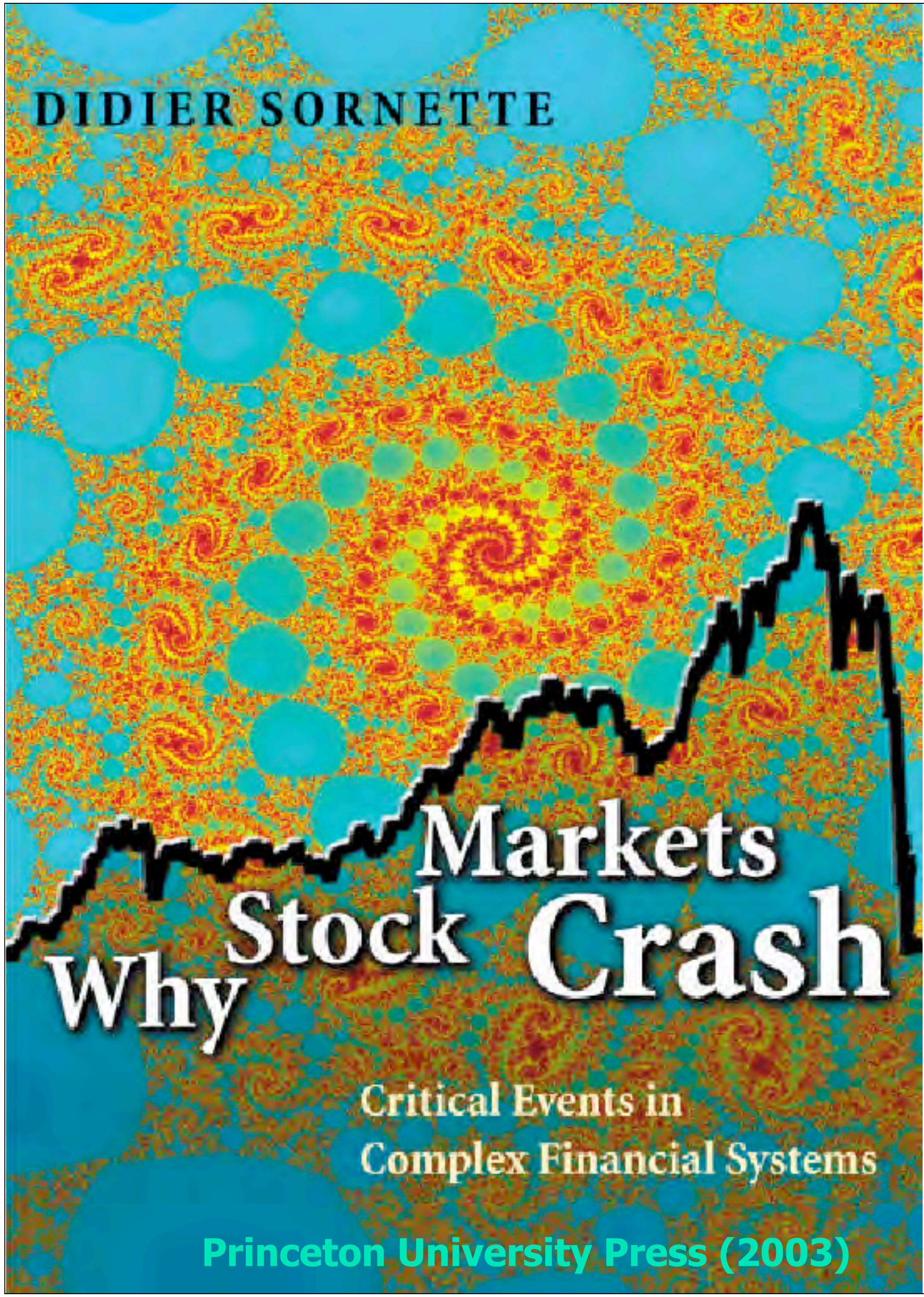


ETH-Zurich
Chair of Entrepreneurial Risks
Department of Management, Technology
and Economics (D-MTEC), ETH Zurich
Switzerland
http://www.mtec.ethz.ch/

- What are bubbles?
- Do they exist really?
- Why do we care?
- Can they be detected?
- Can their end (the CRASH) be predicted?
- Systemic risks? Sub-prime mess...

Kal


JUST A NORMAL DAY AT THE NATION'S MOST IMPORTANT FINANCIAL INSTITUTION...
I'VE GOT A STOCK HERE THAT COULD REALLY EXCEL
REALLY EXCEL?
EXCEL?
SELL?
SELL?
SELL
SE
SELL!
SELL!
KAL
SELL!
SELL!
ELL!
SELL!
THIS IS MADNESS! I CAN'T TAKE ANYMORE
GOOD BYE!
GOOD BYE?
BYE?
Buy?
BUY!
Buy!
BUY!!!
Buy!
Bu
BUY!
I'VE GOT A STOCK HERE..
CARTOONISTS & WRITERS SYNDICATE http://CartoonWeb.com


THIS WAY TO THE
Bull Market!
Almost there. . . 300 feet. . . Don't Miss The Fun!
I'm a
trader.
Hey this Koolaid
tastes great!
Must own
Yahoo.
Stoopid bears.
Don't be negative.
Take a
deep
breath!
I'm flying
mommy!
El Cliffo

Imitation

-Imitation is considered an efficient mechanism of social learning.

- Experiments in developmental psychology suggest that infants use imitation to get to know persons, possibly applying a ‘like-me’ test (‘persons which I can imitate and which imitate me’).

- Imitation is among the most complex forms of learning. It is found in highly socially living species which show, from a human observer point of view, ‘intelligent’ behavior and signs for the evolution of traditions and culture (humans and chimpanzees, whales and dolphins, parrots).

- In non-natural agents as robots, tool for easing the programming of complex tasks or endowing groups of robots with the ability to share skills without the intervention of a programmer. Imitation plays an important role in the more general context of interaction and collaboration between software agents and human users.

Humans Appear Hardwired To Learn By 'Over-Imitation'

ScienceDaily (Dec. 6, 2007) — Children learn by imitating adults--so much so that they will rethink how an object works if they observe an adult taking unnecessary steps when using that object, according to a new Yale study.

Thy Neighbor's Portfolio: Word-of-Mouth Effects in the Holdings and Trades of Money Managers

HARRISON HONG, JEFFREY D. KUBIK, and JEREMY C. STEIN*

A mutual fund manager is more likely to buy (or sell) a particular stock in any quarter if other managers in the same city are buying (or selling) that same stock. This pattern shows up even when the fund manager and the stock in question are located far apart, so it is distinct from anything having to do with local preference. The evidence can be interpreted in terms of an epidemic model in which investors spread information about stocks to one another by word of mouth.

THE JOURNAL OF FINANCE • VOL. LX, NO. 6 • DECEMBER 2005

A fundamental observation about human society is that people who communicate regularly with one another think similarly. There is at any place and in any time a *Zeitgeist*, a spirit of the times.... Word-of-mouth transmission of ideas appears to be an important contributor to day-to-day or hour-to-hour stock market fluctuations. (pp. 148, 155)

Shiller (2000)

