Why is there excess volatility?  
An explanation based on stochastic resonance

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What is excess volatility?

- Too big changes in stock prices compared to changes of their fundamentals like corporate earnings, dividends, interest rates [1].

- First documented by Robert Shiller in 1981 [2], where he found that the volatility of the S&P 500 is 5-13 times too high compared to the volatility of information about future dividends.

What is excess volatility?

- Dividend Discount Model:

\[ p_t = \sum_{k=1}^{\infty} \frac{d_{t+k}}{(1+r)^k} \]

- Because the future dividends are unknown:

\[ p_t^* = \sum_{k=1}^{\infty} \frac{d_{t+k}^*}{(1+r)^k} \quad \leftrightarrow \quad p_t = E_t[p_t^*] \quad \leftrightarrow \quad p_t^* = p_t + u_t \]

\[ \sigma(p) \leq \sigma(p^*) \]
What is excess volatility?


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.
Basic ideas of the model:

Agent $i$ receives information from their network of colleagues and news. This information is private to them. The question they ask is: "What should I do?"
Basic ideas of the model:

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

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ABSTRACT

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 model:

Updating:

- \[ s_i(t + \delta) = D \left( k(t) \sum_{j=1}^{N} \omega_{ij} \cdot s_j(t) + f(t) + \Theta_i(t) \right) = a(t + \delta) \]
  - \( \delta = \frac{1}{N} \)
  - imitating term
  - news term
  - idiosyncratic term

- \[ D(x) = \text{sign}(x) \quad \text{or} \quad D(x) = x \quad \text{or} \quad D(x) = \text{sign}(x) \cdot \text{Heaviside}(|x|\text{-threshold}_i) \]

- return: \[ r_\Delta(t) = \sum_{\tau=1}^{\Delta} a(t + \tau \delta) \]

- \[ \log \left[ \text{price}(t + \Delta) \right] = \log \left[ \text{price}(t) \right] + r_\Delta(t) \]
The model:
Control parameters:

- $N$, the number of agents
- $\omega_{ij} = \frac{1}{\text{# of neighbors}}$
- $f(t)$ is a Gaussian white noise, with $f(t) \sim N(0, A^2)$
- $\Theta_i(t) \sim N(0, Q^2)$
- $k(t)$, dynamic coupling constant
Some results:
Some results:

\[ k = \text{constant} \]

approximation, MF-equation & ABM

signal = white noise, \( A = 0.01 \); ABM with size=\( 10^4 \)

increase of volatility by tuning \( k/Q \)
What is stochastic resonance?
Some results:

$k = \text{constant}$

Mean Field; signal WHITE-NOISE

size = 10000; A = 0.02

increase of volatility $\rightarrow$ decrease of cross-correlation
Some results: $k = \text{dynamic}$
Conclusions:

- We are able to explain excess volatility, having its origin in the interaction of the agents with private information.
- Increase of volatility (stochastic resonance) in a wide range of parameters and setups.
- Few assumptions are needed: 1) interacting agents, 2) distribution of personal information, 3) external influence.
- Clustered volatility originates from the dynamics in the coupling strength.
Outlook:

- Different network-topologies
- Solving for different demand functions $D$
- Endogenize the dynamics of the coupling strength
- Dependence of the results with the time window $\Delta$ of returns
- ...

Q=1.0; A=0.06

- News
- k
- Returns

Auto-correlation(τ)

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