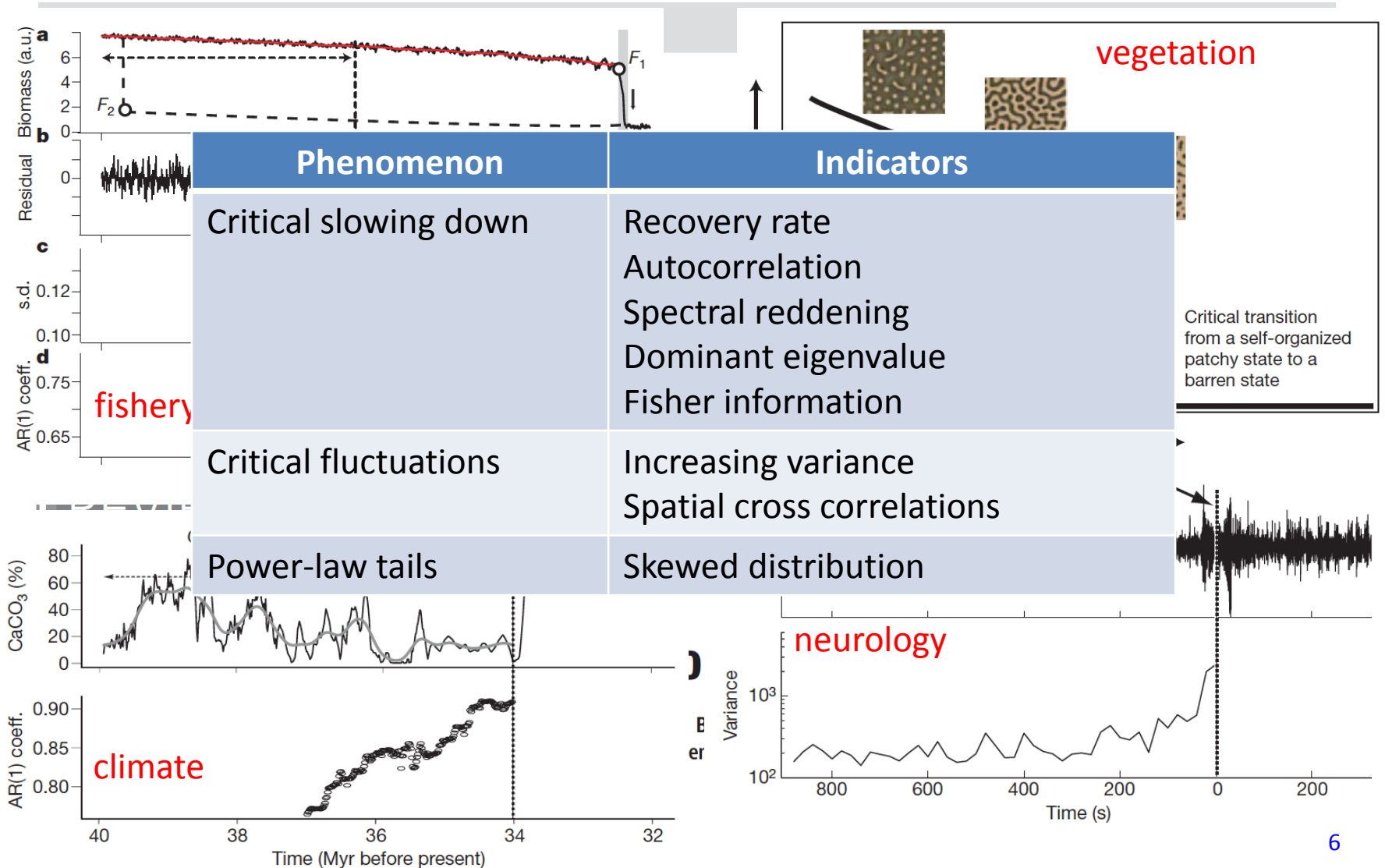
SOURCE: Bloomberg



Regime Shifts in Societies

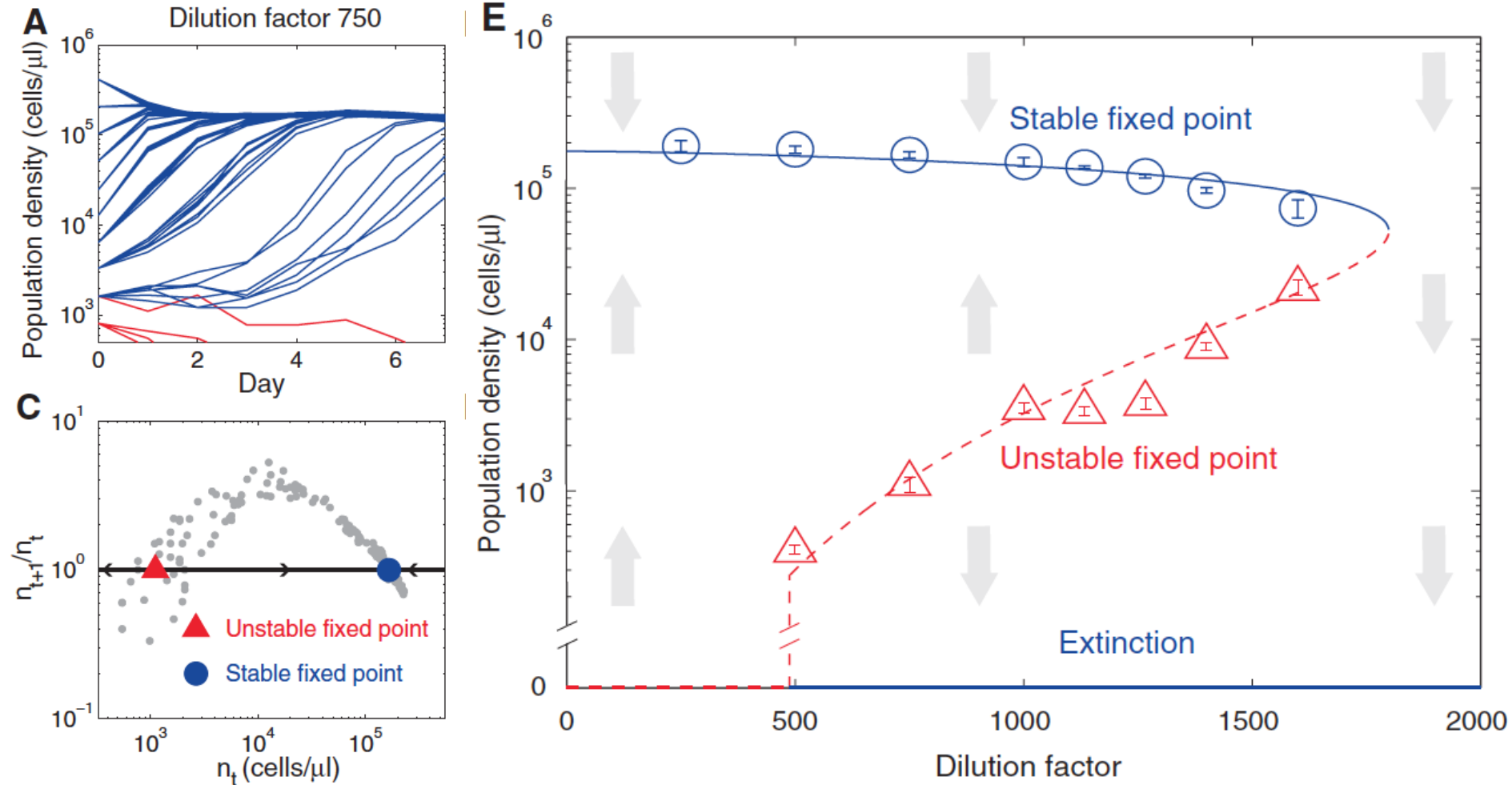


Critical Slowing Down



Slow Recovery

Dai et al., *Science* **336**, 1175 (2012)



