Economic Crises: Natural or Unnatural Catastrophes?

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Black Swan

Crises as Rare Events

- *"*With notably rare exceptions (2008, for example), the global "invisible hand" has created relatively stable exchange rates, interest rates, prices and wage rates.*"*
- *Alan Greenspan, Former Chairman of the Federal Reserve Bank*
- "With notably rare exceptions, Germany remained largely at peace with its neighbours during the 20th century."
- "With notably rare exceptions, Alan Greenspan has been right about everything."
- *Comments on the blog Crooked Timber*

Analogies

- Monday, October 19, 1987, a drop in the Dow Jones Industrial Average of 22.6% -- the largest single day drop in history.
- *« I was stunned. It was almost surreal. It was so rapid. It hit you all at once. I equate to a category five hurricane. »*
- Robert Hormats of Goldman Sachs,

The nature of economic crises

- Standard macroeconomic models do not contain the possibility of a crisis in the sense of the one that we are currently experiencing
- The only changes that can knock an economy off its equilibrium track are caused by exogenous shocks and by assumption the economy returns to equilibrium.
- The latter are given very superficial explanations such as « technological shocks » or « important and unexpected news ».
- But these shocks are not directly measured nor is much said about their distribution

Confidence in our theory

The "central problem of depression-prevention has been solved," , Robert Lucas 2003 presidential address to the American Economic Association.

In 2004, Ben Bernanke, chairman of the Federal Reserve Board, celebrated the « Great Moderation » in economic performance over the previous two decades, which he attributed in part to improved economic policy making.

The view of those responsible in the U.K

- « But there is also a strong belief, which I share, that bad or rather over-simplistic and overconfident economics helped create the crisis. There was a dominant conventional wisdom that markets were always rational and self-equilibrating, that market completion by itself could ensure economic efficiency and stability, and that financial innovation and increased trading activity were therefore axiomatically beneficial. »

  Adair Turner, Head of the U.K.
  Financial Services Authority

The Ex Governor of the European Central Bank

- When the crisis came, the serious limitations of existing economic and financial models immediately became apparent. Arbitrage broke down in many market segments, as markets froze and market participants were gripped by panic. Macro models failed to predict the crisis and seemed incapable of explaining what was happening to the economy in a convincing manner. As a policy-maker during the crisis, I found the available models of limited help. In fact, I would go further: in the face of the crisis, we felt abandoned by conventional tools. In the absence of clear guidance from existing analytical frameworks, policy-makers had to place particular reliance on our experience. Judgement and experience inevitably played a key role. Trichet (2010)

Different dynamics

- In the face of repeated, if infrequent crises should we not question our models where sudden changes are attributed to exogenous shocks? Rather than trying to return to our basic assumptions perhaps we should rethink the whole structure.
- Ben Bernanke « The brief market plunge was just an example of how **complex and chaotic, in a formal sense**, these systems have become… What happened in the stock market is just a little example of how things can cascade, or how technology can interact with market panic »

Interview with the IHT May 17th 2010

Bringing Crises to Centre Stage

- Rather than build more and more sophisticated models which « work well » in non-crisis situations should we not build models in which endogenous crises can occur
- Understanding crises is surely more important than modelling economies which are not in trouble
- Remember the « black swan ».

Bob Solow's View

- Maybe there is in human nature a deep-seated perverse pleasure in adopting and defending a wholly counterintuitive doctrine that leaves the uninitiated peasant wondering what planet he or she is on.—Robert M Solow 2009

Self Organisation

- This idea that markets self organise was espoused by Hayek
- This has been used as a justification for not interfering with markets.
- Markets do clearly self organise but we have no reason to believe that this is a stable process.
- As the actors within them modify their rules new norms appear and these can gently lead the system to major “phase transitions”.

The crucial role of information

Underlying the faith in the capacity of markets to self organise in a stable way is the « efficient markets hypothesis » But as Greenspan observed,

« The whole intellectual edifice collapsed in the summer of last year »

Alan Greenspan, testimony to House of Representatives Committee on Government Oversight and Reform, October 23rd 2008

A Warning

- Quand des hommes sont rapprochés, ils ne se décident plus au hasard et indépendamment les uns des autres ; ils réagissent les uns sur les autres. Des causes multiples entrent en action, et elles troublent les hommes, les entraînent à droite et à gauche, mais il y a une chose qu'elles ne peuvent détruire, ce sont leurs habitudes de moutons de Panurge. Et c'est cela qui se conserve

Henri Poincaré La Valeur de la Science 1908

Isaac Newton

« I can calculate the motion of heavenly bodies,
but not the madness of people »

No Panic!

Looking into the sky quickly gets passers-by to follow.


