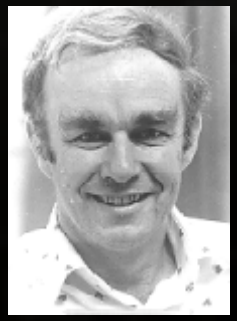
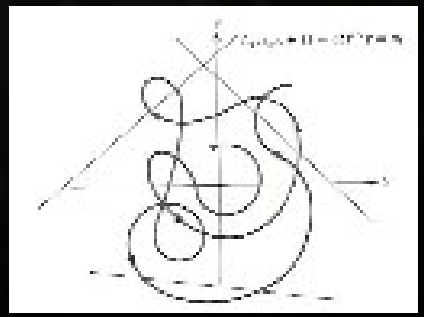
From market prices to market participants' behavior (and vice-versa): the SimTrade approach

By François Longin - ESSEC Business School

Symposium on Recent Advances in Extreme Value Theory
honoring Ross Leadbetter





18 - 20 March 2013, Lisbon

My mission statement

“Sharing my knowledge and experience
by associating training, research and business
with internet leverage.”

Plan

- Risk and uncertainty
- Stylized facts about financial asset prices
- SimTrade
  - Deep understanding of financial markets
  - Beyond statistics: explanation of stylized facts

Risk and uncertainty (1)

Risk and uncertainty (1)

- Franck Knight (1885 - 1972)
- Professor of economics
  at Chicago University

Risk and uncertainty (2)

- Franck Knight (1885 - 1972)
- Professor of economics
  at Chicago University
- Cofounder of the Chicago School
  (definitely an extremist)
- Author of a book « Risk, uncertainty and profit » (a reference)

An economic point of view of business (1)

- Business as usual
  - Economic theory says : in a competitive environnement, at equilibrium, the firm (managers / shareholders) doesn’t make any (economic) profit.
  - The remuneration of the firm is related to the risk that it has taken.
  - Just make money (usual returns)

An economic point of view of business (2)

- Innovative business
  - Knight says: the firm (the entrepreneur) may make a profit.
  - Make a fortune (extreme returns)
- Source: Knight (1921) « Risk, uncertainty and profit »

Risk and uncertainty (1)

- Risk
  - A probability can be associated to each event.
    - Theoretical model
      - Example: a perfect dice
    - Data and statistical model
      - Example: an imperfect dice that you have throwned *n* times.
- Uncertainty
  - A probability cannot be associated to events.
    - No theory, no data
      - Example: an imperfect dice that you haven’t thrown yet.

Risk and uncertainty (2)

- Our preliminary examination of the problem of profit will show, however, that the difficulties in this field have arisen from a confusion of ideas which goes deep down into the foundations of our thinking. The key to the whole tangle will be found to lie in the notion of risk or uncertainty and the ambiguities concealed therein. It is around this idea, therefore, that our main argument will finally center. A satisfactory explanation of profit will bring into relief the nature of the distinction between the perfect competition of theory and the remote approach which is made to it by the actual competition of, say, twentieth-century United States; and the answer to this twofold problem is to be found in a thorough examination and criticism of the concept of Uncertainty, and its bearings upon economic processes.
- But Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated. The term "risk," as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least, in their causal relations to the phenomena of economic organization, are categorically different. The nature of this confusion will be dealt with at length...but the essence of it may be stated in a few words at this point. The essential fact is that "risk" means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomenon depending on which of the two is really present and operating. There are other ambiguities in the term "risk" as well, which will be pointed out; but this is the most important. It will appear that a *measurable* uncertainty, or "risk" proper, as we shall use the term, is so far different from an *unmeasurable* one that it is not in effect an uncertainty at all. We shall accordingly restrict the term "uncertainty" to cases of the non-quantitive (sic) type. It is this "true" uncertainty, and not risk, as has been argued, which forms the basis of a valid theory of profit and accounts for the divergence between actual and theoretical competition.
- —*Risk, Uncertainty and Profit*, 19–20.