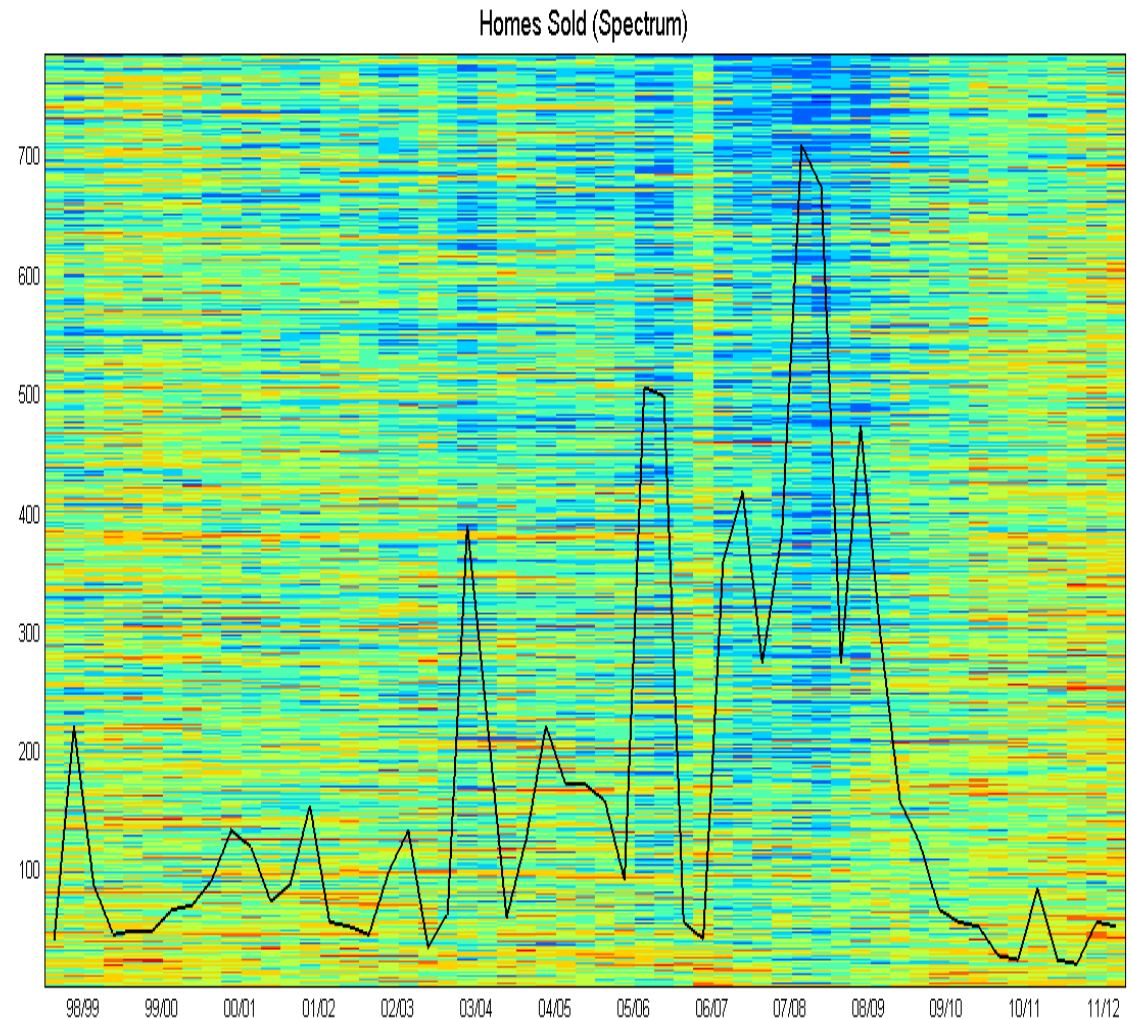


James Peng Lung TAN
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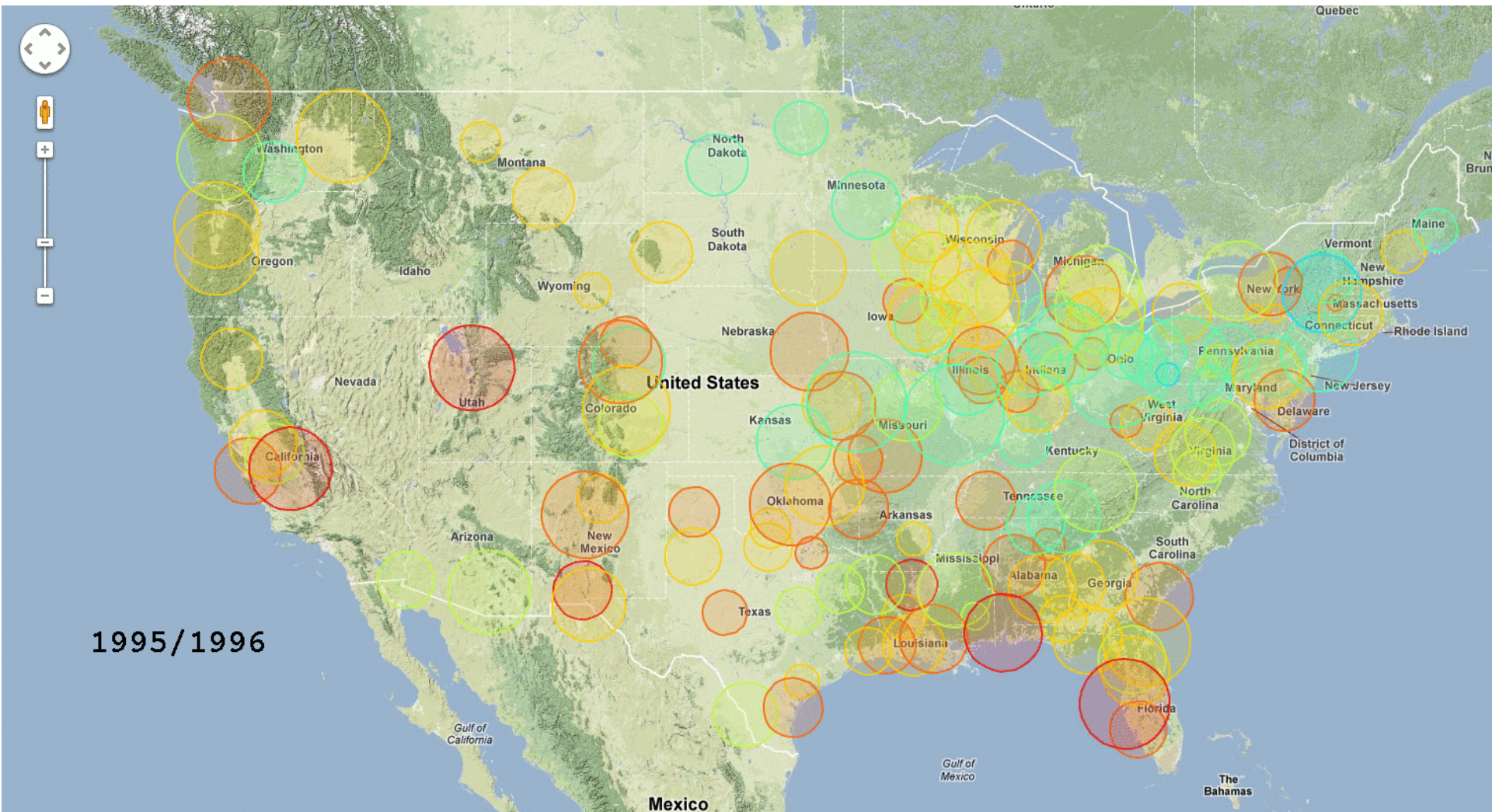
US HOUSING MARKET

Red Shift in Power Spectrum

- **US Census Bureau**
 - <http://www.census.gov/construction/bps/>
 - 158 metropolitan statistical areas (MSAs)
 - Jan 1995 to Nov 2012
 - monthly housing permit
- **Zillow.com**
 - <http://www.zillowblog.com/research/data/>
 - about 3000 US cities
 - Sep 1997 to Dec 2012
 - home sold, median sale price, % of homes sold for profit