A week on the wild side
I'VE GOT A STOCK HERE THAT COULD REALLY EXCEL!
REALLY EXCEL?
EXCEL?
SELL?
SELL?
SELL
SE
SELL!
SELL!
SELL!
SELL!
ELL!
SELL!
GOOD BYE?
Bye?
Buy?
BUY!
Buy!
BUY!!!
Buy
Buy
Buy!
THIS IS MADNESS! I CAN'T TAKE ANYMORE
GOOD BYE!

Ants

- Ants learn in an environment of which they have only very limited and local knowledge.
- Yet they produce quite sophisticated aggregate behavioiur.

Ants learn to find the route to food

- Ants communicate with each other
- either through a pheromone trail
- or by tandem recruiting.

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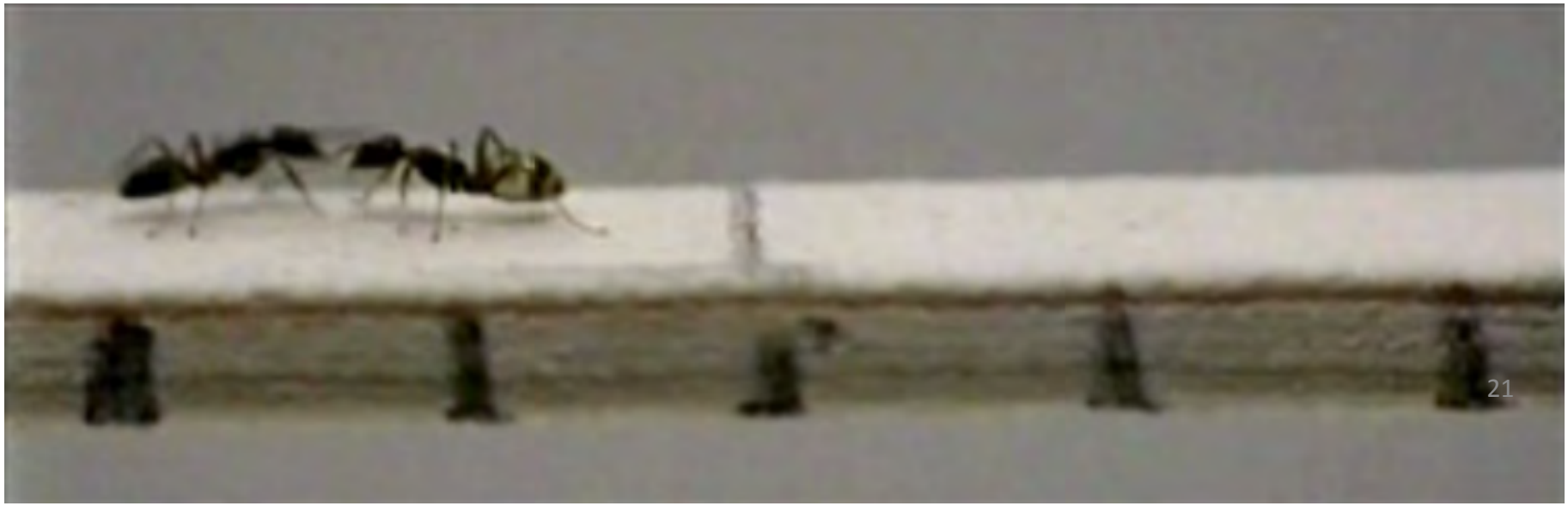

