# Toward a trans-disciplinary econophysics?

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## I. The existing financial economics

- A priorist approach
- Does it matter ?

## II. Definition and emergence of Econophysics

## III. Contributions of Econophysics: statistical econophysics vs agent-based econophysics

- Statistical econophysics
- Agent-based econophysics

## IV. Toward a trans-disciplinary econophysics?

- Why a unified framework ?
- What about potential collaborations between economists and econophysicists?

# I. The existing financial economics

- Financial economics deals with matters related to markets and money.
- A field concerned with resource allocation and resource management, acquisition and investment allowing actors to achieve goals.
- Financial economics is pedagogically divided into Corporate Finance and Market Finance

# I. The existing financial economics:

- *Lemma/theorem* style is required: *A priorist* perspective (equilibrium and Gaussian framework is assumed, for example)

- Little effort to compare *theoretical* predictions to *"experimental data"* (data mining is used in econometrics)

- Key papers (ex: Harrison, Kreps and Pliska, 1979, 1980, 1981) are *inaccessible* and of no interest to *practitioners* of the field

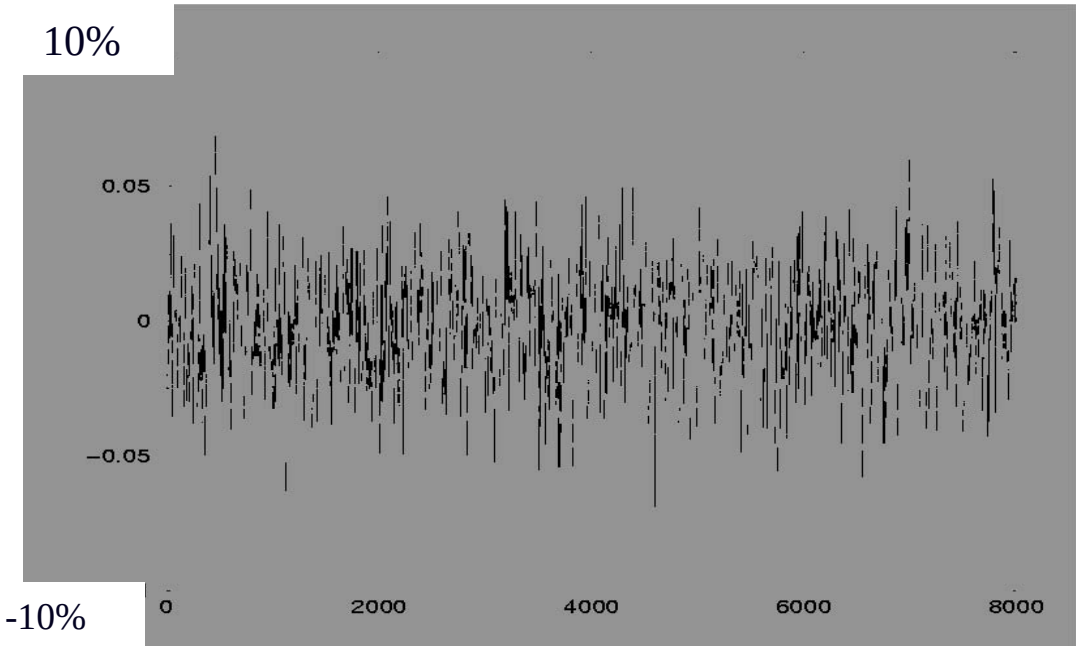
# I. The existing financial economics

*A priorist* perspective: Importance of Gaussian framework

Fluctuations of financial prices p(t) are seen as a random walk,

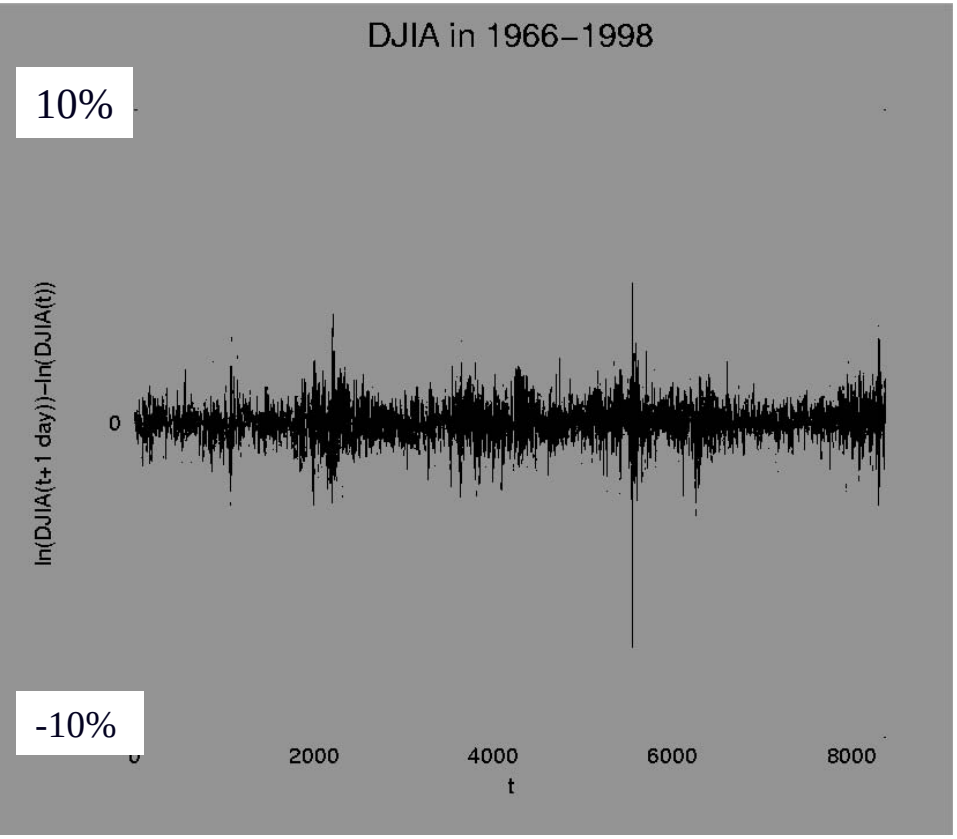
$$\ln[p(t+\Delta t)]=\ln[p(t)]+\eta_{\Delta t}(t)$$

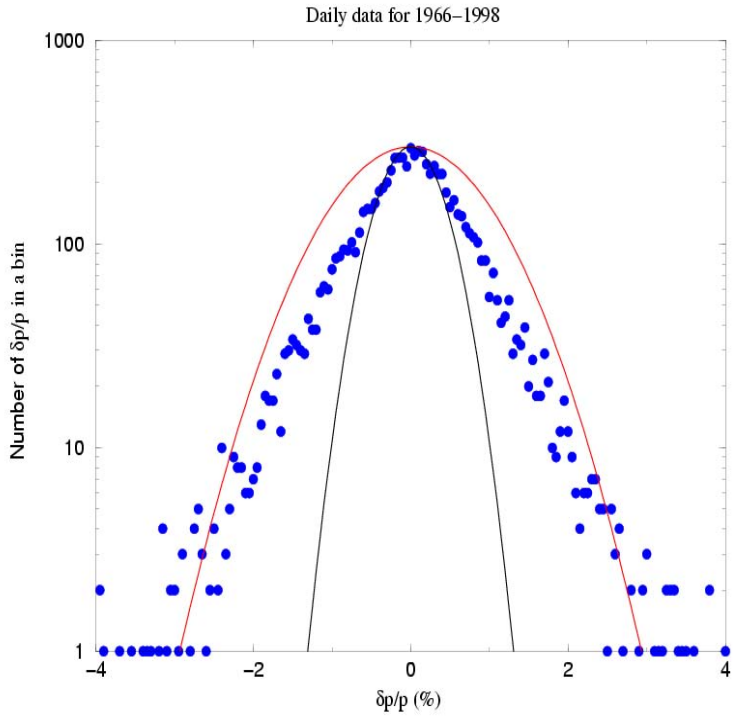
where η(t) is a gaussian uncorrelated random variable




Maslov (2002)

# I. The existing financial economics
## (example 1966-1998, Maslov, 2002)




In a gaussian world the probability of the October 1987 crash would be $10^{-135}$!

# I. The existing financial economics – does it matter ?

- Financial industry (Insurance companies, banks etc) assuming normal risk would go broke via unexpected occurrence of large events

- What if economists treat economies this way? Encourage policies that make economy more fragile because of excessive belief in robustness ?