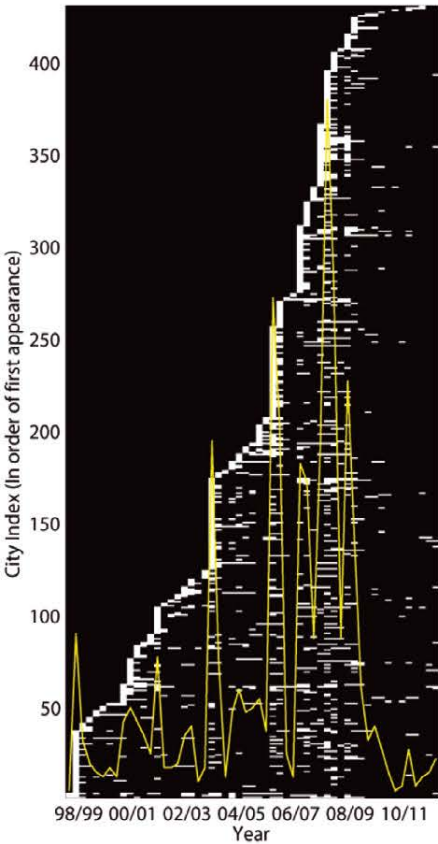


Spatio-Temporal Dynamics

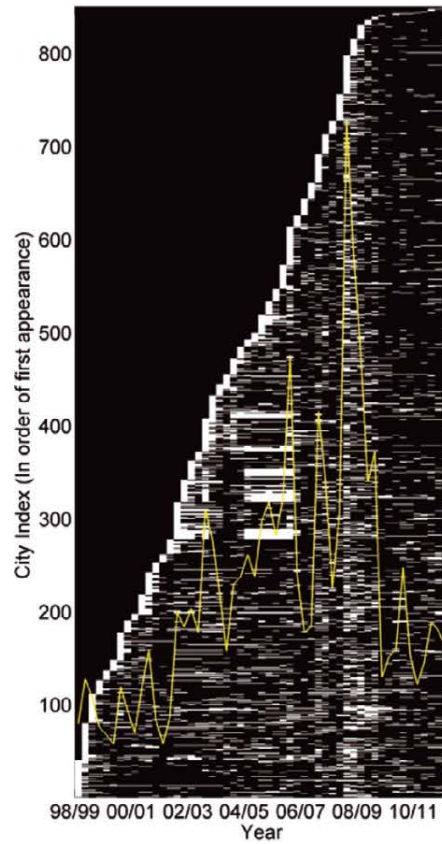


Transition Cross Sections

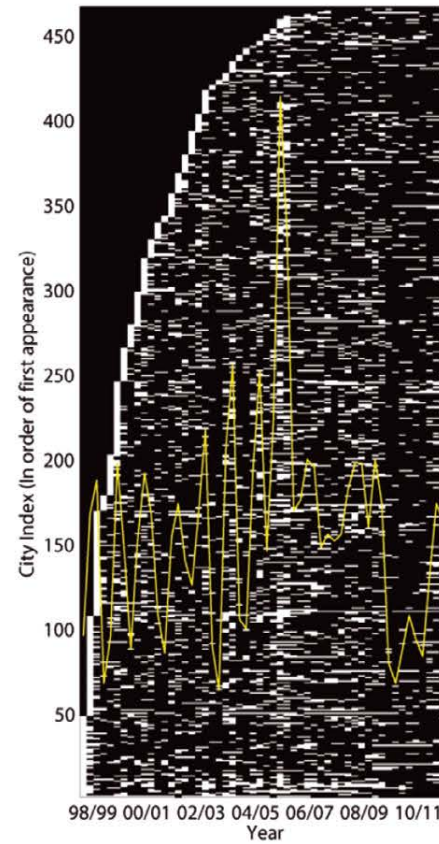
homes sold



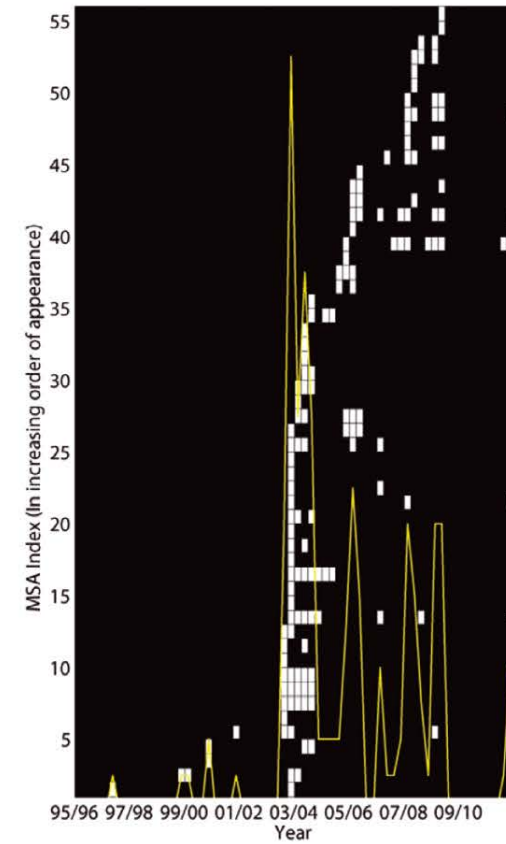
% sold for profit



median price



building permits



Tan & Cheong, *Eur. Phys. J. B* **87**, 38 (2014)