Ants learn to find a source of food

- Ants communicate with each other
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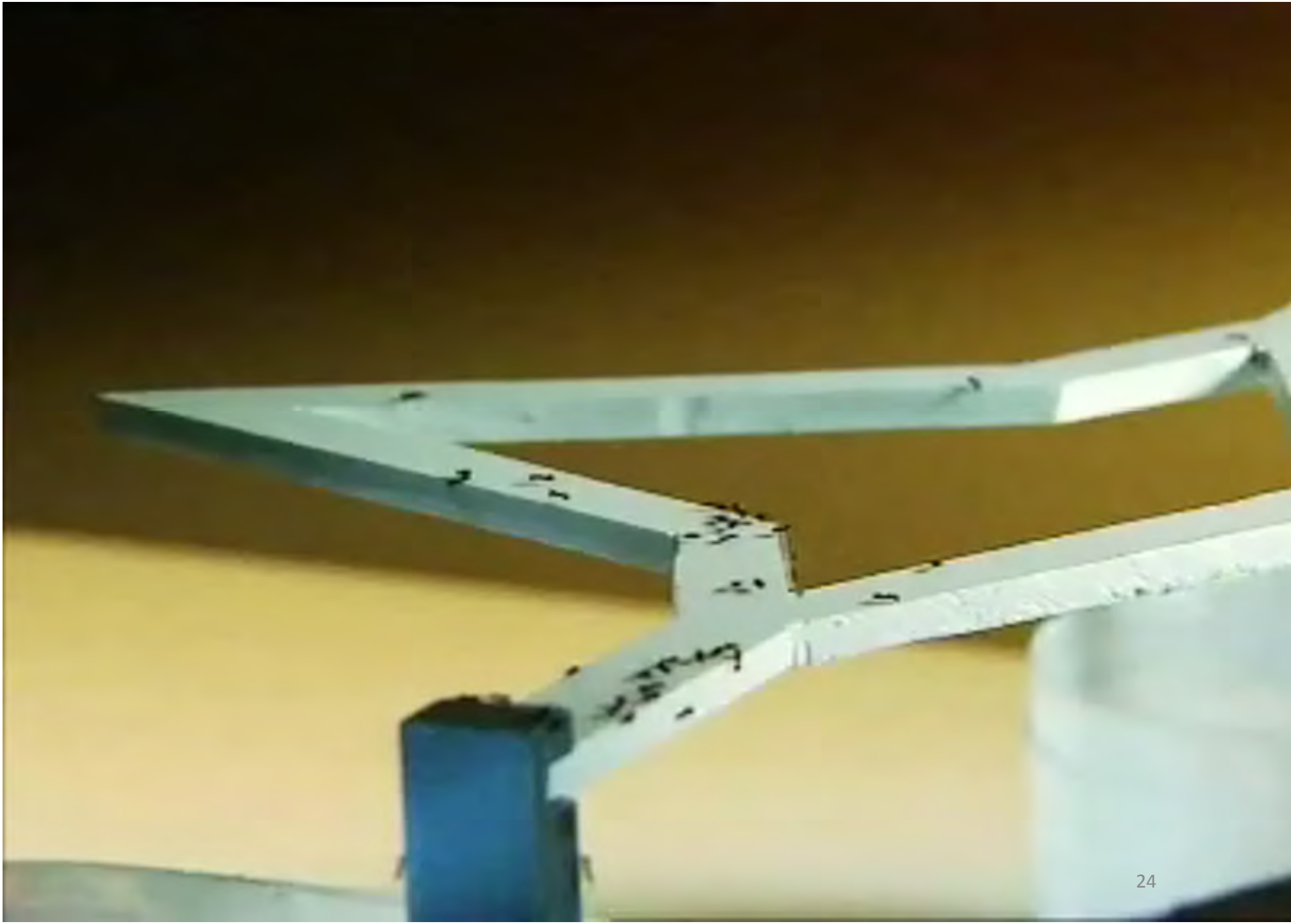
- or by tandem recruiting.



How might we use this idea to model financial markets?

- Think of two types of agents or forecasting rules
- Fundamentalists who believe that prices will come back to some « fundamental » level
- Chartists who extrapolate from previous prices.
- Success of one rule reinforces the recruitment to that rule.

Models in this spirit

- With Hans Foellmer and Ulrich Horst,we have built models of financial markets to help understand where these sudden changes come from
- These models incorporate the idea that people follow the behaviour of others particularly when that behaviour is successful
- The behaviour is not irrational. Horizons.
- These models capture the contagion effects
- There is structure in financial time series but no convergence to equilibrium in the standard sense.

A Microstructure Model for Financial Markets

• Temporary equilibrium model for stock price dynamics.

• Heterogeneous agents: fundamentalists and chartists.

• Agents follow the recommendations of financial "gurus".

• Propensities to follow individual gurus depend on the gurus' Performances → reinforcing learning effect.

• Stock prices are driven by the fluctuations in the gurus' market shares and aggregate liquidity demand → feedback effects.

• Spontaneous herding generates temporary bubbles and crashes.

• Prices temporarily deviate, but inevitably return to fundamentals.

We study a financial market model where temporary bubbles occur,
But where the overall behavior of the asset price process is ergodic.