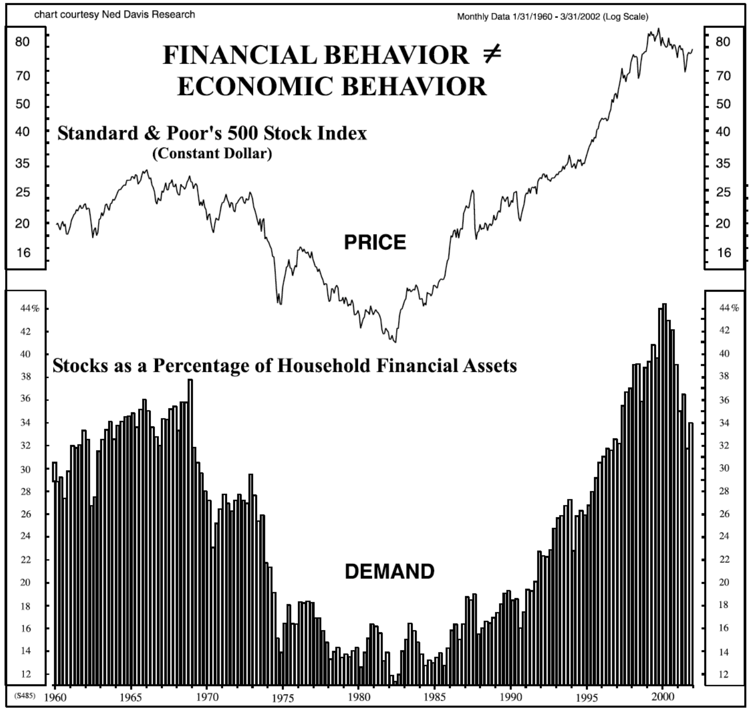
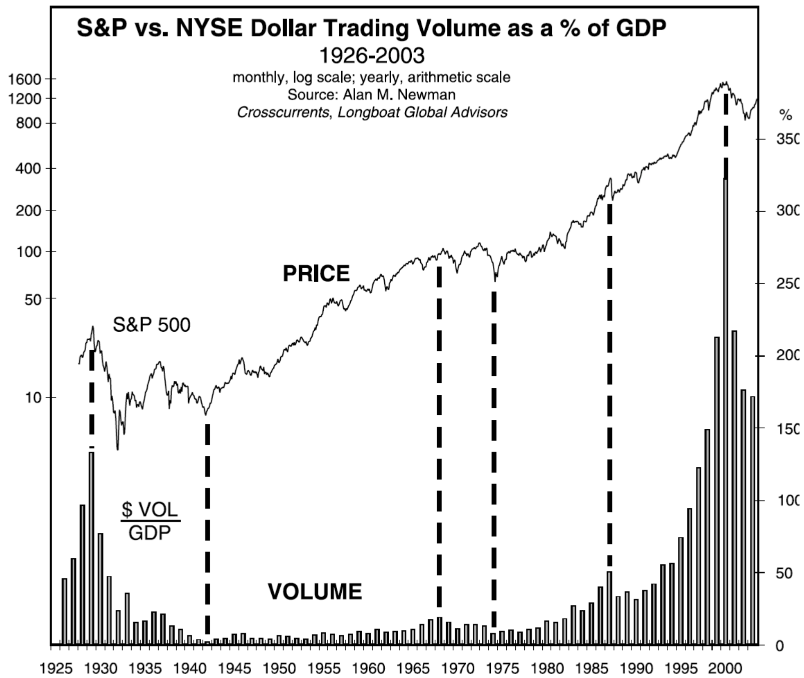
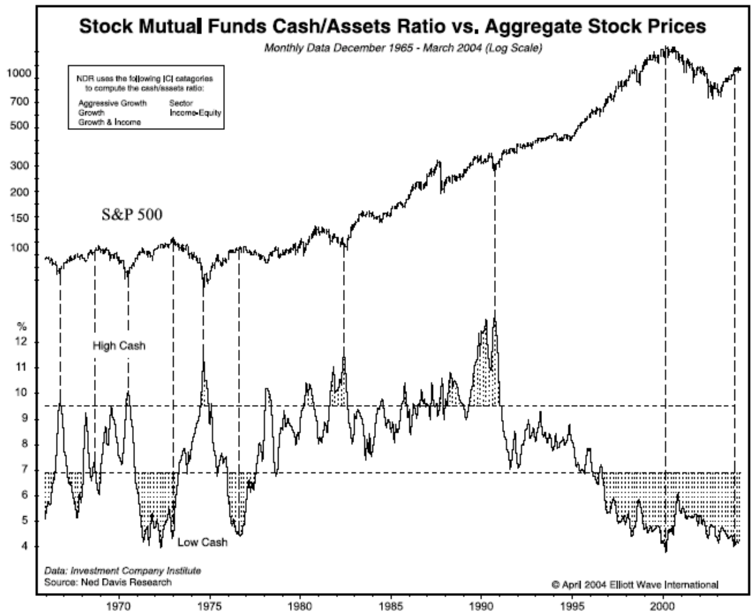
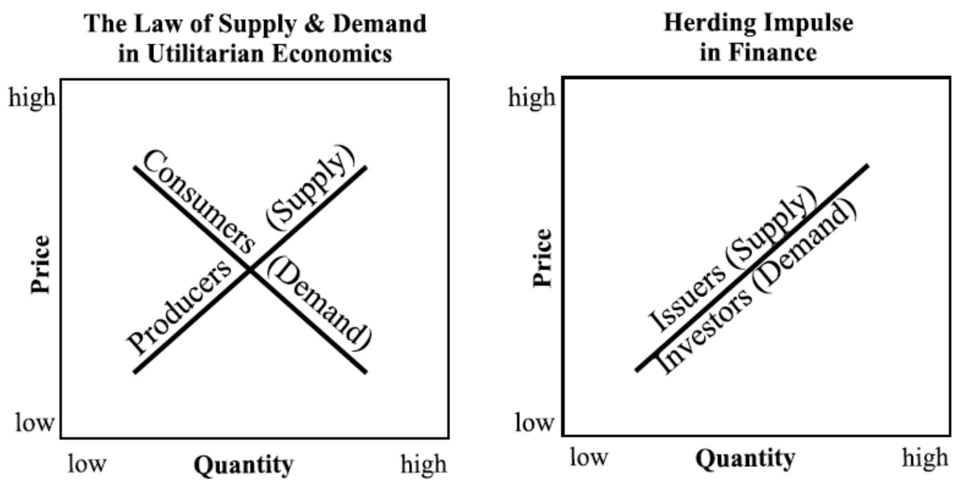


chart courtesy Ned Davis Research
Monthly Data 1/31/1960 - 3/31/2002 (Log Scale)
FINANCIAL BEHAVIOR ≠
ECONOMIC BEHAVIOR
Standard & Poor's 500 Stock Index
(Constant Dollar)
PRICE
Stocks as a Percentage of Household Financial Assets
DEMAND
1960
1965
1970
1975
1980
1985
1990
1995
2000


S&P vs. NYSE Dollar Trading Volume as a % of GDP
1926-2003
monthly, log scale; yearly, arithmetic scale
Source: Alan M. Newman
Crosscurrents, Longboat Global Advisors
PRICE
S&P 500
$ VOL
GDP
VOLUME
%
1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000


Stock Mutual Funds Cash/Assets Ratio vs. Aggregate Stock Prices
Monthly Data December 1965 - March 2004 (Log Scale)
NDR uses the following ICI categories to compute the cash/assets ratio:
Aggressive Growth
Growth
Growth & Income
Sector
Income-Equity
S&P 500
High Cash
Low Cash
Data: Investment Company Institute
Source: Ned Davis Research
© April 2004 Elliott Wave International
1970
1975
1980
1985
1990
1995
2000


The Law of Supply & Demand
in Utilitarian Economics
high
low
Price
Consumers
(Supply)
Producers
(Demand)
low
Quantity
high
Herding Impulse
in Finance
high
low
Price
Issuers (Supply)
Investors (Demand)
low
Quantity
high

Optimal strategy obtained under limited information

Equation showing optimal imitation solution of decision in absence of intrinsic information and in the presence of information coming from actions of connected "neighbors"

$$s_i(t+1) = \mathrm{sign}\left(K \sum_{j \in N_i} s_j + \varepsilon_i \right)$$

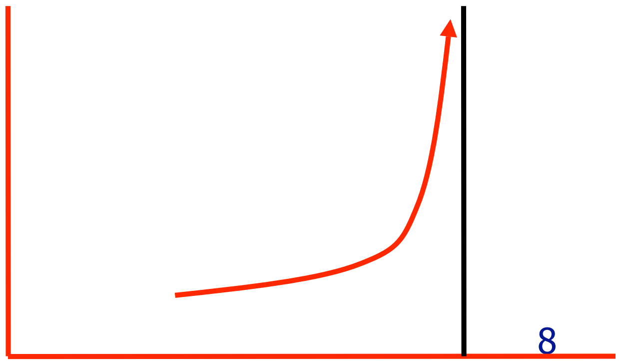
This equation gives rise to critical transition=bubbles and crashes

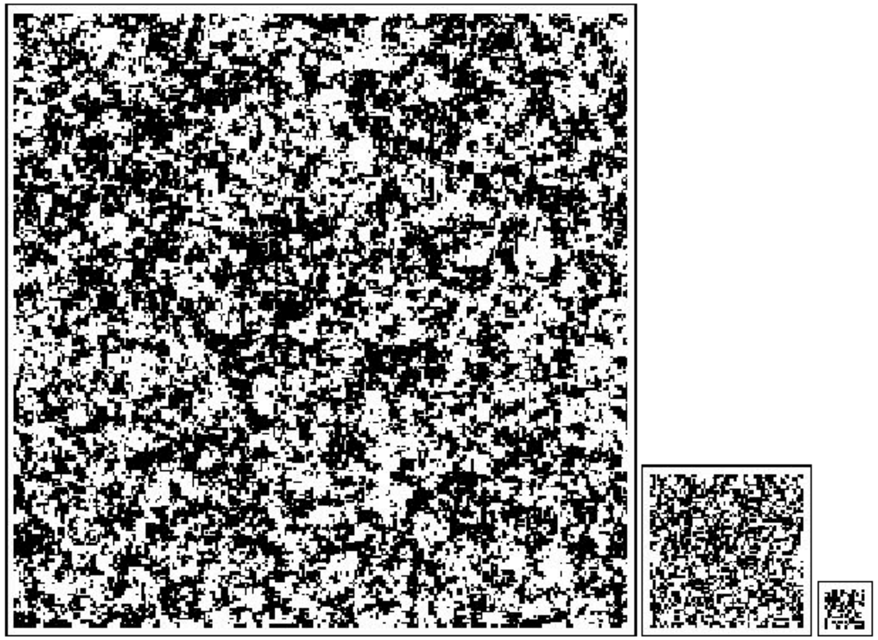
-Crash = coordinated sell-off of a large number of investors
-single cluster of connected investors to set the market off-balance
-Crash if 1) large cluster s>s* and 2) active