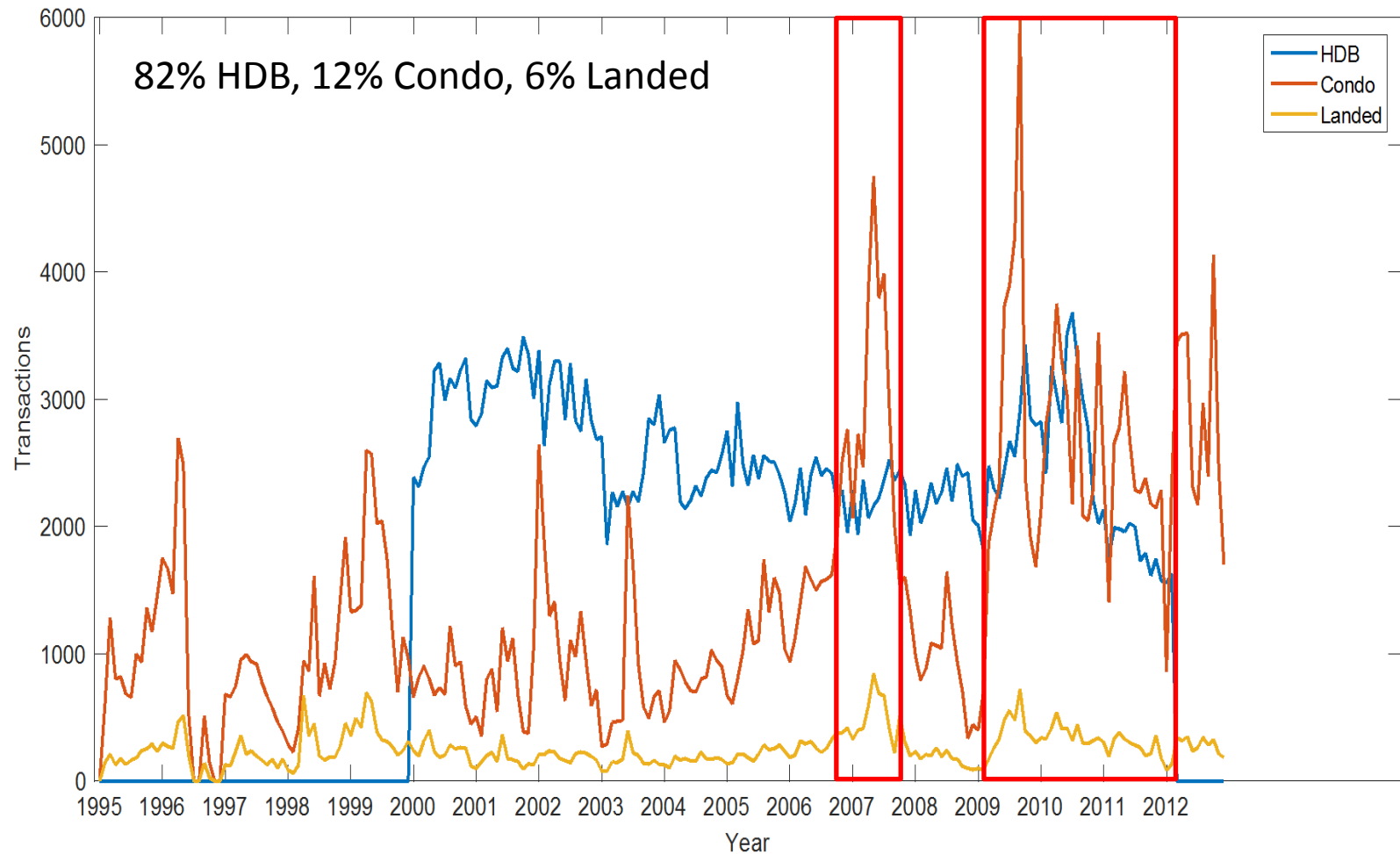
Darrell TAY

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SINGAPORE HOUSING MARKET

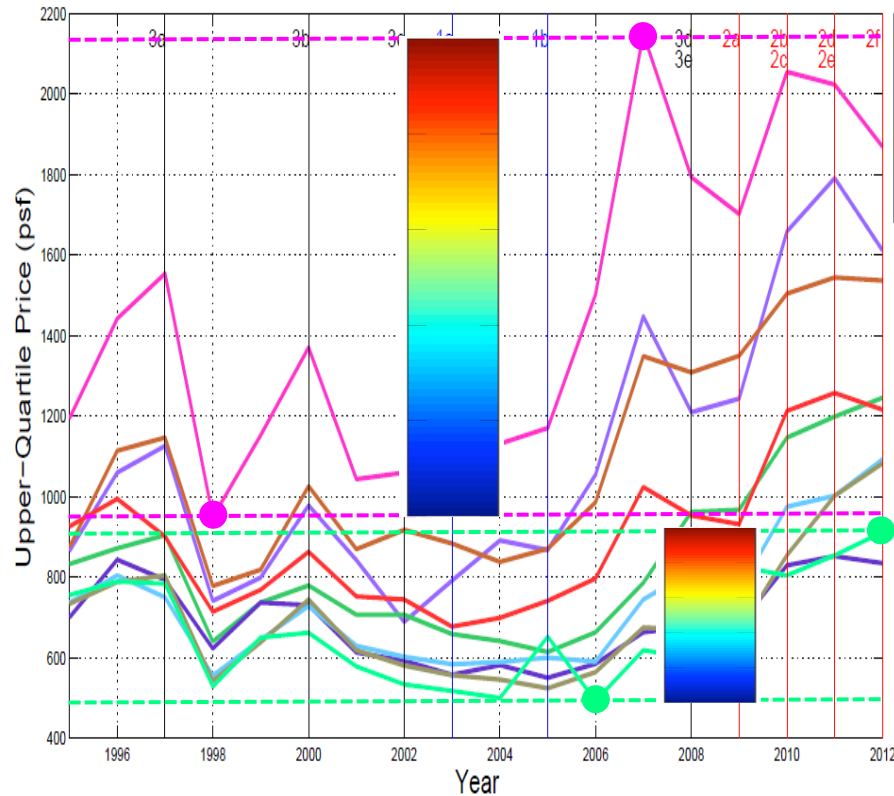


Housing Bubble

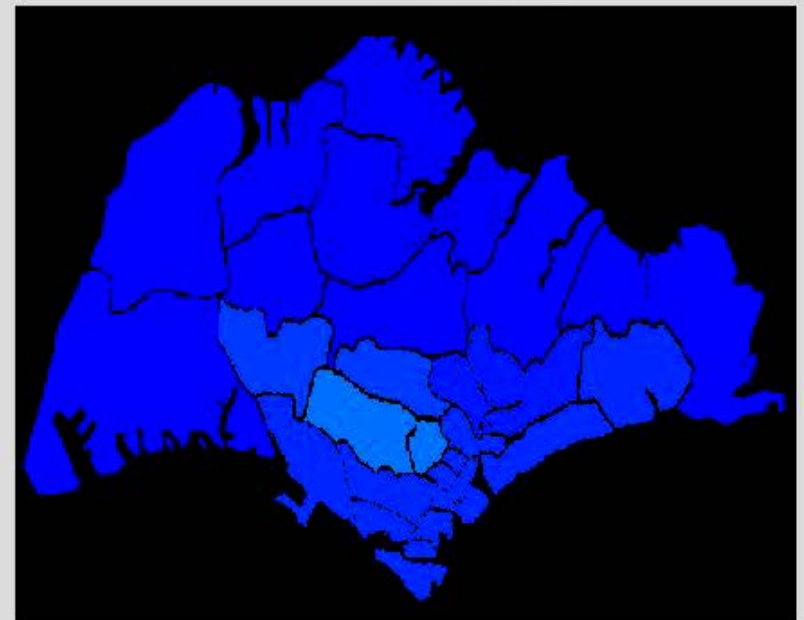


Spatio-Temporal Bubble Dynamics

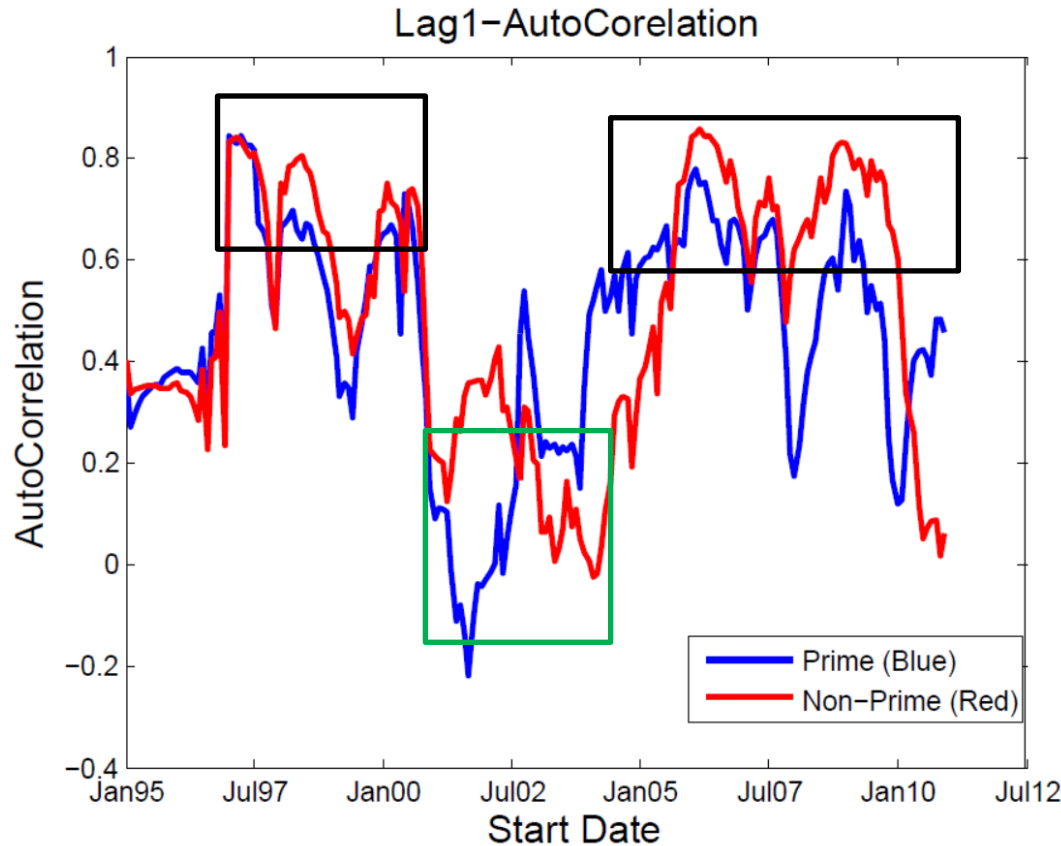
Price Movement for Condos



Year 2004 Month 12



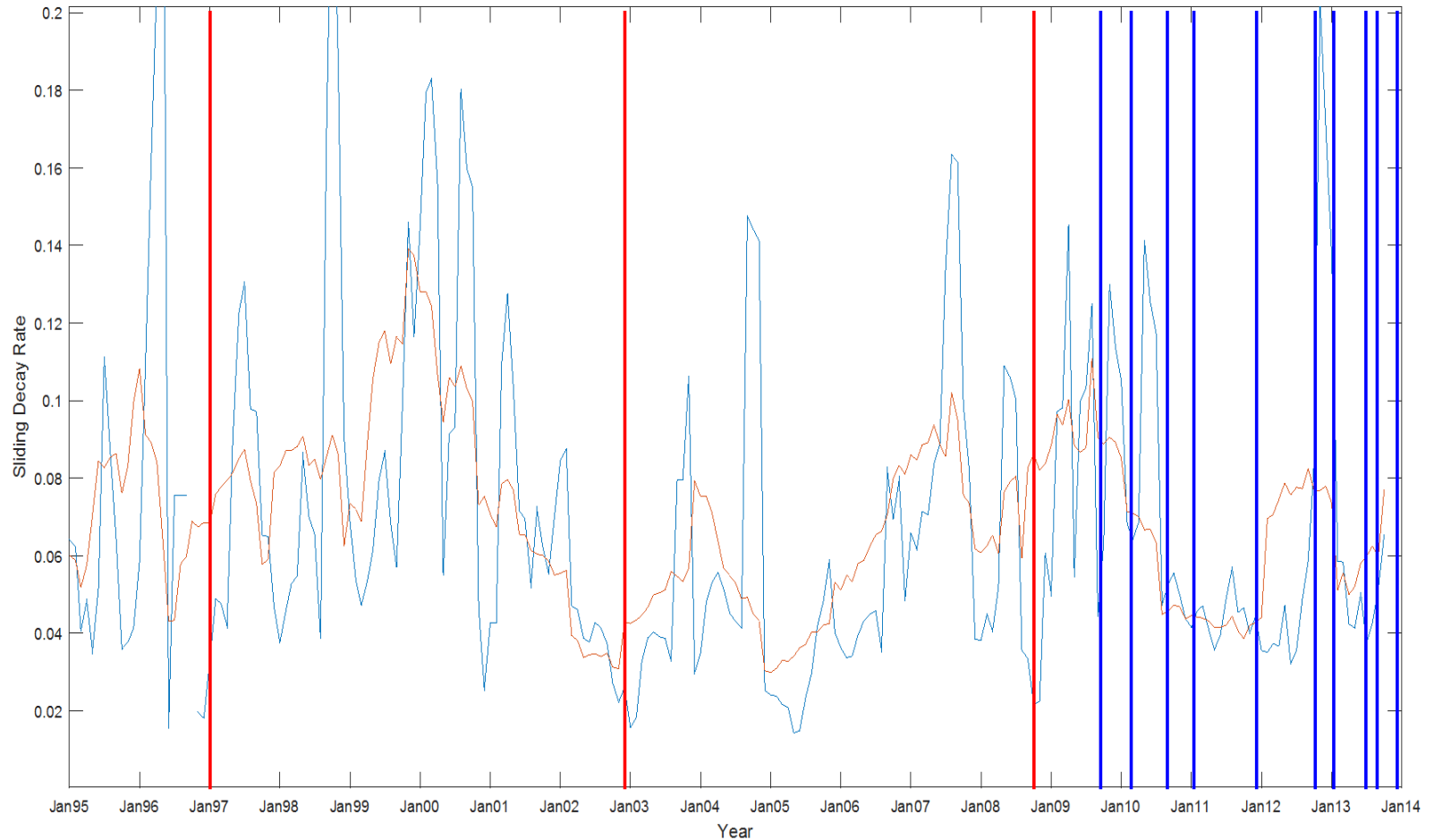