The Distribution of Stock Prices

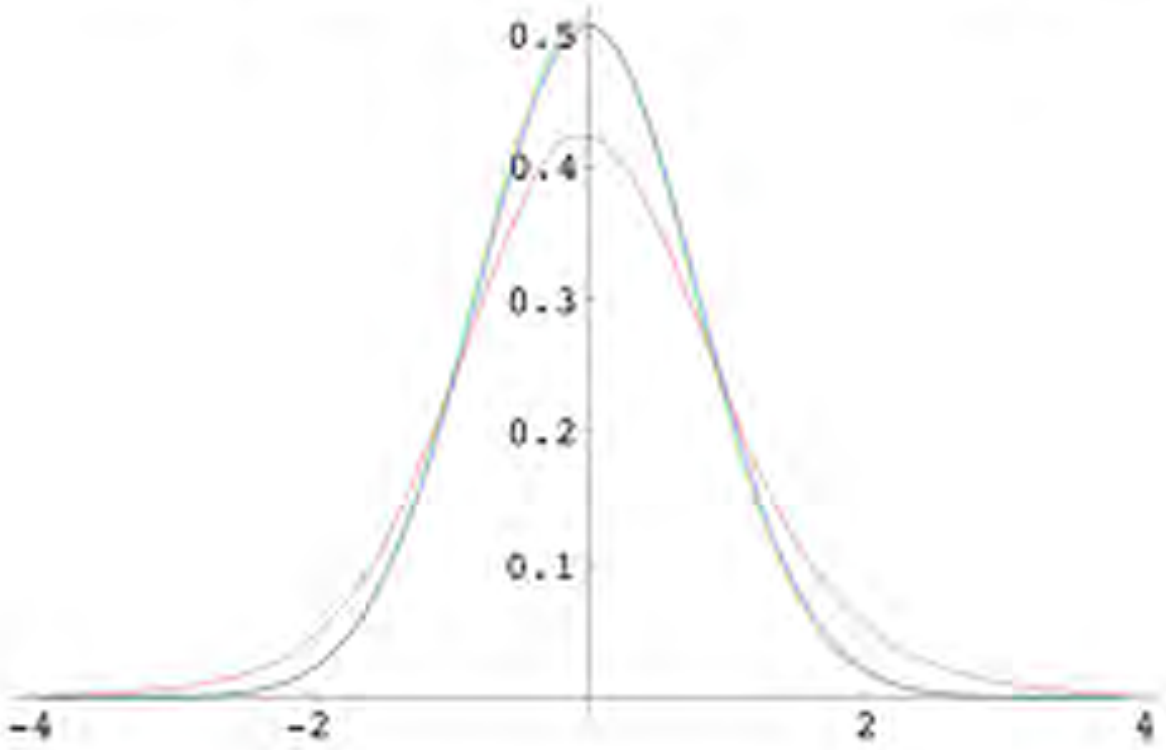


Figure 1: Empirical stationary distribution of asset prices in a model with (red) and without (green) chartists.

Bubbles and Crashes

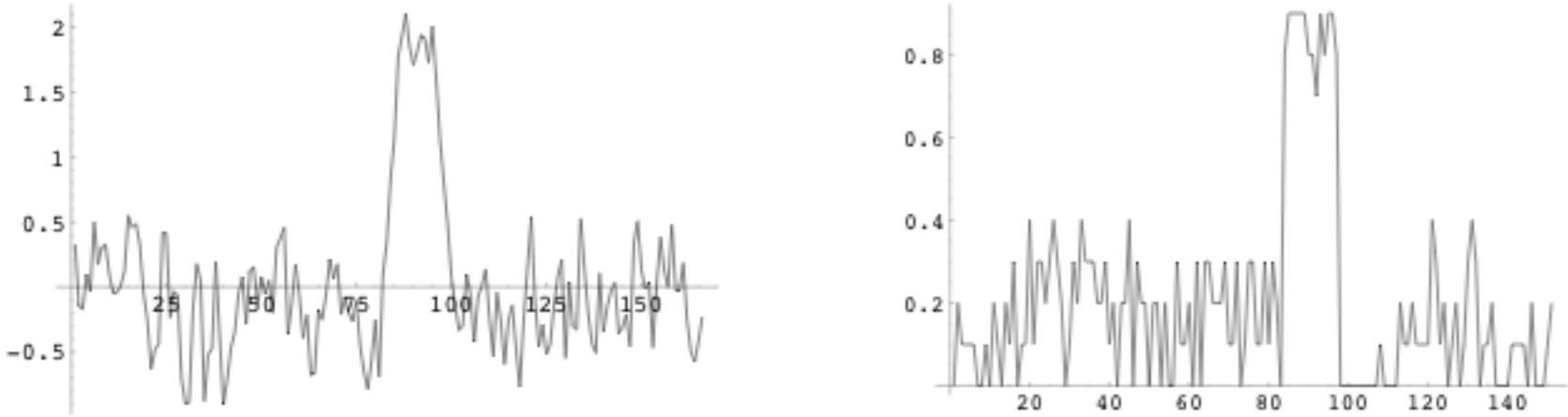


Figure 2: A bubble and the corresponding fraction of chartists.

Derivatives Warren Buffett

- The derivatives genie is now well out of the bottle, and these instruments will almost certainly multiply in variety and number until some event makes their toxicity clear. Central banks and governments have so far found no effective way to control, or even monitor, the risks posed by these contracts. In my view, derivatives are financial weapons of mass destruction, carrying dangers that, while now latent, are potentially lethal.

- Warren Buffet 2002

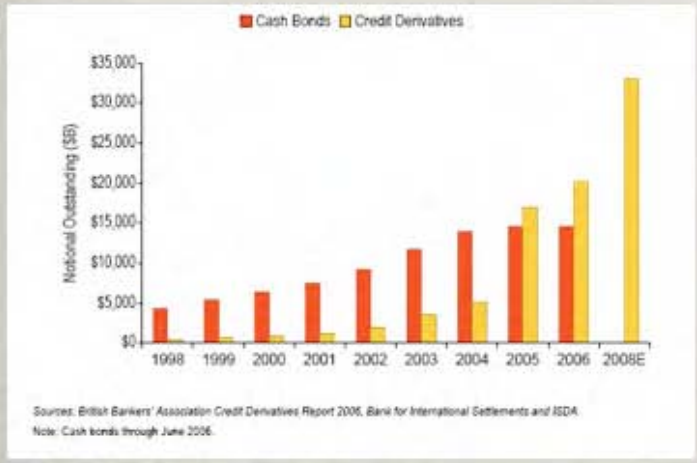
A Very Simple Example

- So what we must do is to build models which capture the role of the interaction between individuals, their local rationality and the impact of this on the aggregate evolution of the market or economy.