-Proba(1) = n(s)
-Proba(2) ~ s^a with 1 < a < 2 (coupling between decisions)

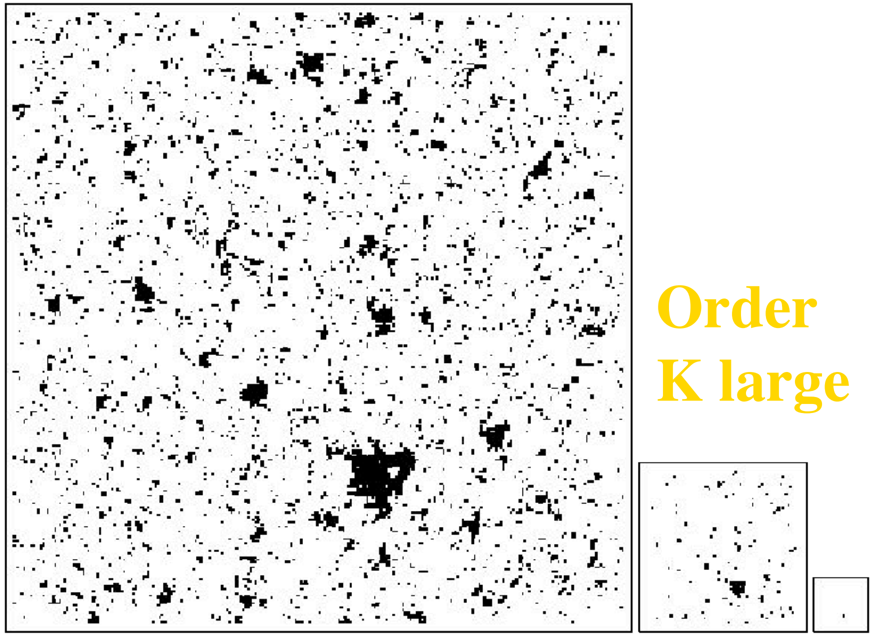
Proba(crash) ~ $\sum_{s>s^*} n(s)\, s^a$

If a=2, $\sum_{s>s^*} n(s)\, s^2 \sim |K-Kc|^{-\gamma}$





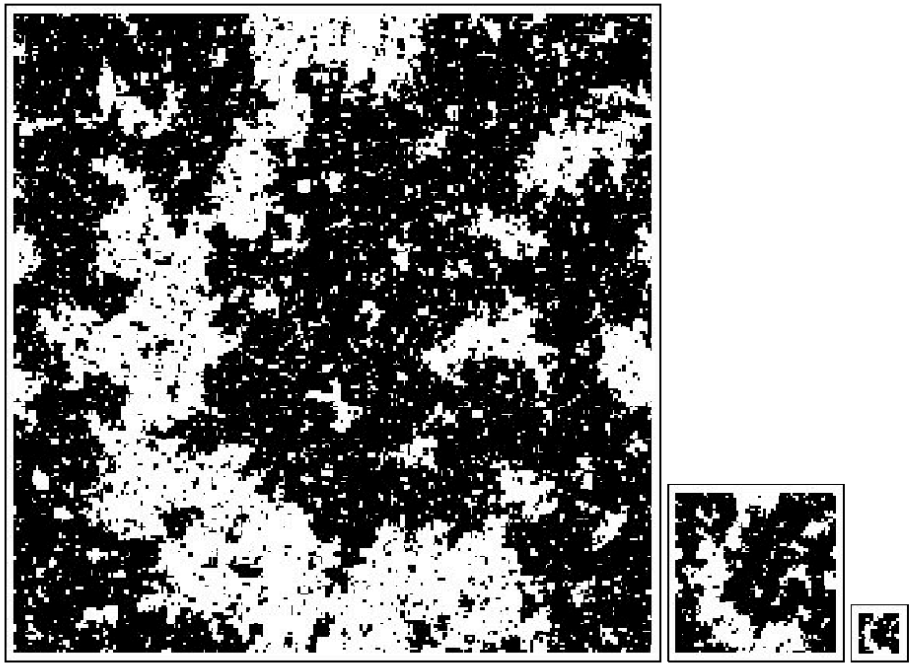
Disorder : K small



Order
K large

Renormalization group:
Organization of the description scale by scale

Critical:
K=critical value



Endogenous versus exogenous origins of financial bubbles and crashes

Georges Harras & Didier Sornette

Importance of Positive Feedbacks and Over-confidence in a Self-Fulfilling Ising Model of Financial Markets

$$s_i(t) = \text{sign}\left[\sum_{j \in \mathcal{N}} K_{ij}(t)\mathrm{E}[s_j](t) + \sigma_i(t)G(t) + \epsilon_i(t)\right]$$

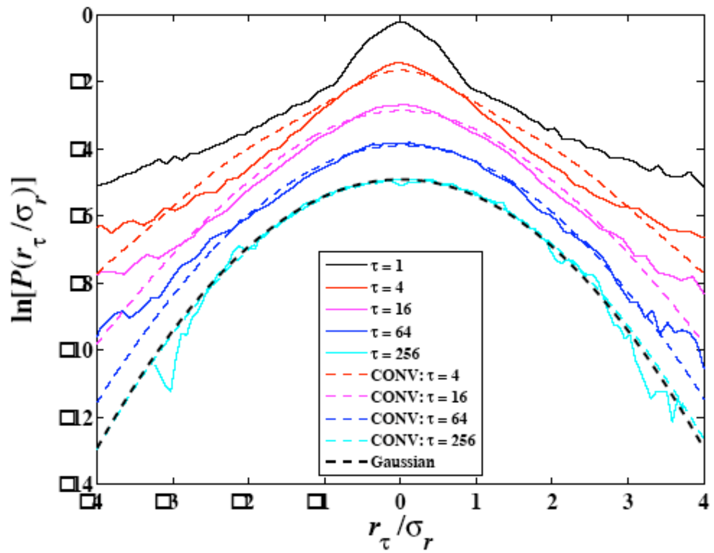
Imitation **News** **Private information**

$$K_{ij}(t) = b_{ij} + \alpha_i K_{ij}(t-1) + \beta r(t-1)G(t-1)$$

β<0: rational agents

β>0: over-confident agents

Didier Sornette and Wei-Xing Zhou
Physica A 370 (2), 704-726 (2006))



Opinion formation

$$\mathrm{opinion_i}(t) = c_{1i} \cdot \sum_{j=1}^{J} k_{ij}(t-1) \cdot E_i[s_j(t)] + c_{2i} \cdot u(t-1) \cdot \mathrm{news}(t) + c_{3i} \cdot \epsilon_i(t)$$

Trading decision

$$\begin{array}{llrcl}
\text{- if opinion}_i(t) > |\text{opinion-th}_i| & : & s_i(t) & = & +1 \\
 & & a_i(t) & = & g \cdot \frac{cash_i(t)}{price(t-1)} \\
\text{- if opinion}_i(t) < -|\text{opinion-th}_i| & : & s_i(t) & = & -1 \\
 & & a_i(t) & = & g \cdot stocks_i(t),
\end{array}$$

Learning and adaptation

$$\begin{aligned}
u(t) &= \alpha \cdot u(t-1) + r(t) \cdot news(t-1) \cdot \frac{1-\alpha}{\sigma_r} \\
k_{ij}(t) &= \alpha \cdot k_{ij}(t-1) + r(t) \cdot E_i[s_j(t-1)] \cdot \frac{1-\alpha}{\sigma_r}.
\end{aligned}$$