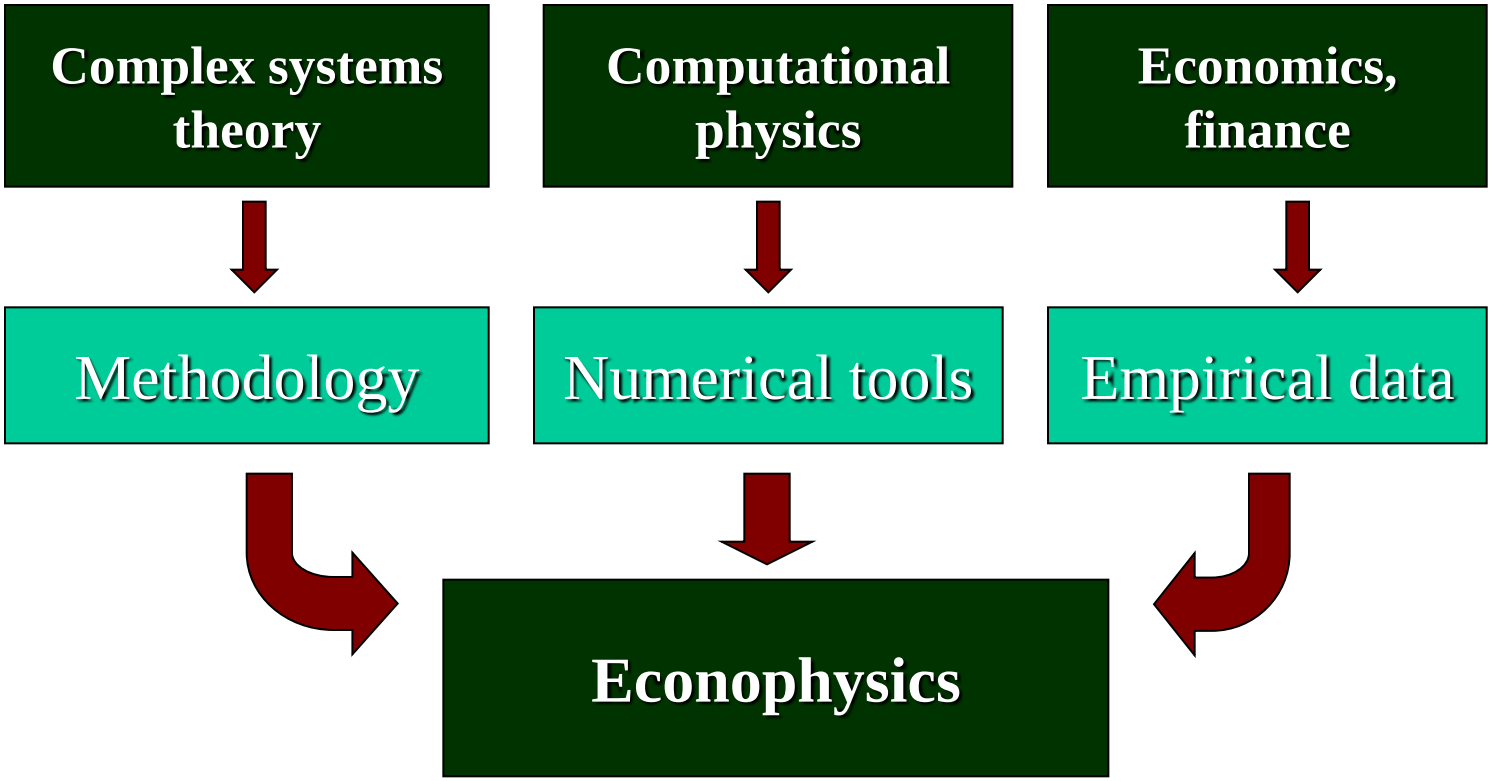
"Most of the quantitative studies of optimal monetary policy have also assumed that the shocks hitting the economy have a time-invariant Gaussian distribution" Mishkin (Monetary Policy Strategy: Lessons from the crisis", NBER, 2011)

"Existing theories about the behavior of stock prices are remarkably inadequate. They are of so little value to the practitioner that I am not even fully familiar with them. The fact that I could get by without them speaks for itself." G. Soros, *Alchemy of Finance* 1994.