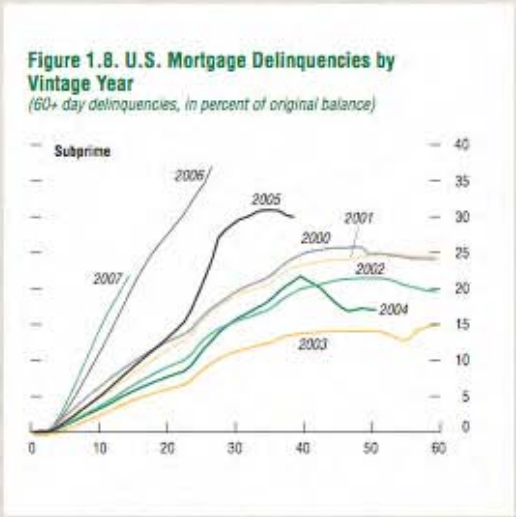
- The idea of our example is to show how the gradual but rational adoption of rules at the individual level may lead to radical change at the aggregate level

Historical motivation

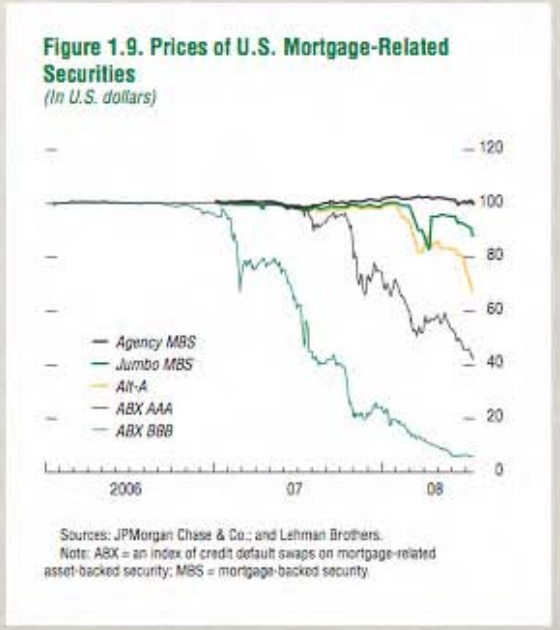
1. trading complex credit derivative products without really understanding what they're worth



2. ... in the face of bad news accumulating ...



3. Crash!!!



Why so sharp?

Figures from Global Financial Stability Report Oct. 2008

THE MODEL: RULE EPIDEMICS

- The rule:
  buy an ABS without checking whether it is "toxic" or not

- Strategy: follow the rule (z_i=1, i=1,...,N labels agents)
  don't, i.e. check before buying (z_i=0)
  Idea: checking is costly, if majority follows the rule, then I better follow it too

- Prob{ABS is toxic when checked} = p (bad news: p larger than expected)

- Agents connected in a network (OTC market):
  i trades with j drawn at random among his neighbors

- Payoffs: pay a price p_0 to seller
  resell at $p_2 < p_0$ if buyer checks & ABS toxic
  resell at $p_1 > p_0$ else
  checking costs $-\chi_i$ (drawn from pdf $\Phi(\chi)$)

  (reduce # params. by rescaling: $p_1-p_2=1$, $c=p_0-p_2$)

	check & toxic	no check
$z_i=0$	$-\chi_i$	$1-c-\chi_i$
$z_i=1$	$-c$	$1-c$

Analysis

- Expected payoffs:

$$\begin{aligned} u_i(z_i = 1) &= E_j\left[-p(1-z_j)c + [1-p(1-z_j)](1-c)\right] \\ &= 1 - p(1-\bar{z}_i) - c \end{aligned}$$

$$u_i(z_i = 0) = (1-p)(1-c) - \chi_i \qquad \bar{z}_i = \frac{1}{|N_i|}\sum_{j \in N_i} z_j$$

- Best response:

$$\begin{aligned} z_i^* &= \theta\left(u_1(1) - u_i(0)\right) \\ &= \theta\left(p(\bar{z}_i - c) + \chi_i\right) \end{aligned}$$

- Nash equilibria?