Price clearing condition

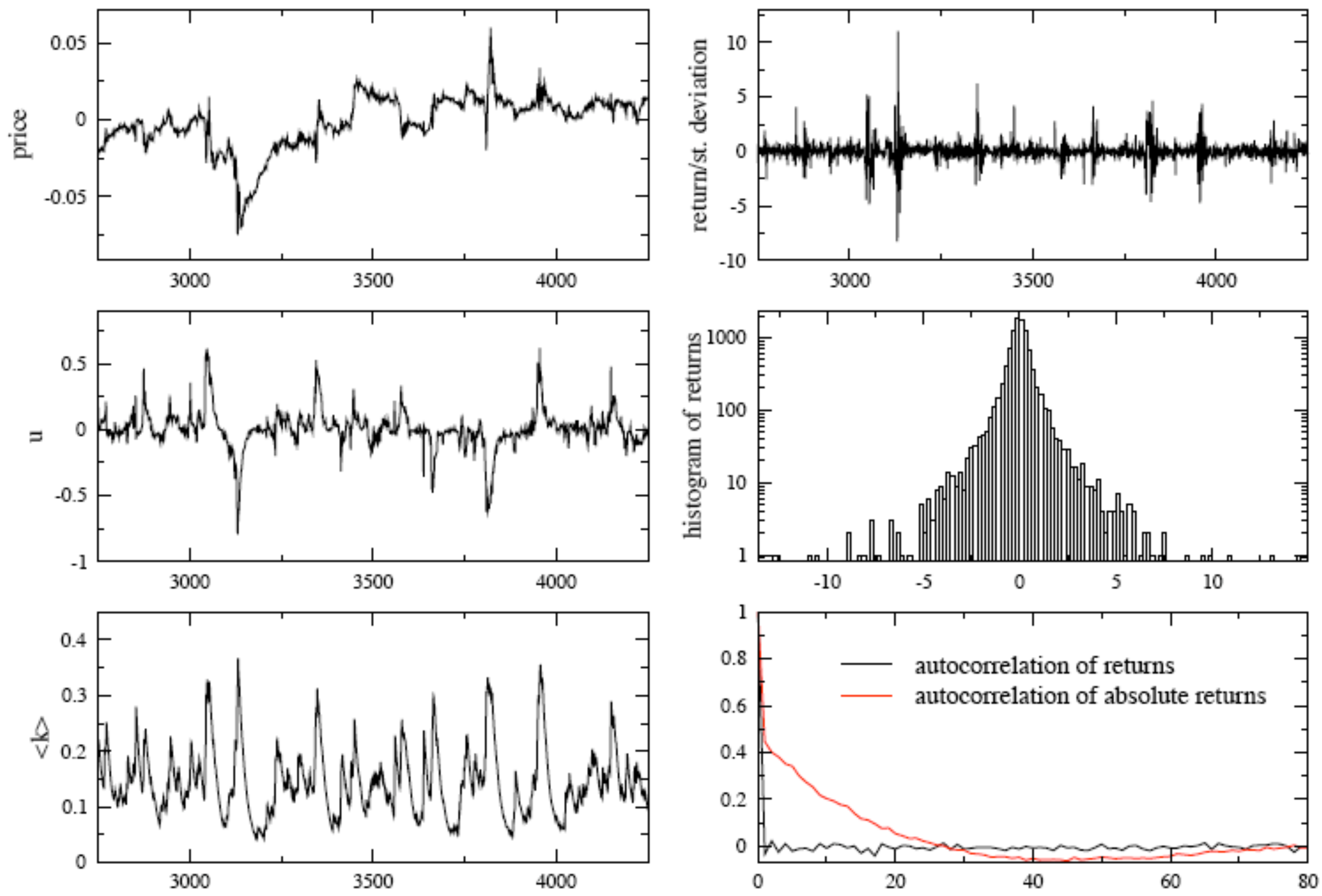
$$r(t) = \frac{1}{\lambda \cdot N} \sum_{i=1}^{N} s_i(t) \cdot a_i(t)$$

$$\log[\mathrm{price}(t)] = \log[\mathrm{price}(t-1)] + r(t),$$

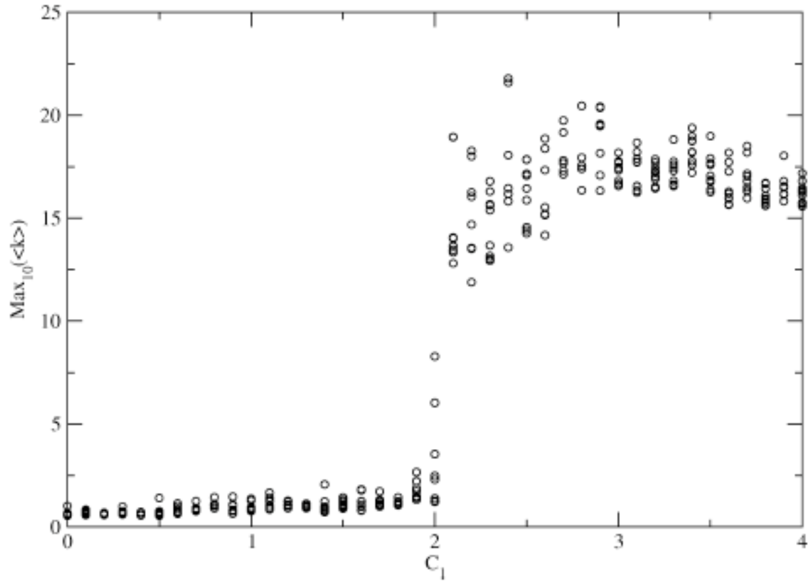
Wealth evolution

$$cash_i(t) = cash_i(t-1) - a_i(t) \cdot \mathrm{price}(t)$$

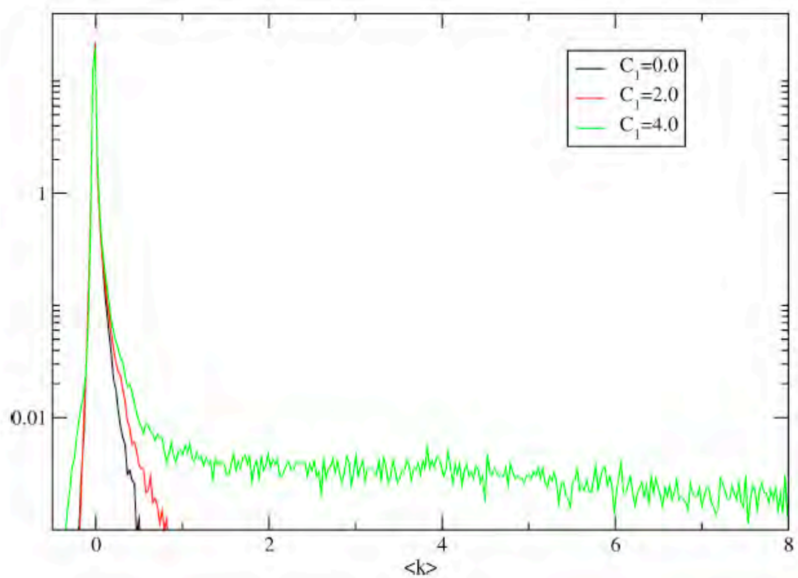
$$stocks_i(t) = stocks_i(t-1) + a_i(t).$$


price
0.05
0
-0.05
3000
3500
4000
return/st. deviation
10
5
0
-5
-10
u
0.5
0
-0.5
-1
histogram of returns
1000
100
10
1
-10
-5
0
5
10
<k>
0.4
0.3
0.2
0.1
0
1
0.8
0.6
0.4
0.2
20
40
60
80
autocorrelation of returns
autocorrelation of absolute returns