Risk, uncertainty and business

- Knight says :
  - Business as usual: risk
  - Innovative business: uncertainty

Extremes in finance (1)

- A theoretical result: extreme value theory
  - Domain of attraction: many distributions lead to the extreme value distribution.
    - Relevant examples in finance:
      - Domain of attraction of the Gumbel distribution: Gaussian distribution, mixture of Gaussian distributions, auto-correlated processes, etc.
      - Domain of attraction of the Fréchet distribution: Student t distributions, GARCH processes

Extremes in finance (2)

- Empirical results: application of extreme value theory
  - Estimation with financial asset returns
  - Resuts: a Fréchet distribution with a tail index between 0.1 and 0.4.
    - Similar results for individual stocks, stock indexes, interest rates, foreign exchange rates, commodities, etc.
    - Results (remarquably) consistent over time

Extremes in finance (3)

- Stylized fact about the tails
  - The Fréchet distribution seems to fit well extreme returns.

A puzzle / A paradox (1)

- On one hand:
  - Extreme events in finance (booms and crashes) are associated with periods of innovations
    - IT innovations during the internet bubble / crisis.
    - Financial innovations during the subprime bubble crisis.
  - Extreme events are associated with periods of great uncertainty
  - Extreme events are not well understood (outliers / cancelled data).

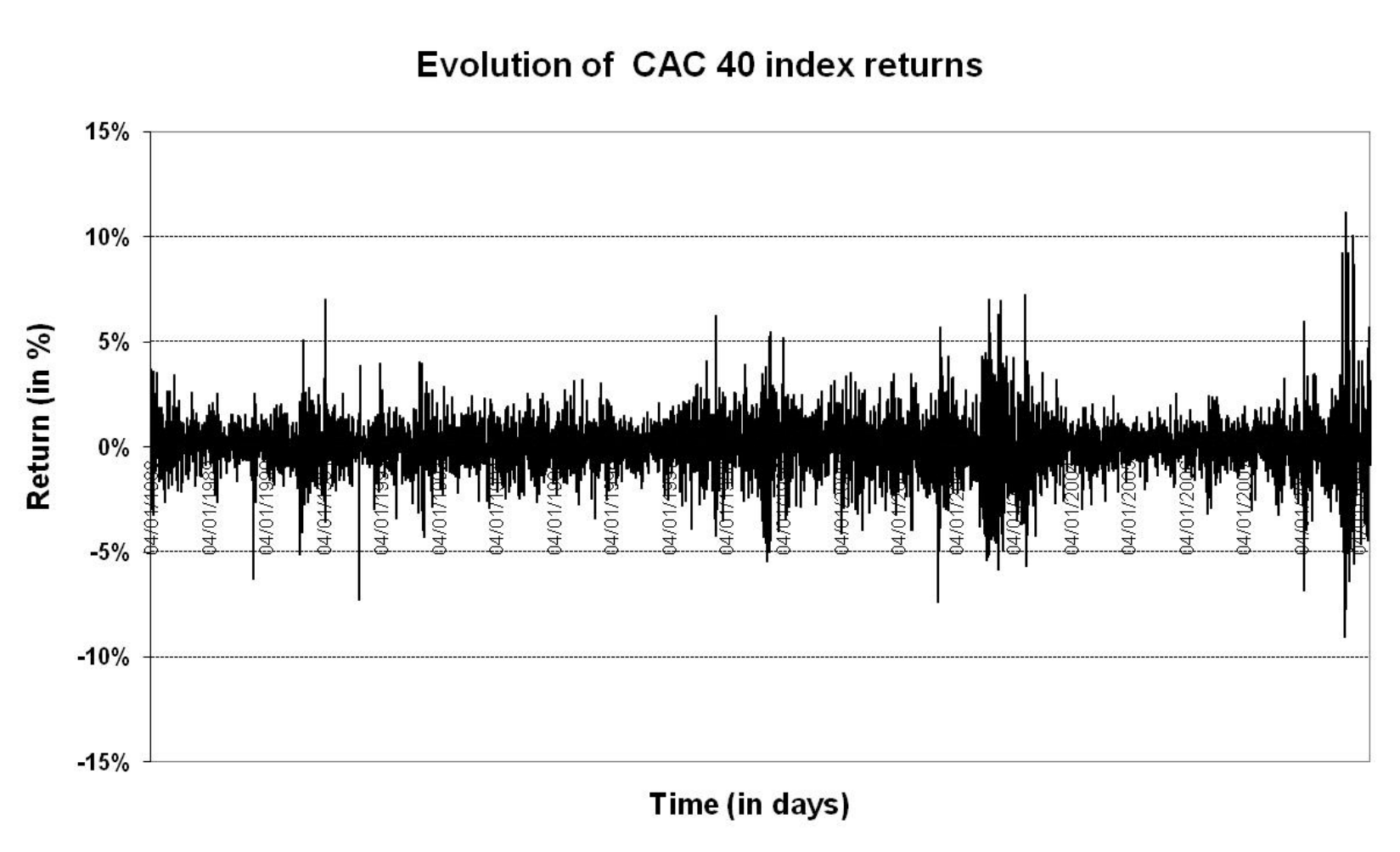
A puzzle / A paradox (2)