Mean field analysis

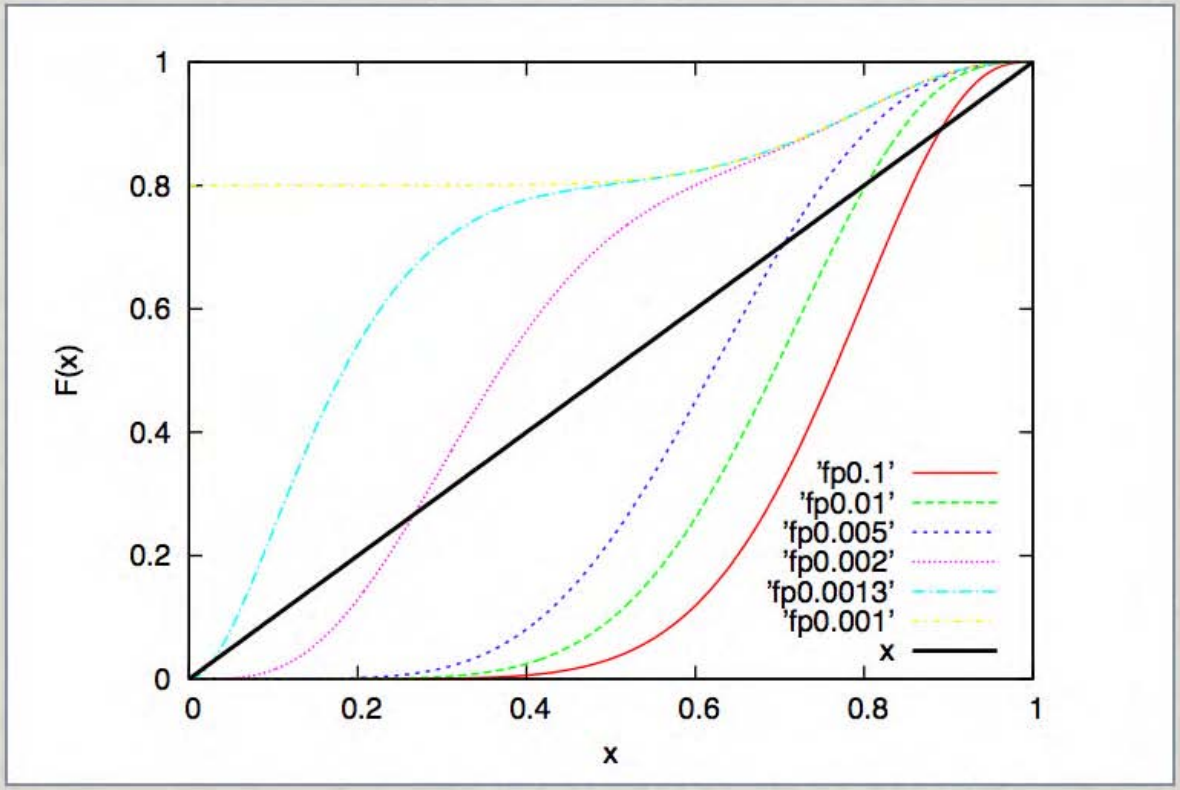
- Regular random graph ($|N_i|=k$ for all i)

$$\pi(\chi) \equiv P\{z_i^* = 1 | \chi_i = \chi\} = \sum_{\ell > (c-\chi/p)k} \binom{k}{\ell} \bar{\pi}^\ell (1-\bar{\pi})^{k-\ell} \qquad \bar{\pi} = E_\chi[\pi(\chi)]$$