$$C_1 = C_2 = C_3 = 1.0$$

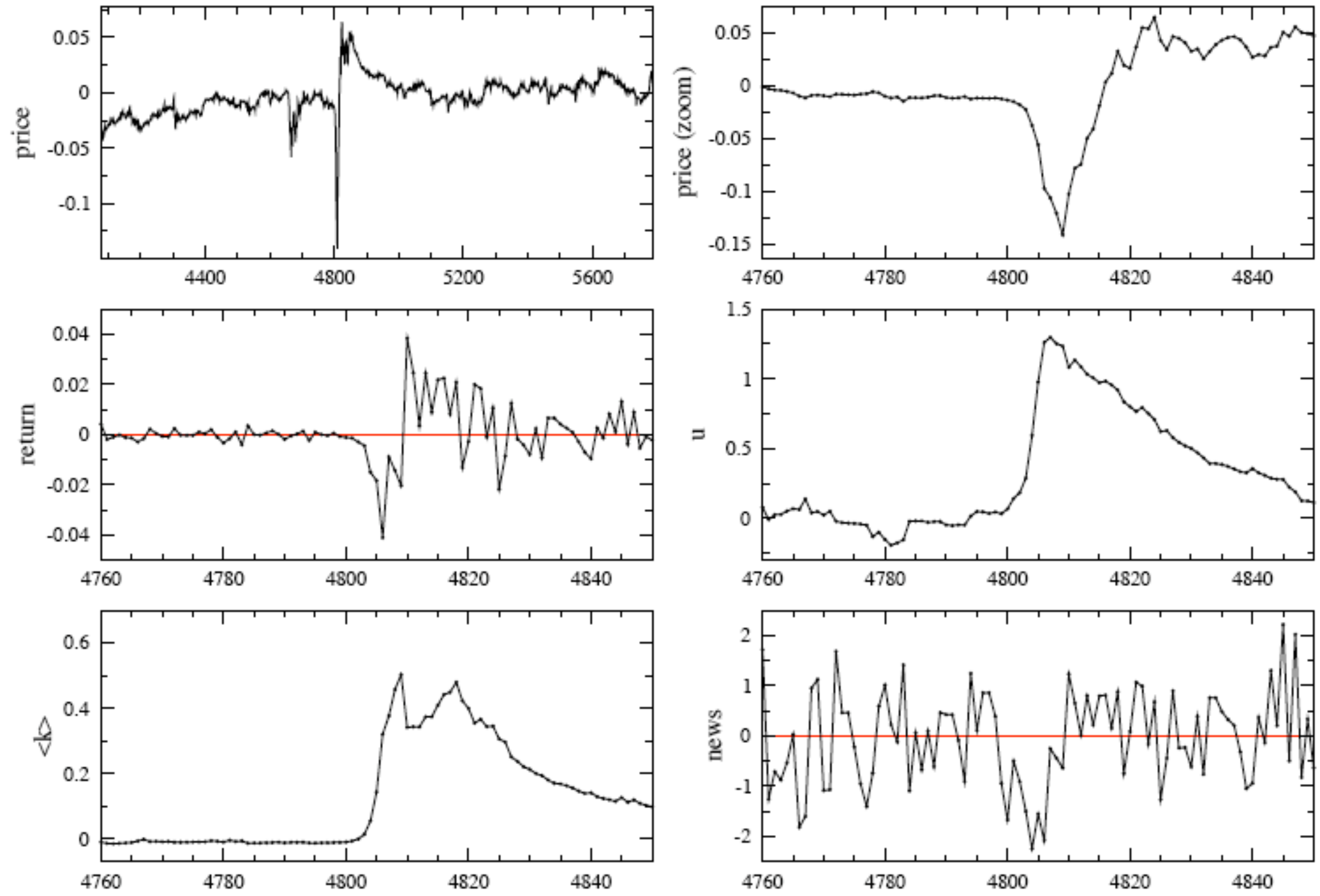


10 largest peaks in $< k > (t)$ for C_1 ranging from 0 to 4.

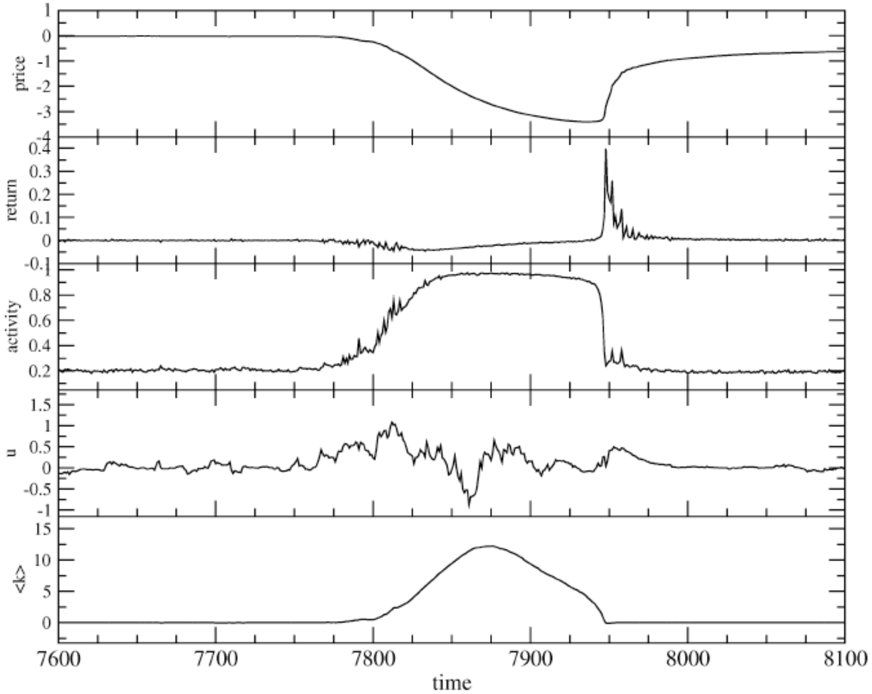


Normalised histogram of $< k >$ for different values of C_1.

NEWS IMPACT



Impact of the news to some values, generated with $C_1 = C_2 = C_3 = 1.0$.



Impact of the news to some values, generated with $C_1 = 3$ and $C_2 = C_3 = 1.0$.

- ENDO-EXO view of bubbles and crashes; Transient runs of news are sufficient to trigger large crashes in a system of over-learning and over-controlling agents

Internet Bubble Model

Taisei Kaizoji, Alex Saichev and Didier Sornette

Model of 3 stocks and two populations of traders (rational and noise)

A Classical Question:
Why do bubbles persist in the presence of rational arbitrageurs?

A Traditional Answer (M. Friedman (1953))

Rational speculators must stabilize asset prices.

Speculators who destabilize asset prices do so by, on average, buying when prices are high and selling when prices are low; such destabilizing speculators are quickly eliminated from the market.

By contrast, rational arbitragers who earn positive profits do so by trading against the less rational investors who move prices away from fundamentals. Such speculators rationally counter the deviations of prices from fundamentals and so stabilize them.

Market Efficient Hypothesis (Eugene F. Fama 1970)

Rational Expectations + Risk Neutral Investors

"If there are many sophisticated traders in the market, they may cause these bubbles to burst before they really get under way"

A Counter Evidence for Efficient Market Hypothesis

Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?

Robert J. Shiller

The American Economic Review, Vol. 71, No. 3. (Jun., 1981), pp. 421-436.

FIGURE 1

Note: Real Standard and Poor's Composite Stock Price Index (solid line p) and *ex post* rational price (dotted line p^*), 1871–1979, both detrended by dividing a long-run exponential growth factor. The variable p^* is the present value of actual subsequent real detrended dividends, subject to an assumption about the present value in 1979 of dividends thereafter. Data are from Data Set 1, Appendix.

FIGURE 2

Note: Real modified Dow Jones Industrial Average (solid line p) and *ex post* rational price (dotted line p^*), 1928-1979, both detrended by dividing by a long-run exponential growth factor. The variable p^* is the present value of actual subsequent real detrended dividends, subject to an assumption about the present value in 1979 of dividends thereafter. Data are from Data Set 2, Appendix.

An Authority's Question on Efficient Market Hypothesis

Whether are sophisticated speculators indeed

a correcting force that prevent the bubble?

Fisher Black (1986): Noise, The Journal of Finance 41-3 (1986)

Noise makes financial markets possible, but also make them imperfect. If there is no noise trading, there will be very little trading in individual assets. People will hold individual assets, directly or indirectly, but they will rarely trade them. People trading to change their exposure to broad market risks will trade in mutual find,…..

Stressing the Necessity of Noise Traders

⇩

Noise Trader Approach in Finance

Answer I: Noise Trader Risk

J. De Long, A. Shliefer, L. Summers and R. Waldmann: Positive Feedback Investment Strategies and Stabilizing Rational Speculation, Journal of Finance 45-2 (1990) pp. 379-395.

In DSSW (1990), rational investors anticipate demand from positive feedback traders. If there is good news today, rational traders buy and push the price beyond its fundamental value because feedback traders are willing to take up the position at a higher price in the next period.

Answer I: Noise Trader Risk

Their Motivation: G. Soros's View of Self-Feeding Bubbles

G. Soros's trading strategy:

"betting not on fundamentals but on future crowd behavior",

1987 Alchemy of Finance (Simon and Schuster, New York)

Answer II: Synchronization Failure

D. Abreu, and M. K. Brunnermeier,
Bubbles and crashes, Econometrica 71, 2003, 173–204.

In their model, a price bubble is growing unless a sufficient number of arbitrageurs decide to attack. As a result, arbitrageurs who conclude that other arbitrageurs are yet unlikely to trade against the bubble find it optimal to ride the still-growing bubble for a while.

Summary:

In both of the coordination-failure model of AB (2003), and the noise-trader model of DSSW (1990), the incentive to ride the bubble stems from predictable sentiment:

-anticipation of continuing bubble growth in AB (2003) and

-predictable feedback trader demand in DSSW (1990b).

An Empirical Evidence on Riding Bubble:

M. Brunnermeier and S. Nagel,

Hedge Funds and the Technology Bubble,

Journal of Finance LIX No.5 (2004) 2013-2040

ABSTRACT

This paper documents that hedge funds did not exert a correcting force on stock prices during the technology bubble. Instead, they were heavily invested in technology stocks. This does not seem to be the result of unawareness of the bubble: Hedge funds captured the upturn, but, by reducing their positions in stocks that were about to decline, avoided much of the downturn. Our findings question the efficient markets notion that rational speculators always stabilize prices. They are consistent with models in which rational investors may prefer to ride bubbles because of predictable investor sentiment and limits to arbitrage.

Answer III: Miller's Hypothesis

Edward Miller (1977) "Risk, Uncertainty and Divergence of Opinion", Journal of Finance 32, 1151-1168.