Early Warning Indicators



Autocorrelation low at quiet years
quiet years spread out
ring quiet years

Autocorrelation spikes up during the possible bubble years
possible bubble years
Asian Financial Crisis
Asian Financial Crisis

Slow Recovery





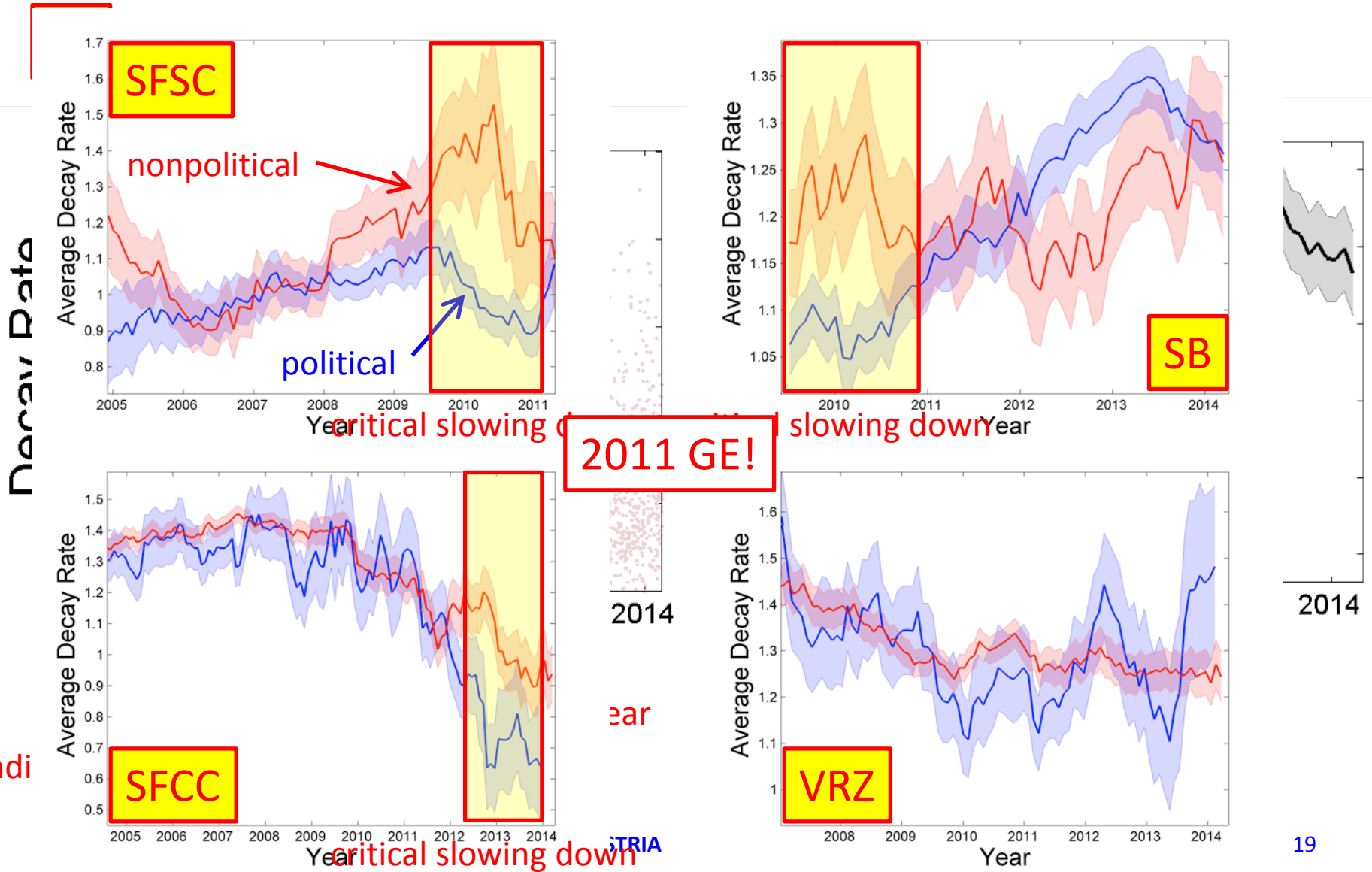
James Peng Lung TAN
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SINGAPORE 2011 GENERAL ELECTION