- Taking expectation over $\chi_i \Rightarrow$ self-consistent equation

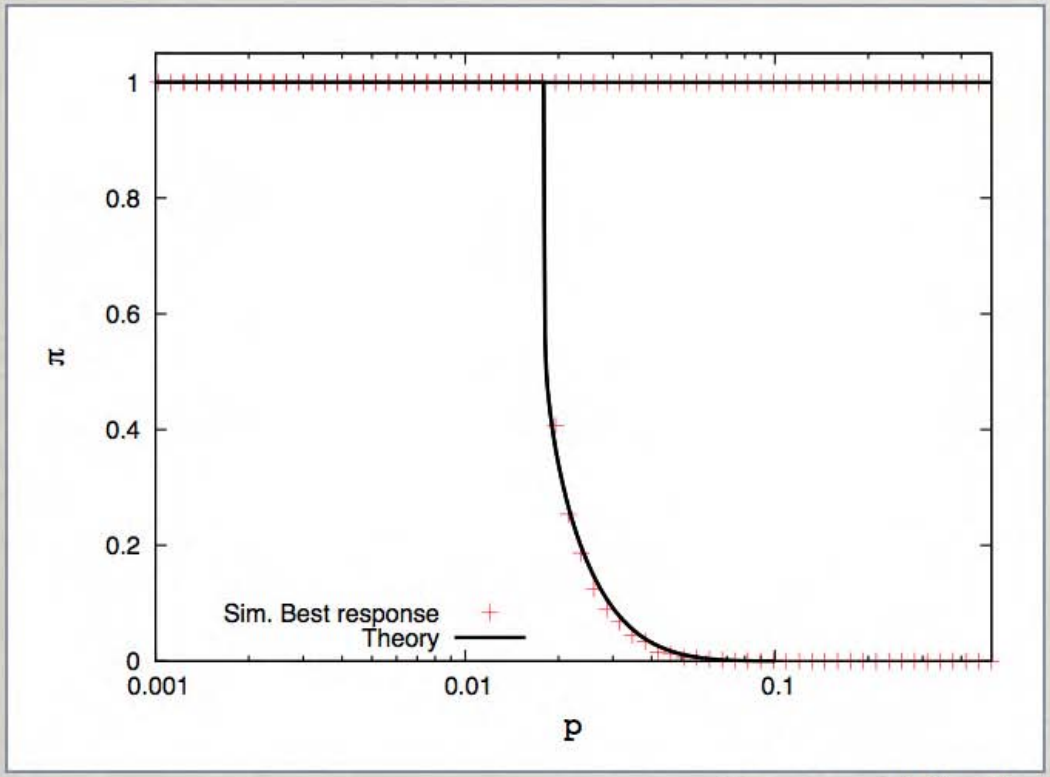
$$\begin{aligned} \bar{\pi} &= E\left[\chi_i > p(c - \bar{z}_i)\right] \\ &= \sum_{\ell=0}^{k} \binom{k}{\ell} \bar{\pi}^\ell (1-\bar{\pi})^{k-\ell} P\{\chi > p(c-\ell/k)\} \\ &= F(\bar{\pi}) \end{aligned}$$

THE FUNCTION $F(\bar{\pi})$



p=0.1, 0.01, 0.005, 0.002, 0.0013, 0.001
χ_i = 0.01 for 80% of agents, 20% informed minority (χ_i=0)
k=11 neighbors, c=0.8

Coexistence



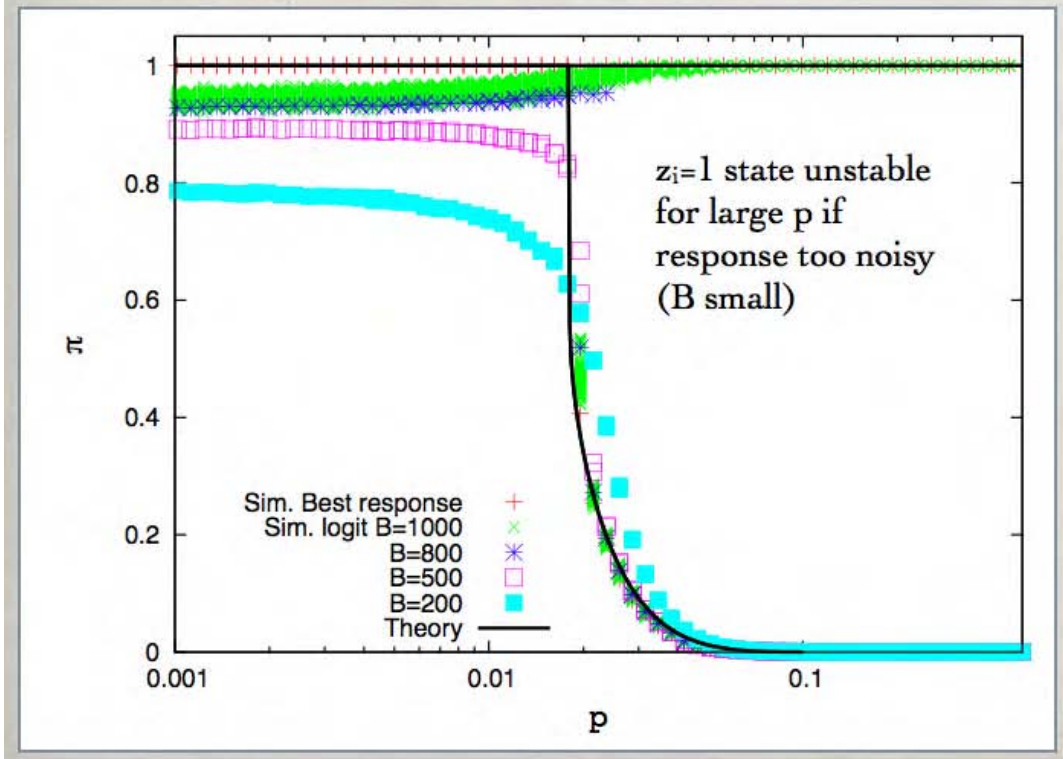
$z_i = 1$ for all agents is always an equilibrium