# II. Definition and emergence of econophysics

- Statistical Physics applied to economics & finance
- ≠ importation of physics concepts in economics
- Importance of the instability (vs equilibrium in economics
- Data-driven models (vs axiomatic approach in economics)
- Financial markets = complex systems (emergent properties, scale invariance etc)

## II. Definition and emergence of econophysics




Agaev (2004)

# II. Definition and emergence of econophysics

Movement initiated in the 1970s – Sociophysics (Weidlich, 1971; Callen and al. 1974; Galam 1982 etc

It emerged in the 1990s (Mantegna (1991), Mantegna and Stanley (1994), Stanley and al. (1996) etc)

In the 1980s & 1990s, we observed a lot of modifications in the financial sphere:

- New data from financial markets (intra-day data)
- Higher liquidity and volatility
- Financial Crises (1987, 1998, 2008…)

## III. Contributions of Econophysics: Statistical econophysics vs Agent-based econophysics

**Statistical econophysics** is based on phenomenological regularities where the agents behaviour is random and the result is mathematically analogous to diffusion models in physics

- Agents are implicitly assumed to be heterogeneous but their behavior is seen too complex to be clarified through specific interaction rules

- Phenomenological description of the evolution of economic data

- Macro-perspective

## III. Contributions of Econophysics: Statistical econophysics vs Agent-based econophysics

For a decade, an **agent-based econophysics** has been developed. Agent-based approach is founded on computerized simulations of a large number of decision-makers which can interact through specified procedures

This methodology appeared in the 1990s as a new tool for empirical research in a lot of fields:

economics (Axtell, 1999), voting behaviors (Lindgren and Nordahl, 1994), military tactics (Illachinsky, 1997), organizational behaviors (Prietula and al. 1998), epidemics (Epstein & Axtell, 1996), traffic congestion patterns (Rasmussen and Nagel, 1994) etc

→ it is a computational method which can be applied in a lot of disciplinary contexts

## III. Contributions of Econophysics: Statistical econophysics vs Agent-based econophysics

Agent-based econophysics provides models in which,

- Agents are seen as interacting components and they have have learning abilities whose basic behavior can be clarified through interaction rules
- « No final equilibrium » situation
- Main objective is to reproduce empirical data
- Example: Donengelo and al (2000) or Shinohara and al. (2001) explained the emergence money through studying the dynamics of exchange in a system composed by learning agents

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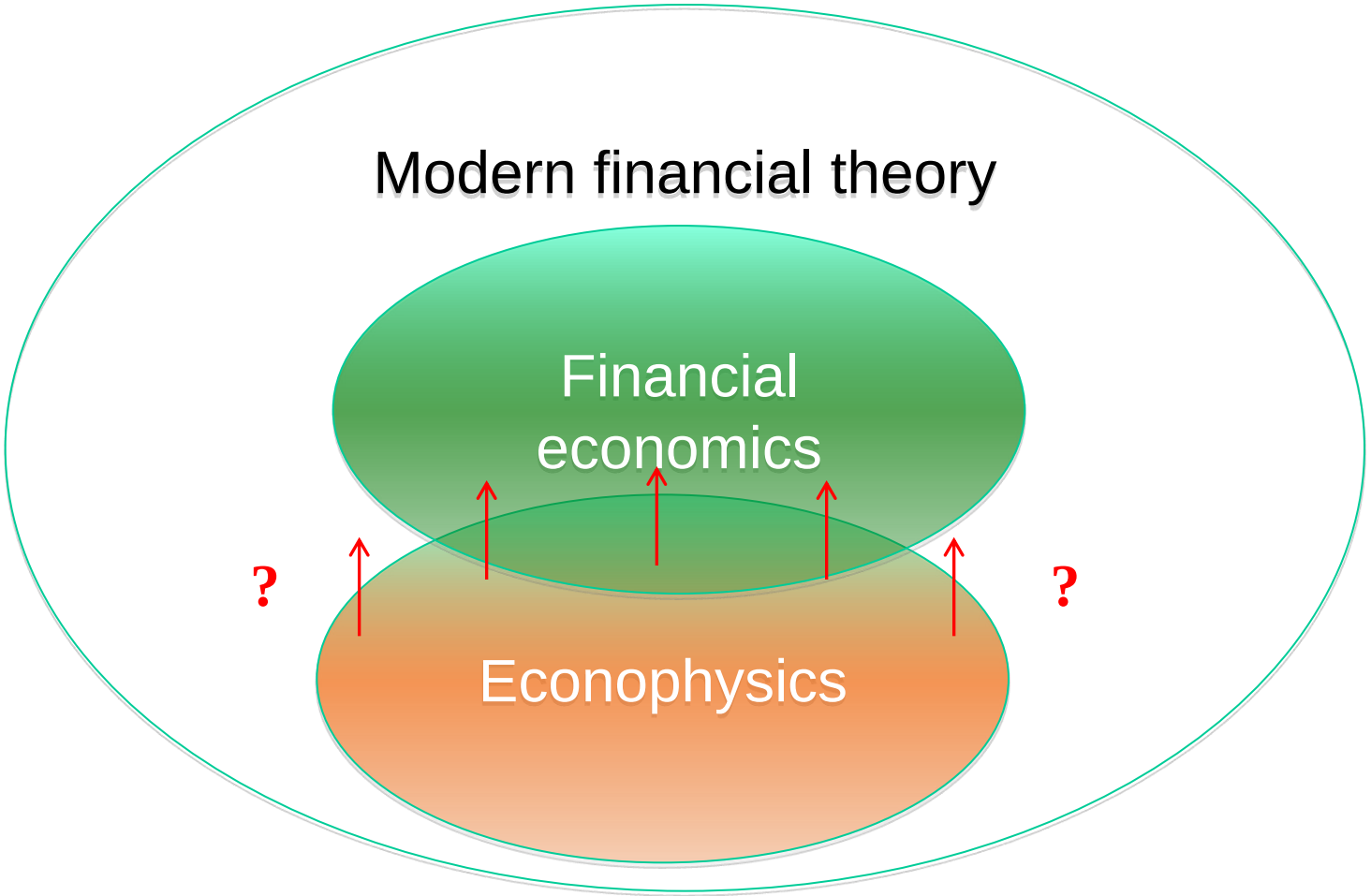
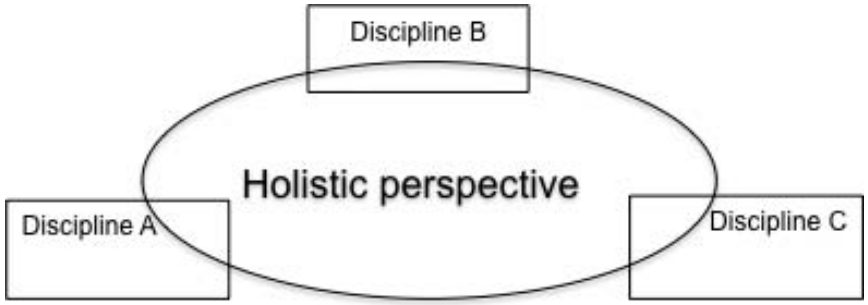
# IV. Toward a trans-disciplinary econophysics ?