Online Discourse as Perturbations

The screenshot shows the SGFORUMS website interface. On the left, there are navigation menus for 'Speaker's Corner' and 'Chit Chat'. The main content area displays a list of forum threads under the sub-forum 'The Courtyard Café'. A sidebar on the right contains social media sharing icons (Facebook, LinkedIn, Twitter, Email) and a list of threads. A table at the bottom right shows a list of threads with columns for 'Title / Thread Starter', 'Replies / Views', and 'Last Post'. Red boxes highlight specific elements: 'SFSC' in the left sidebar, 'SB' in the sidebar thread list, 'SFCC' in the bottom left, and 'VRZ' in the bottom right. The top of the page features the 'Sam's Alfresco Heaven' banner and navigation tabs like 'Forum', 'Chat Room', and 'What's New?'. A navigation bar below the banner includes 'VR-ZONE', 'NEWS', 'PRICEWATCH', 'SGCAFE', 'SHOP', 'PHOTOS', and 'PHOTOGRAPHY GUIDE'. The main forum title is 'Forum: Chit Chatting'.

Relaxation Rates

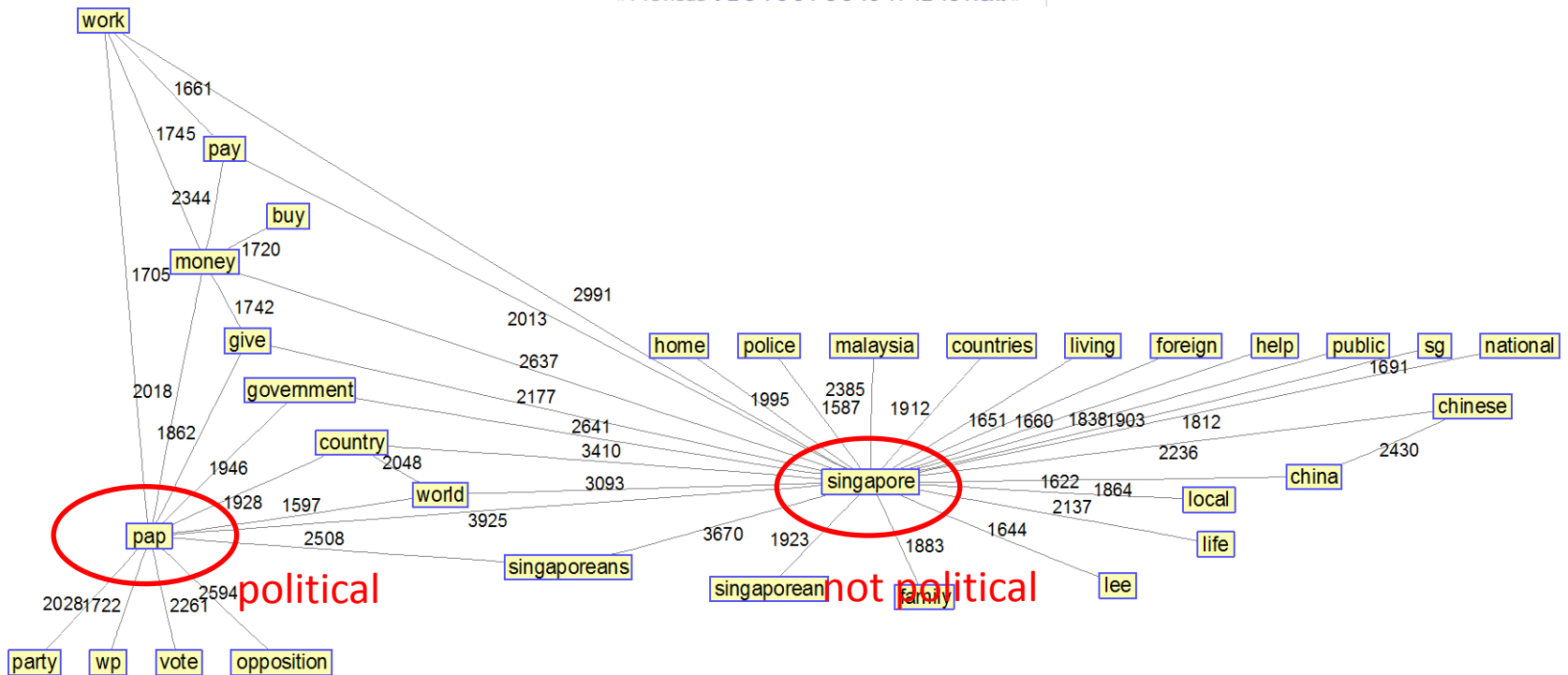


Text Co-Occurrence Analysis

Home - Chat - PMFG: Tumminello et al., PNAS 102, 10421-10426, 2005
What is your ideal age for retirement? Please Login or Signup to reply.