- On the other hand:
  - By application of extreme value theory, we know well the statistical distribution of extreme returns (**risk**) even if we do not know precisely the distribution of all returns.

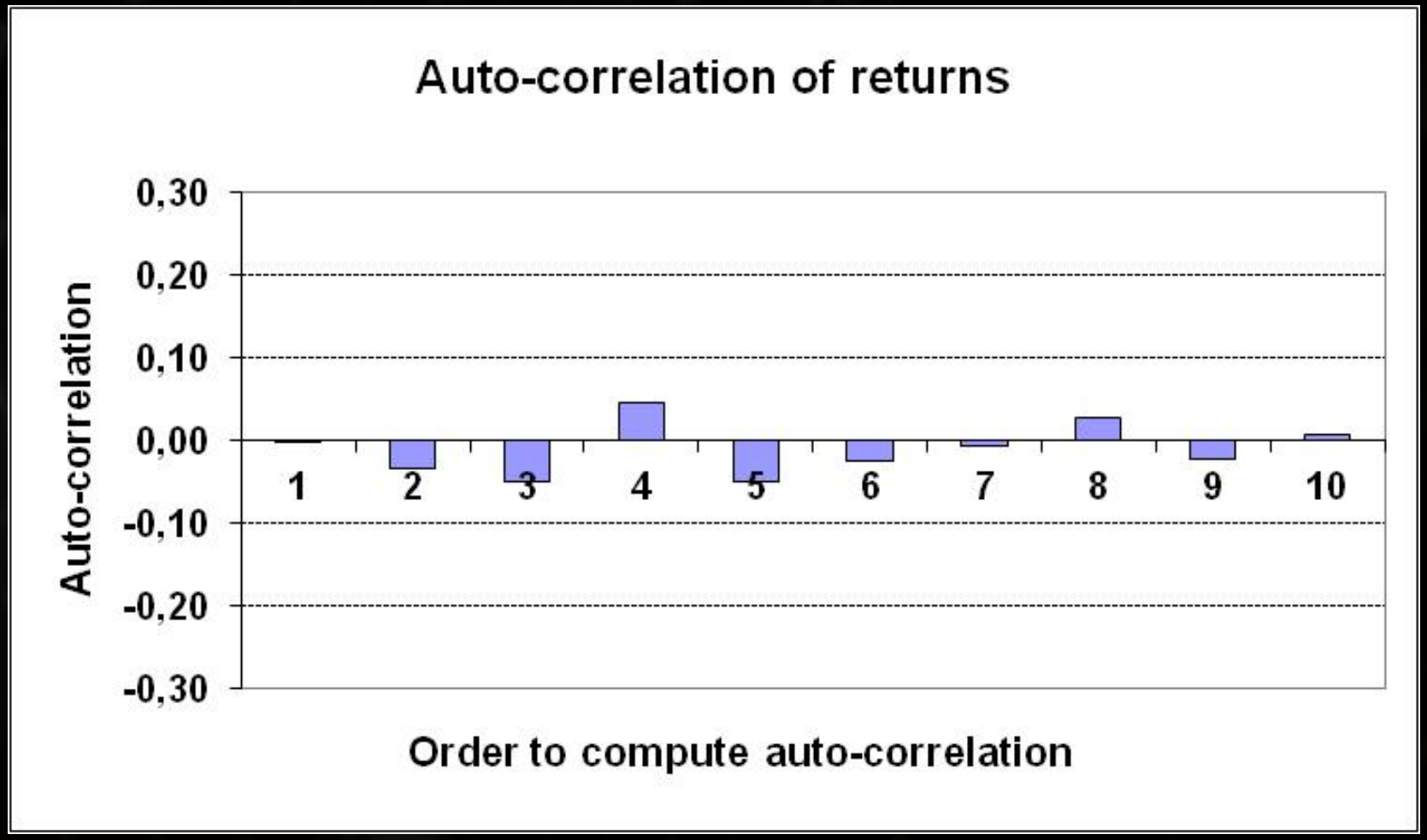
Stylized facts for financial asset prices