When there are short-sales constraints, a stock's price will reflect the valuations that optimists attach to it, but will not reflect the valuations of pessimists

⇓

Given short sale constraints, the greater the divergence in the valuations of the optimists and the pessimists, the higher will be the price of a stock in a equilibrium, and hence the lower will be subsequent returns.

Modeling the Miller's hypothesis:

J. Chen, H. Hong and J. Stein (2002) "Breadth of Ownership and Stock Returns", Journal of Financial Economics 66

A model of stock prices in which there are both differences of opinion among investors as well as short-sales constraints.

An Empirical Evidence on the Miller's hypothesis:

Eli Ofek and Mathew Richardson: DotCom Mania

Journal of Finance vol. LVIII. No.3, (2003)

Abstract

This paper explores a model based on agents with heterogenous beliefs facing short sales restrictions, and its explanation for the rise, persistence, and eventual fall of Internet stock prices. First, we document substantial short sale restrictions for Internet stocks. Second, using data on Internet holdings and block trades, we show a link between heterogeneity and price effects for Internet stocks. Third, arguing that lockup expirations are a loosening of the short sale constraint, we document average, long-run excess returns as low as -33 percent for Internet stocks post-lockup. We link the Internet bubble burst to the unprecedented level of lockup expirations and insider selling.

A Counter Evidence on the Miller's hypothesis:

R. Battalio and P. Schultz: Options and the Bubble

Journal of Finance 59 No. 5, 2017-2102 (2004).

ABSTRACT

Many believe that a bubble existed in Internet stocks in the 1999 to 2000 period, and that short-sale restrictions prevented rational investors from driving Internet stock prices to reasonable levels. In the presence of such short-sale constraints, option and stock prices could decouple during a bubble. Using intraday options data from the peak of the Internet bubble, we find almost no evidence that synthetic stock prices diverged from actual stock prices. We also show that the general public could cheaply short synthetically using options. In summary, we find no evidence that short-sale restrictions affected Internet stock prices.

Internet Bubble Model

Taisei Kaizoji, Alex Saichev and Didier Sornette

A model with

-rational and noise traders
-risk-free, Internet stocks and Non-internet stocks

-Noise traders (i) herd and (ii) follow momentum

GOAL: describe endogenously (a) bubbles, (b) crashes, (c) role of rational investors...

RATIONAL INVESTORS

constant-absolute risk aversion (CARA) utility
with the coefficient of risk aversion γ.

maximization problem which the rational investors solve is equivalent to the mean-variance model:

$$
\begin{aligned}
&\max\left\{E(W)-\frac{\gamma}{2}V(W)\right\} \\
&=\max\{[x_1E(p_1)+x_2E(p_2)+x_f] \\
&-\frac{\gamma}{2}[\sigma_{11}(x_1)^2+\sigma_{12}x_1x_2+\sigma_{21}x_1x_2+\sigma_{22}(x_2)^2]\} \\
&s.t.\quad p_1(x_1-\bar{x}_1)+p_2(x_2-\bar{x}_2)+q(x_f-\bar{x}_f)=0
\end{aligned}
$$

x_1 : excess demand for Internet stock
x_2 : excess demand for non-Internet stock

NOISE TRADERS

The excess demand or excess supply for the internet-stock is defined as

$$J(n_+ - n_-)$$

where n_+ denotes the fraction of buyers and n_- the fraction of sellers, and J is the average trading-unit per a noise trader.

$$\Pr\{\text{to sell stock}|s(t) = s\} \approx \rho_\downarrow(s)\,dt \ll 1$$

$$\Pr\{\text{to buy stock}|s(t) = s\} \approx \rho_\uparrow(s)\,dt \ll 1$$

$$s(t) = n_+(t) - n_-(t)$$

$$\frac{\partial p(s;t)}{\partial t} + \frac{N}{2}\left[(1-s)\rho_\uparrow(s) + (1+s)\rho_\downarrow(s)\right]\,p(s;t) =$$

$$\frac{N}{2}\left[(1-s)\rho_\uparrow(s-\Delta s)p(s-\Delta s;t) + (1+s)\rho_\downarrow(s+\Delta s)p(s+\Delta s;t)\right]$$

total rate of both types of transactions: $\nu(s) = \rho_\downarrow(s) + \rho_\uparrow(s)$

$$p_\downarrow(s) = \frac{\rho_\downarrow(s)}{\nu(s)} \qquad p_\uparrow(s) = \frac{\rho_\uparrow(s)}{\nu(s)} \qquad p_\downarrow(s) + p_\uparrow(s) \equiv 1$$

$$p_\uparrow(s) = \Pr ob(-1 \to +1) = \frac{1}{1 + \exp(-2(\lambda s + H))}$$

$$\lambda = J\ .\ N_{neighbor}$$

$$w_\downarrow(s) = \frac{N}{2}(1+s)p_\downarrow(s) \qquad w_\uparrow(s) = \frac{N}{2}(1-s)p_\uparrow(s)$$

$$\frac{\partial p(s;t)}{\partial t} = [\nu(s+\Delta s)w_\downarrow(s+\Delta s)p(s+\Delta s;t) - \nu(s)w_\downarrow(s)p(s;t)]$$
$$+ [\nu(s-\Delta s)w_\uparrow(s-\Delta s)p(s-\Delta s;t) - \nu(s)w_\uparrow(s)p(s;t)]$$