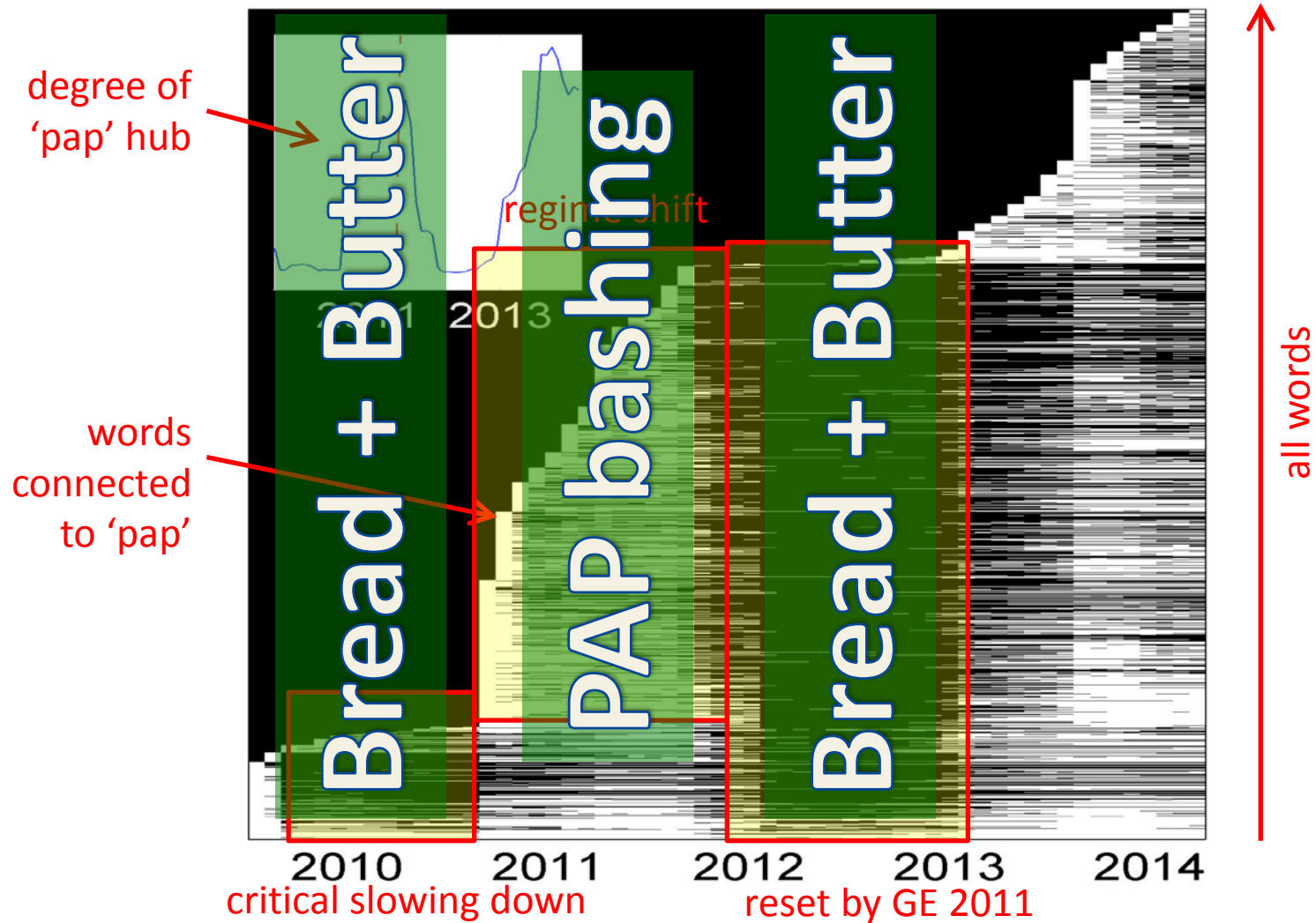
324 posts

« Previous 1 2 3 4 5 6 7 8 9 10 11 12 13 Next »



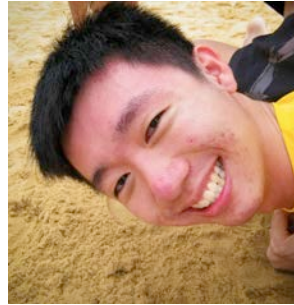
Use political keyword to split threads into political and nonpolitical

Nature of Transition





Boon Kin TEH
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Nanyang Technological
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Teck Liang TAN
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Nanyang Technological
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FUSION-FISSION DYNAMICS & FORECASTING

Soup-of-Group (SOG) Model

Bohorquez, Gourley, Dixon, Spagat, and Johnson, *Nature* **462**, 911 (2009)

Johnson, Ashkenazi, Zhao, and Quiroga, *AIP Advances* **1**, 012114 (2011)

$$\frac{\partial n_s}{\partial t} = \frac{v_{\text{coal}}}{N^2} \sum_{k=1}^{s-1} kn_k(s-k)n_{s-k} - \frac{v_{\text{frag}}sn_s}{N} - \frac{2v_{\text{coal}}sn_s}{N^2} \sum_{k=1}^{\infty} kn_k, \quad s \geq 2,$$

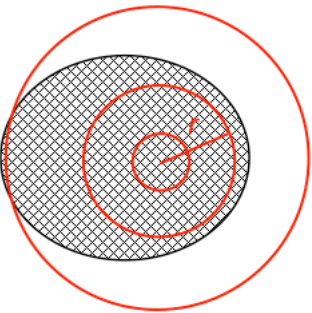
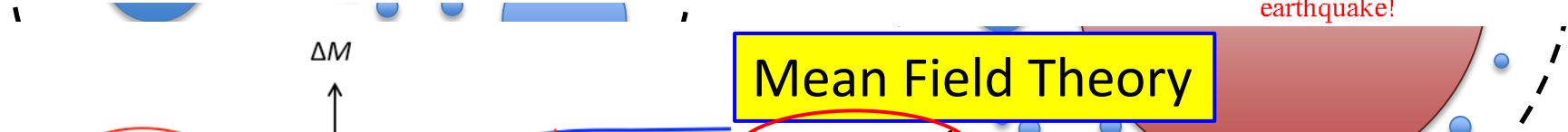
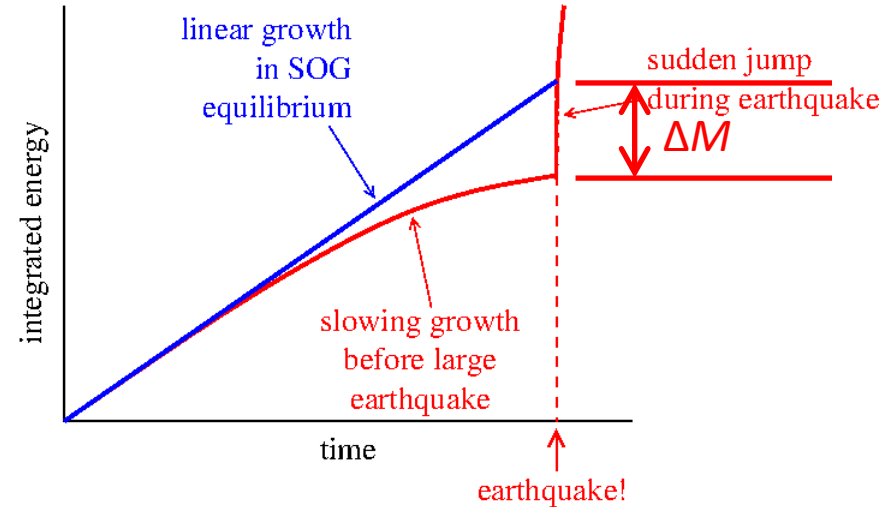
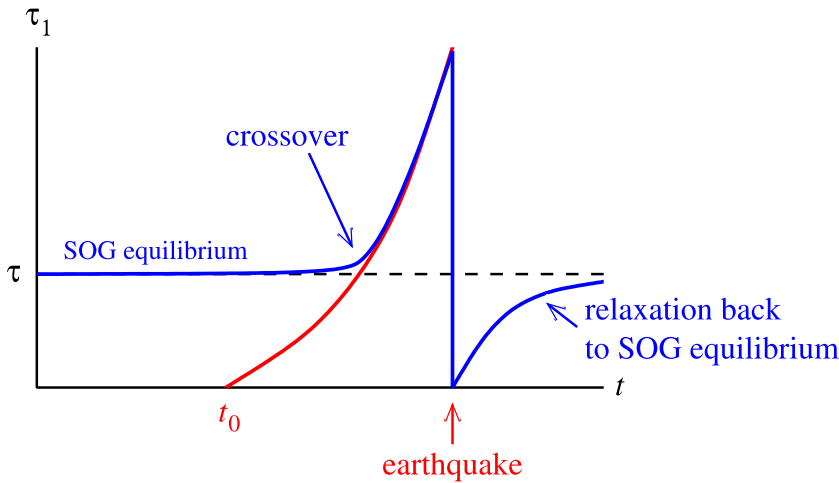
$$\frac{\partial n_1}{\partial t} = \frac{v_{\text{frag}}}{N} \sum_{k=2}^{\infty} k^2 n_k - \frac{2v_{\text{coal}}n_1}{N^2} \sum_{k=1}^{\infty} kn_k,$$



$$p(s) \sim s^{\left(\frac{5}{2}\right)} \xrightarrow{\text{red arrow}} 2 \text{ for } d=2$$

Gutenberg-Richter Law!