# IV. Toward a trans-disciplinary econophysics ?




“Transdisciplinary projects are those in which researchers from different fields not only work closely together on a common problem over an extended period but also create a shared conceptual model of the problem that integrates and transcends each of their separate disciplinary perspectives” (Rosenfield 1992, p.55)

# Toward a trans-disciplinary econophysics ?

Why a unified framework ?

- Same subject of study (financial markets, money etc)
- Same concepts (emergence, complexity etc)
- Same methodological tools (agent-based modelling, stable Levy processes)

These concepts have a different meaning in financial economics and econophysics

Ex: emergence, stable Levy processes

## Toward a trans-disciplinary econophysics ?

Could agent-based econophysics be the conceptual bridge between finance and physics?

- It focuses on the mathematical modelling of atomistic agent (// financial economics)
- Condition of rationality can be seen as a specific case (// financial economics)
- It reproduces no Gaussian processes described by statistical econophysics by giving them micro-foundations (// econophysics) – Schinckus (2013)
- It clarifies the notion of emergence which appears to be
  - the macro-result of complexity in econophysics
  - the macro-result of agents' rationality in financial economics.

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# Toward a trans-disciplinary econophysics ?

- Econophysics might finally make financial economics more data driven with less ideological considerations (such as “free trade is always better than protection”, “market prices are always better than subsidised ones”, “private is always better than public”…

- Economics might give more economic meaning to the interaction rules defined for agents…

# Before developing a trans-disciplinary econophysics

***Two necesary steps:***

1) Semantic step: Economists and Econophysicists use the same concepts but they implicitly mean something else.

⇨ Clarification of the used terminology is required

2) Sociological step: Economics and Physics are the two most "intra-disciplinary fields"

⇨ Economics is the most hermetic field with more than 87 percent of intra-disciplinary references.

⇨ is the second one citing physics journals in about 80 percent of their references.

Pieters & Baumgartner (2002), Gingras and Schinckus (2012)

# Toward a trans-disciplinary econophysics ?

***Potential Impact:***

1) Better understanding of complex social systems by emphasizing the contribution of statistical physics to financial economics.

2) A more realistic portfolio and risk management

3) A less ideological regulation

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**Thank you**
**for**
**your attention**