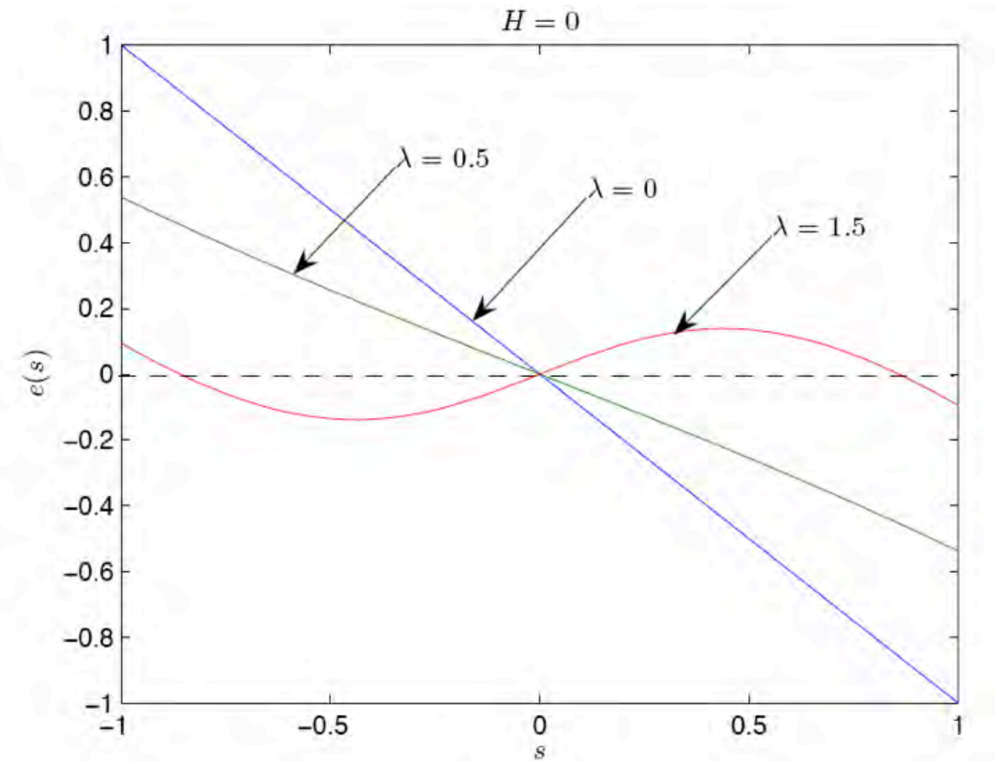
$$\nu(s) \equiv \nu = \text{const}$$

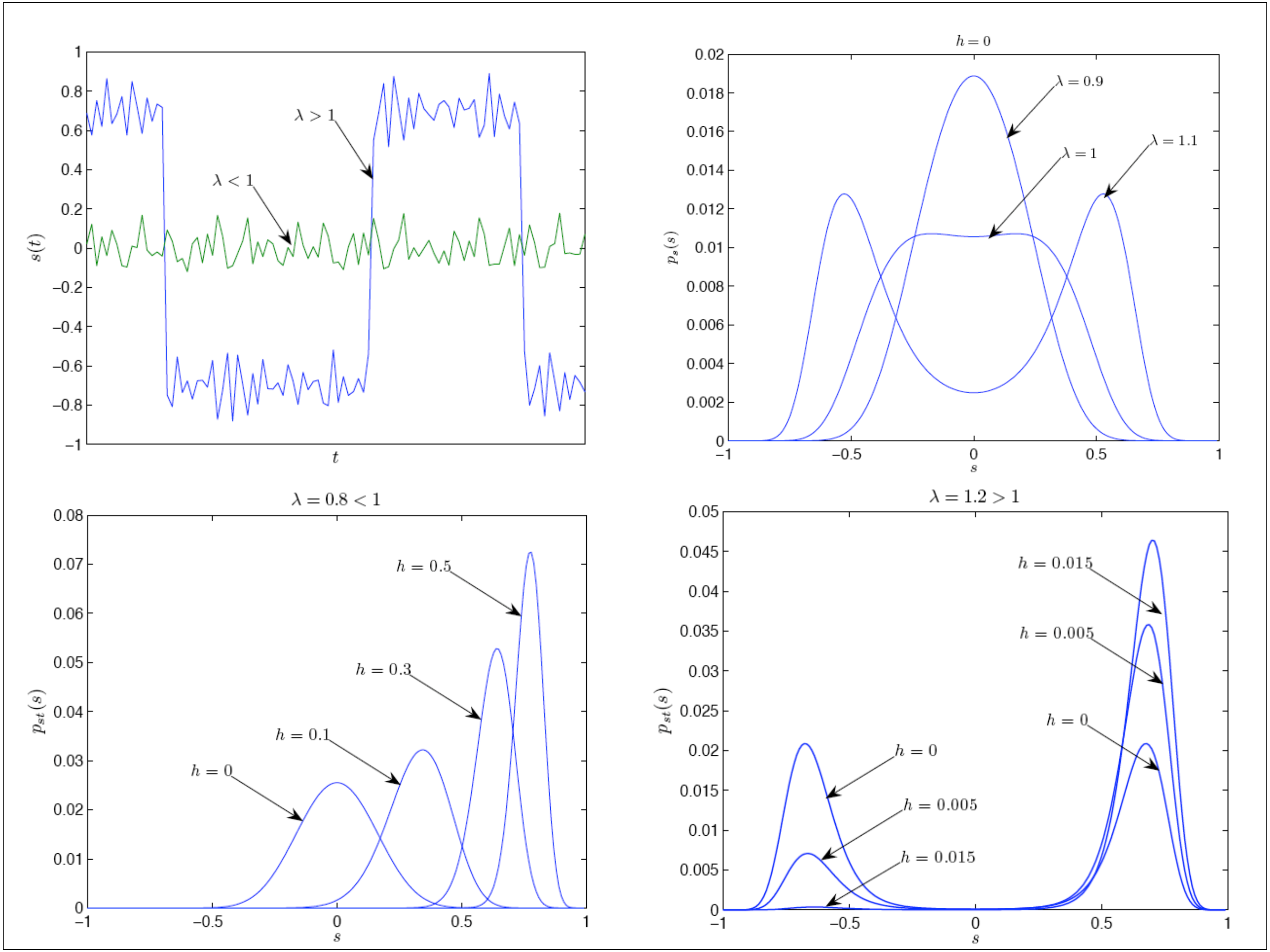
EXCESS DEMAND OF NOISE TRADERS

$$e(s) = n_- \, p_\uparrow(s) - n_+ \, p_\downarrow(s)$$

$$w_\downarrow(s) = n_+ \, p_\downarrow(s) = \frac{N}{2}(1-s)\, p_\downarrow(s)$$

$$Ne(s) = \frac{N}{2}\left[\tanh(\lambda s + H) - s\right]$$





$s(t)$
t
$\lambda > 1$
$\lambda < 1$
$h = 0$
$p_s(s)$
s
$\lambda = 0.9$
$\lambda = 1$
$\lambda = 1.1$
$\lambda = 0.8 < 1$
$p_{st}(s)$
$h = 0.5$
$h = 0.3$
$h = 0.1$
$h = 0$
$\lambda = 1.2 > 1$
$h = 0.015$
$h = 0.005$
$h = 0$

EXCESS DEMAND BY RATIONAL INVESTOR

Balance equation between excess demand of rational investors and excess demand of noise traders

$$N_{rational}(x_1 - \bar{x}_1) + JN_{noise}\left(n_- p_\uparrow - n_+ p_\downarrow\right) = 0$$

$$(x_1 - \bar{x}_1) + \lambda_f\left(n_- p_\uparrow - n_+ p_\downarrow\right) = 0$$

$$\lambda_f = J \ . \ (N_{noise}/N_{rational})$$

We solve for the demand x_1 per rational investor for the Internet stock, knowing the previous demand $\bar{x}_1$ at the previous time step, and knowing e(s)

PRICE DYNAMICS

Knowing x_1, we solve the equation for the market clearing price, which thus determines the price p_1 and p_2 of the two stocks:

$$(x_1 - \bar{x}_1) + \lambda_f\left(n_- p_\uparrow - n_+ p_\downarrow\right) = \frac{1}{\gamma|A|}[\left(E(p_1) - p_1/q\right)\sigma_2^2 \ -\left(E(p_2) - p_2/q\right)\rho\sigma_1\sigma_2] - \bar{x}_1 + \lambda_f\left(n_- p_\uparrow - n_+ p_\downarrow\right) = 0$$

The corresponding equation for the demand of the non-Internet stock is

$$(x_2 - \bar{x}_2) = \frac{1}{\gamma|A|}[-\left(E(p_1) - p_1/q\right)\rho\sigma_1\sigma_2 + \left(E(p_2) - p_2/q\right)\sigma_1^2] - \bar{x}_2 = 0$$

This gives

$$\begin{cases} p_1 = q\{E(p_1) + \gamma[\sigma_1^2(\lambda_f\left(n_- p_\uparrow - n_+ p_\downarrow\right) - \bar{x}_1) - \rho\sigma_1\sigma_2\bar{x}_2]\} \\ p_2 = q\{E(p_2) + \gamma[\rho\sigma_1\sigma_2(\lambda_f\left(n_- p_\uparrow - n_+ p_\downarrow\right) - \bar{x}_1) - \sigma_{22}\bar{x}_2]\}. \end{cases}$$

MOMENTUM STRATEGIES

$$p_{\uparrow}(s) = \Pr ob(-1 \rightarrow +1) = \frac{1}{1 + \exp(-2(\lambda s + H))}$$

Momentum strategies are a strategy that buys stocks with high returns and sells stocks with poor returns over the previous periods. The fact that momentum strategies yield significant profits, have been well investigated (see, e.g, Jegadeesh and Titman (1993, 2000)).

Noise traders use a "momentum strategy".

We define *momentum* as the exponential moving average of the risk premium as

$$H_t = \sum_{k=1}^{\infty} (r_{1,t-k} - r_{f,t-k}) e^{-k/\tau} + \zeta_t$$

FLOWCHART OF THE MODEL

(i) *s*(*t*) and excess demand e(s) of noise traders is given by the Langevin equation associated with the Master equation of imitation and tracking momentum.

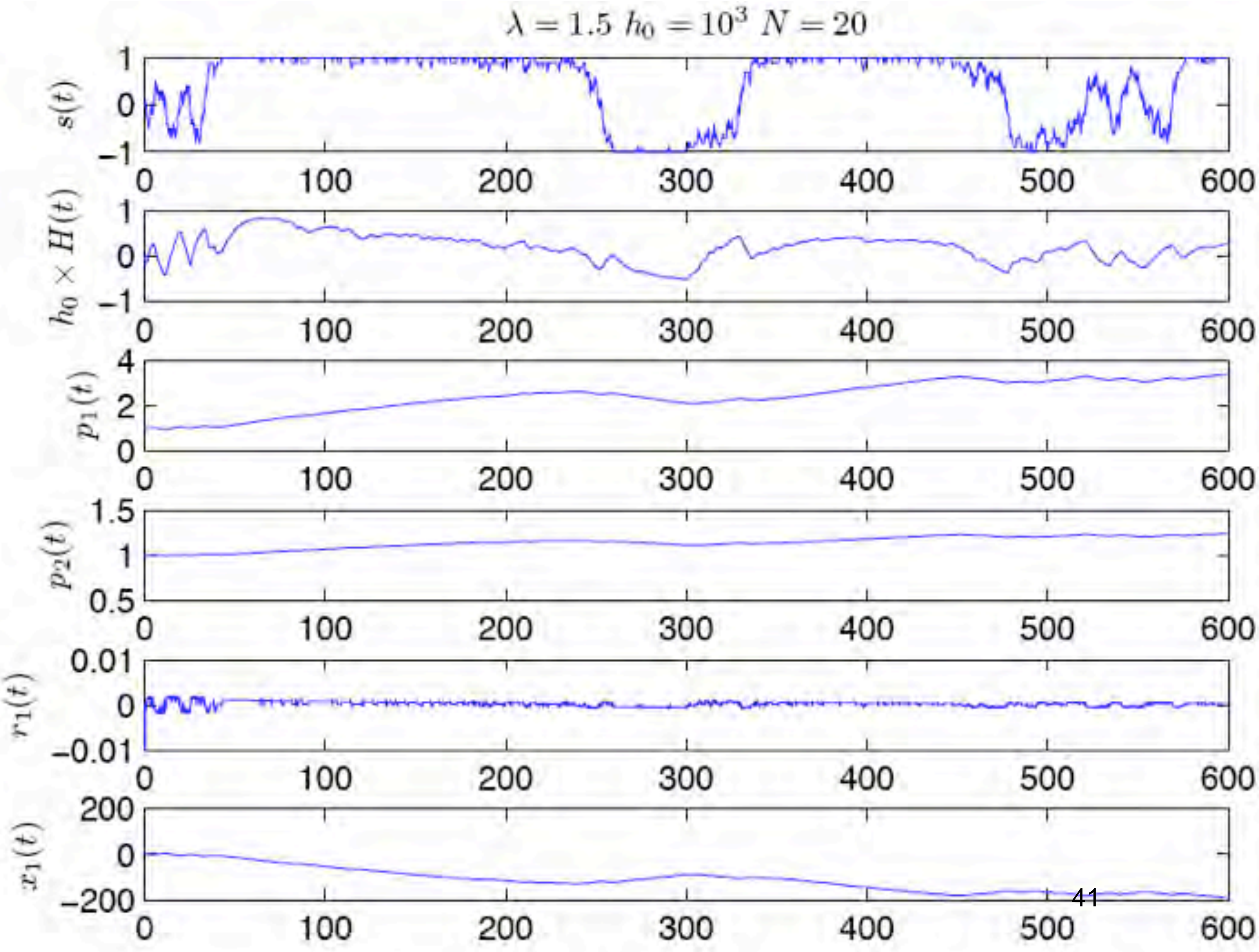
(ii) Balance of supply-demand determines the excess demand of the rational traders