If p is small enough it is the only equilibrium

Exponential distribution of χ_i with $E[\chi_i]=0.01$
k=11 neighbors, c=0.9

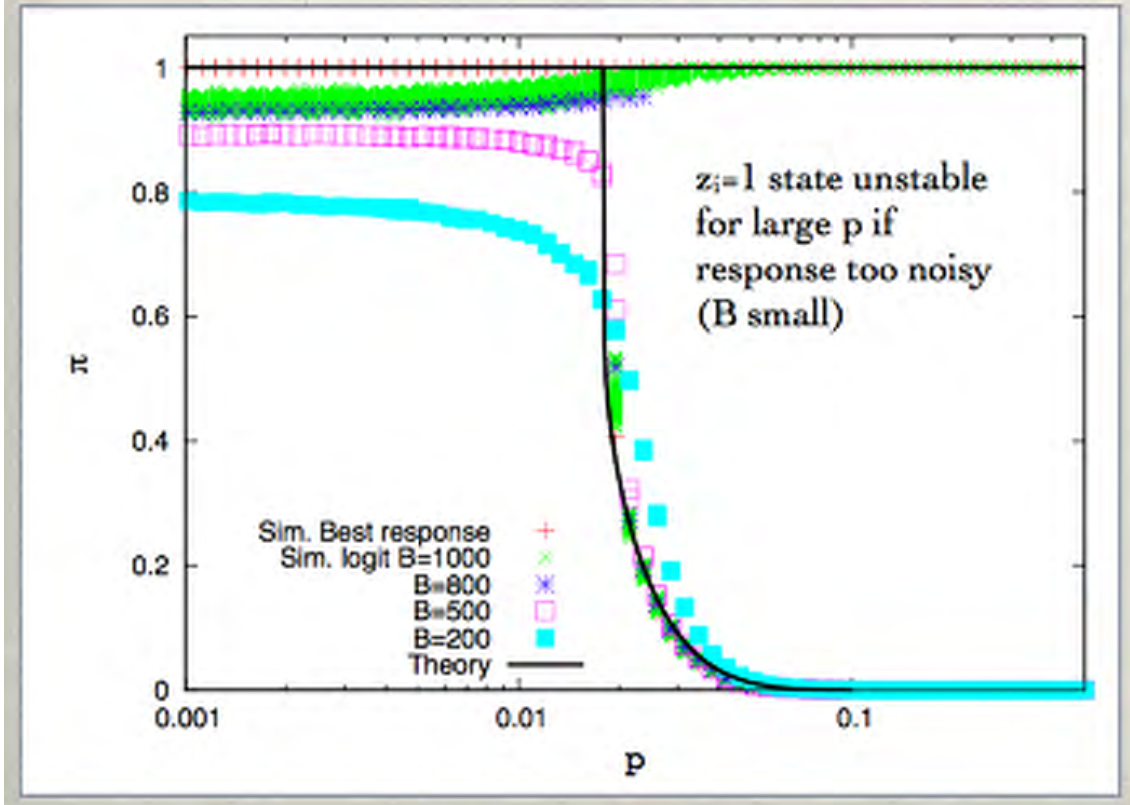
Noisy best response

Logit: $P\{z_i = 1\} \propto e^{B[u_i(1) - u_i(0)]}$

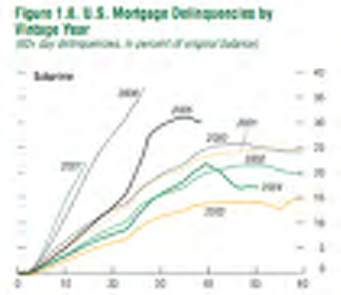


NOISY BEST RESPONSE

Logit: $P\{z_i = 1\} \propto e^{B[u_i(1) - u_i(0)]}$



Back to ABS story:



increasing p ...

... sharp transition!

Regulating this sort of system

- My main argument in this context is that the sort of complex system I have described is intrinsically difficult to control
- What we do not have in our model is an essential feature that as the actors find it profitable to make loans they will gradually lower their standards
- This will, in turn, lead to an increase in *p*

Regulating this sort of system

- If we put in place a set of constraints and rules today they will have to be continually adapted as markets themselves adapt and self organise.
- Individuals act rationally given the limited and local information at their disposal but they may engender major changes in the aggregate
- We cannot simply design from scratch a « new regulatory framework » and then let things run.

How should we stabilise the system?

- The view that we can set up a new more sophisticated set of rules and then everything will be under control is illusory.
- It is based on the idea that there is a « correct » model and that, and if only we can find it we can establish the right rules and leave markets to sort things out.
- But, in reality there is no reason to believe that self organisation is a stable process and furthermore the economy is constantly evolving and and therefore so must the rules.

Conclusion

- In a world where individuals interact with each other locally and with limited information, the collective behaviour of the system may undergo sudden and large changes without any « exogenous shock ». Asset markets, particularly derivative markets, are vulnerable to these. They are not the result of individual irrationality but of the intrinsic fragility of such systems.

How long will it take?

« A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it »

Max Planck, A Scientific Autobiography (1949).

"You want to keep an open mind but you don't want to open it so far that your brain falls out."

Buz Brock

For those who wish to know more