Growth of Giant SOG Cluster



Mean Field Theory

$$E(t) = \int_0^t \int_{m_0}^{\log_{10}(S_0 - \gamma t)} 10^m R(m) dm dt'$$

linear growth
GR law

$$= At \left(\log_{10} \frac{S_0 - \gamma t}{s_0} - 1 \right) - \frac{AS_0}{\gamma} \log_{10} \frac{S_0 - \gamma t}{S_0}$$

suppression of smaller earthquakes

Sep 1999, *M*-7.3, Chi-Chi, Taiwan

SCIE
REF



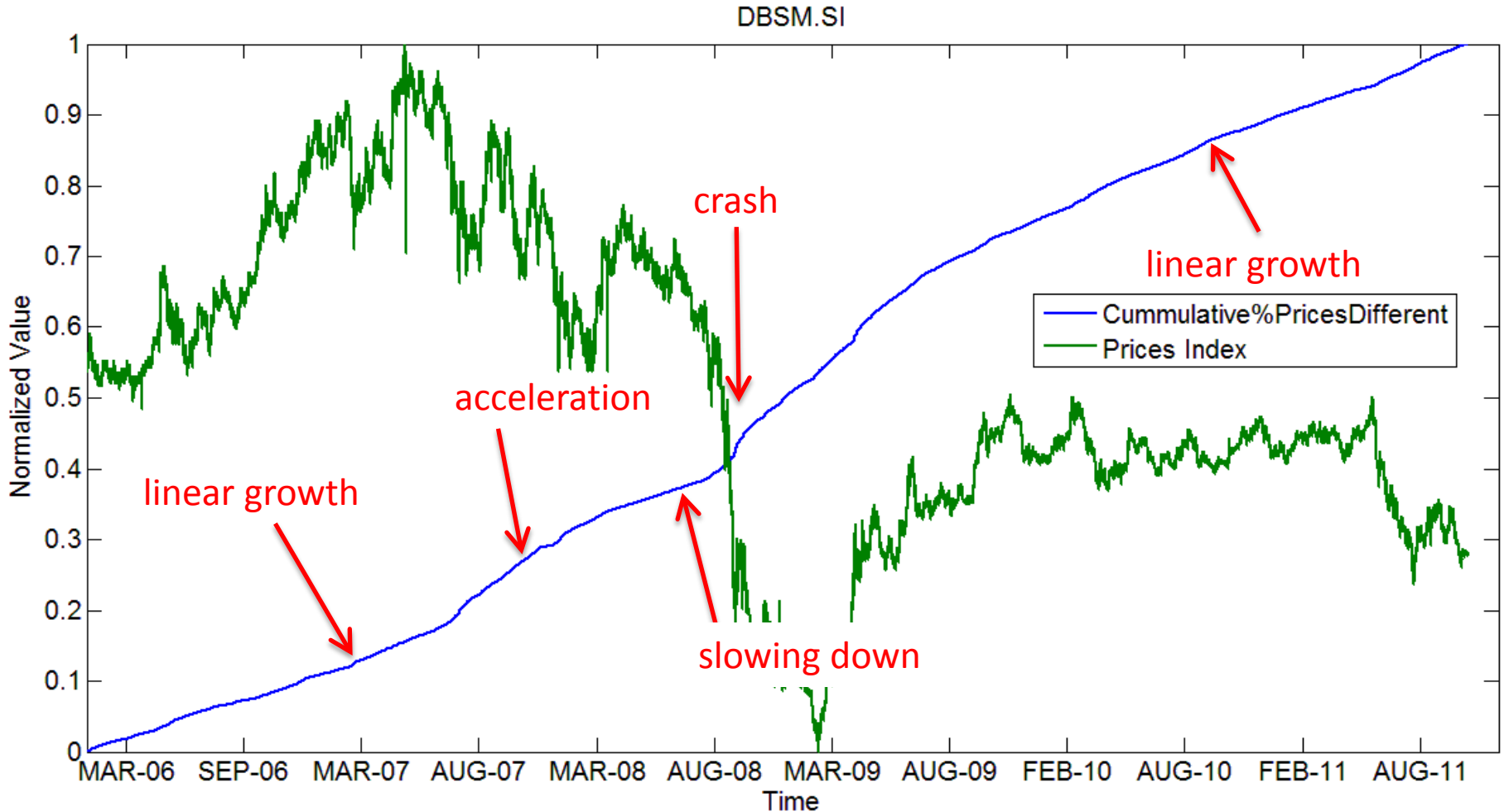
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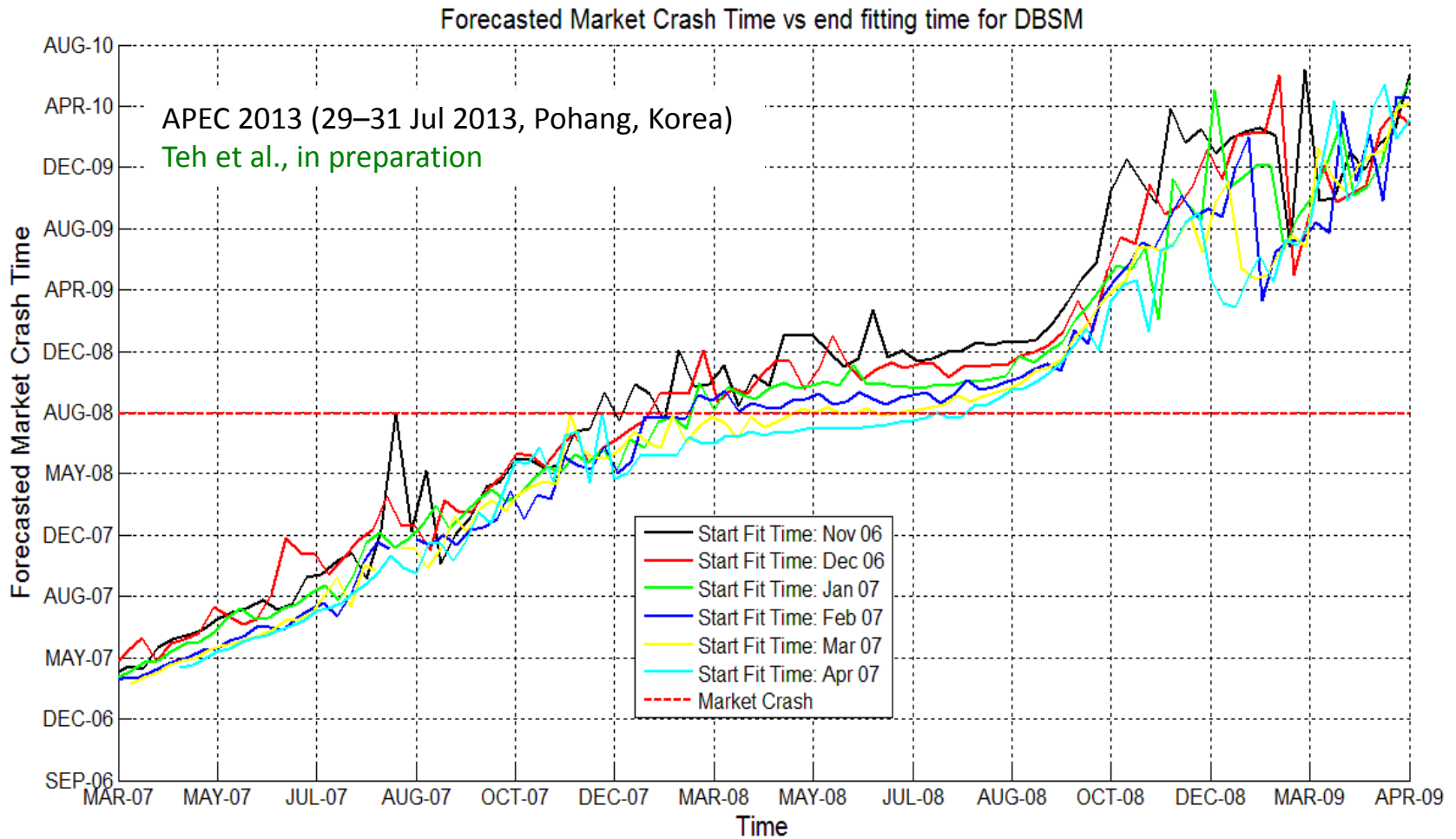
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COMPUTATION
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SOG Precursors in the SGX



Quantitative Crash Prediction





Conclusions

- **Critical Transitions in Socioeconomic Systems**
 - Critical slowing down + Slow recovery
- **US Housing Market**
 - Critical slowing down detected = Subprime Loans Transition
- **Singapore Housing Market**
 - Critical slowing down detected = housing bubble
 - Slow recovery detected
- **SOG Forecasting**
 - Sep 1999 Chi-Chi earthquake, Taiwan
 - Oct 2008 SGX market crash

Thank You!

- **Contact Information**

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