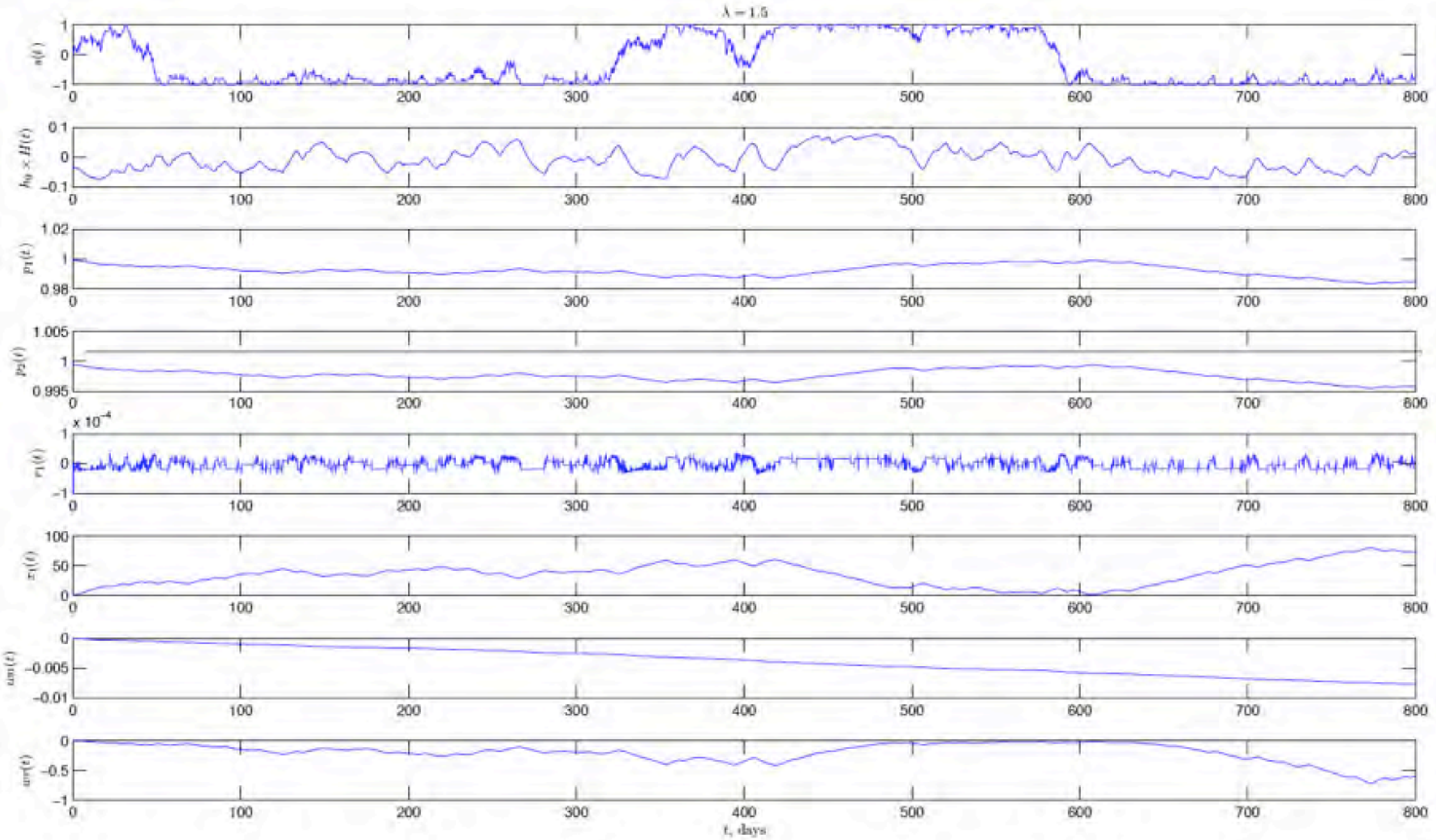
(iii) market-clearing determines prices of Internet and non-Internet stocks

(iv) Knowing the new prices, the noise traders can determine the new momentum and update *H*(*t*).

(v) Knowing *H*(*t*), we can go back to step (i).

$$\lambda_f = 1 \quad \gamma = 5 \quad \sigma_1 = 0.05 \quad \sigma_2 = 0.01 \quad \rho = 0.5 \quad x_2 = 1$$


$\lambda = 1.5\ h_0 = 10^3\ N = 20$
$s(t)$
$h_0 \times H(t)$
$p_1(t)$
$p_2(t)$
$r_1(t)$
$x_1(t)$
0
100
200
300
400
500
600



$$wn_k = wn_{k-1} + e_k \times r_{1,k}$$

$$wr_k = wr_{k-1} + x_{1,k} \times r_{1,k} + x_{2,k} \times r_{2,k}$$

Increase in the number of noise-trader increases the turnover of internet stocks by noise-traders, $\lambda>1$.

When the number of noise traders who are new to the stock market increases>1, the rational expectation equilibrium which is the unique equilibrium is unstable, and appears new bear-market equilibrium and bull-market equilibrium both of which are stable.

Price can either enter a bull market or a bear market. That is, when the initial value of , the internet stock price enter a bubble phase, and visa versa.

The on-line investors of the late 1990s, who are considered as the noise traders in our model, were new to the market and inexperienced. This fact means that the noise traders are potentially buyers of the internet stock because they tend to sell only stocks they already own. Therefore, when the number of the noise-traders increases, the initial value of s at time 0 tend to become positive. As a result, the internet stock enters a bubble phase with almost certainty.

Run-up in the internet-stock price which is due to increases in the noise-traders' excess demand increases momentum H because the risk premium rises positively.

The increases in the momentum next pull up the point of the bull-market equilibrium. The excess demand for the internet stock by noise-traders is increased according to popularity to the internet stock.

As the noise-traders' excess demand is positive and increases, the price of the internet stock increases and is over-evaluated. Thus, the momentum H increases in the first half of bubbles. This inflationary spiral gives cause to internet bubble.

For$1<\lambda$ and large H, the bear-market equilibrium disappears, and the bull-market equilibrium is the unique and stable equilibrium. Thus, bubbles persist until the imbalance of buyers and sellers, arrives at the bull-market equilibrium .

In the second half of bubbles as the bull market equilibrium is approached, a rise in the internet-stock price slows down. Thus, the risk premium for the internet stock H is decreasing and become negative in its final stage of bubbles.

Decreasing the momentum H changes the bull-market equilibrium downward, so that the noise traders' excess demand for the internet stock declines, and the internet-stock price decreases. As momentum decreases, the bear-market equilibrium appears again. This deflationary spiral continues to decrease until a critical threshold.

A crash can be suddenly caused by a trifling bad in the end stage of bubbles. In an instant when H falls below H^*, the noise traders sell the internet stock all at once. In our model the market crash is considered as the so called first-order phase transition.

Conclusions

- ENDO-EXO view of bubbles and crashes; Transient runs of news are sufficient to trigger large crashes in a system of over-learning and over-controlling agents
- Interplay between local imitation (within noise traders) and global imitation (momentum) leads to a competition between fundamental, bull and bear equilibria
- Coherent story of the bubble-crash sequence
- Mechanism for transition to bubble phase by increasing (i) position size, (ii) networking an (iii) newcomers.