- Low auto-correlation of returns (high frequency returns, say daily returns)
- High auto-correlation of squared returns (presisitence of volatility)
- Fat-tailed distributions of returns
- Fréchet distribution for extreme returns

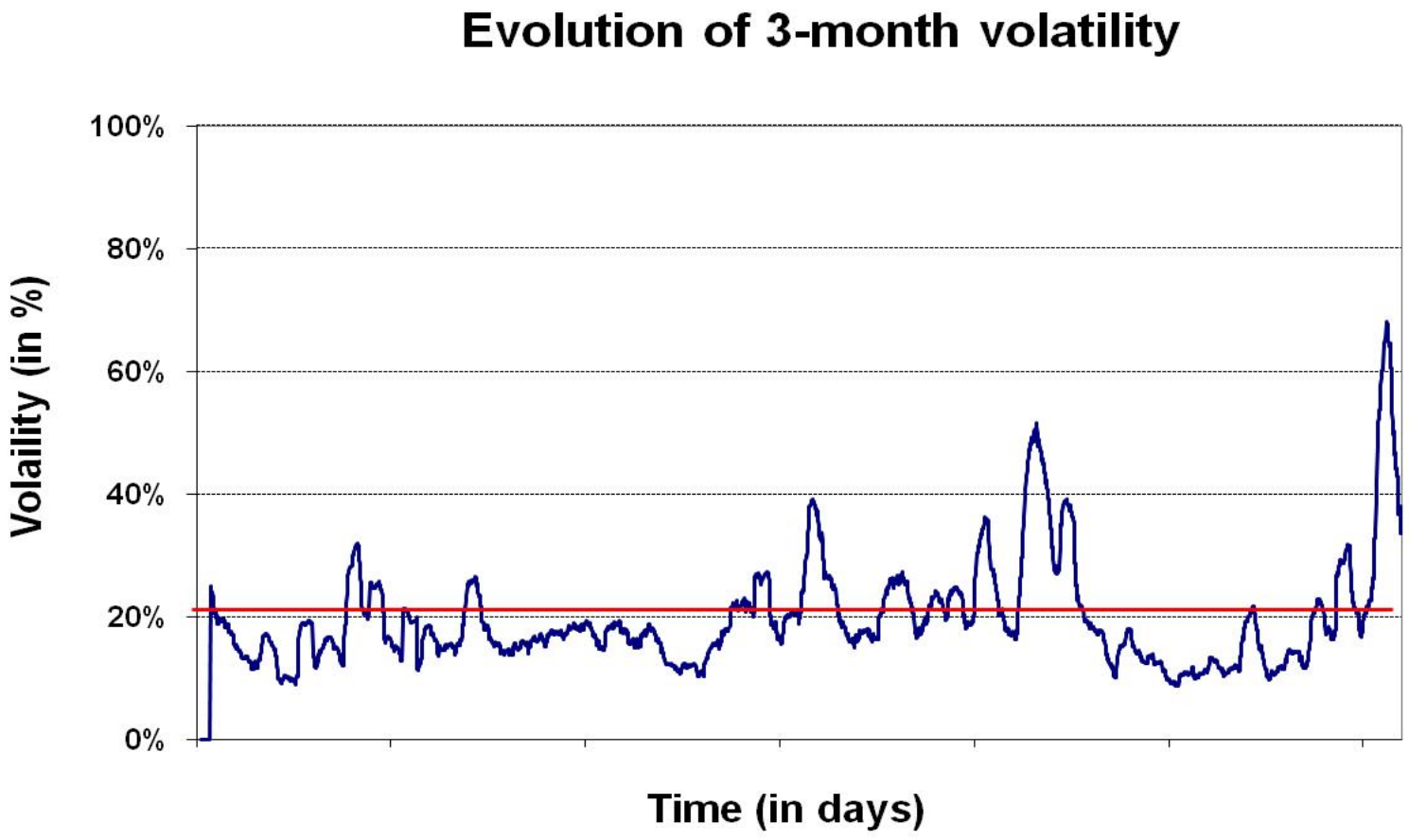
Example: the CAC 40 index



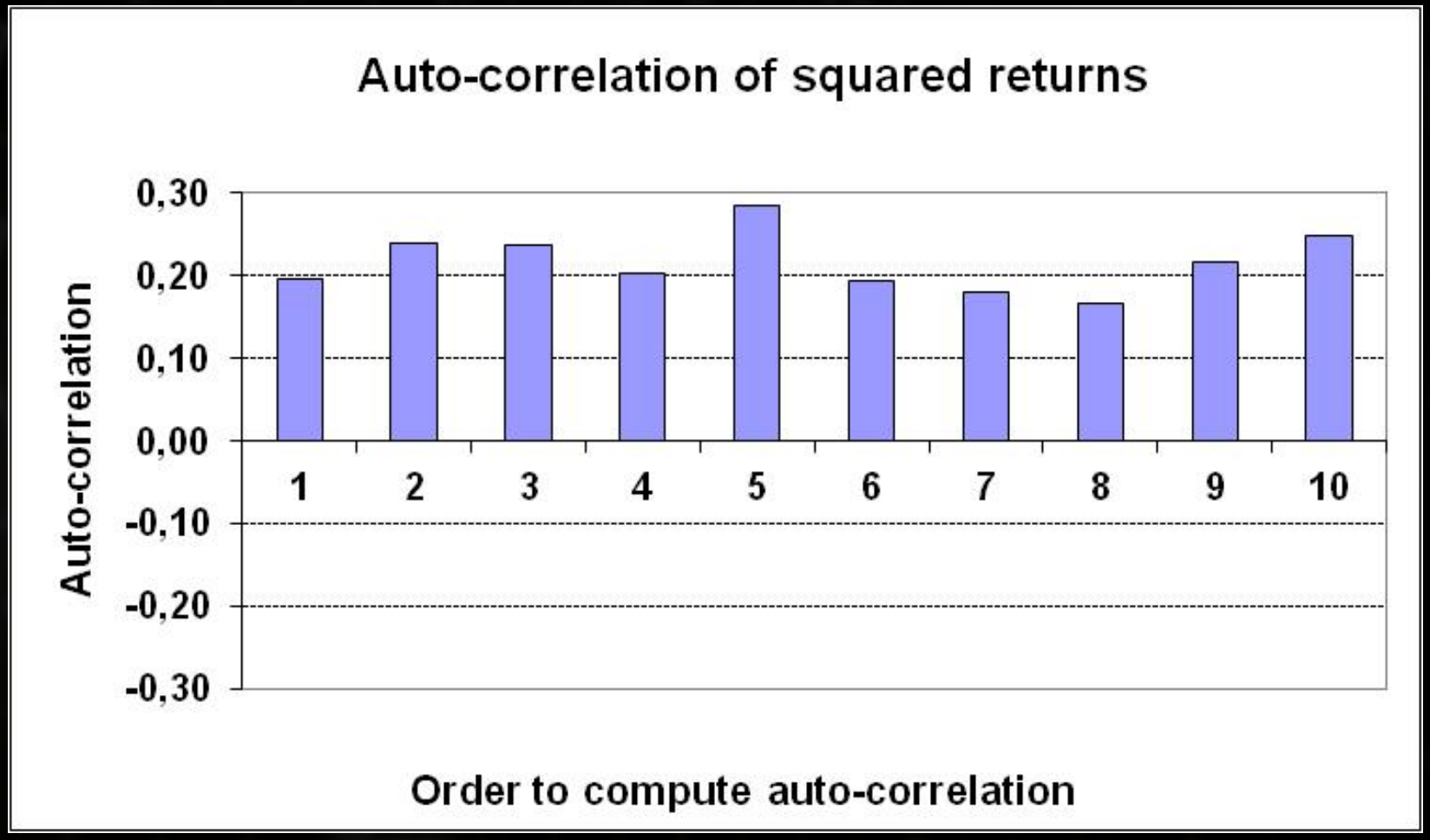
Low auto-correlation of returns



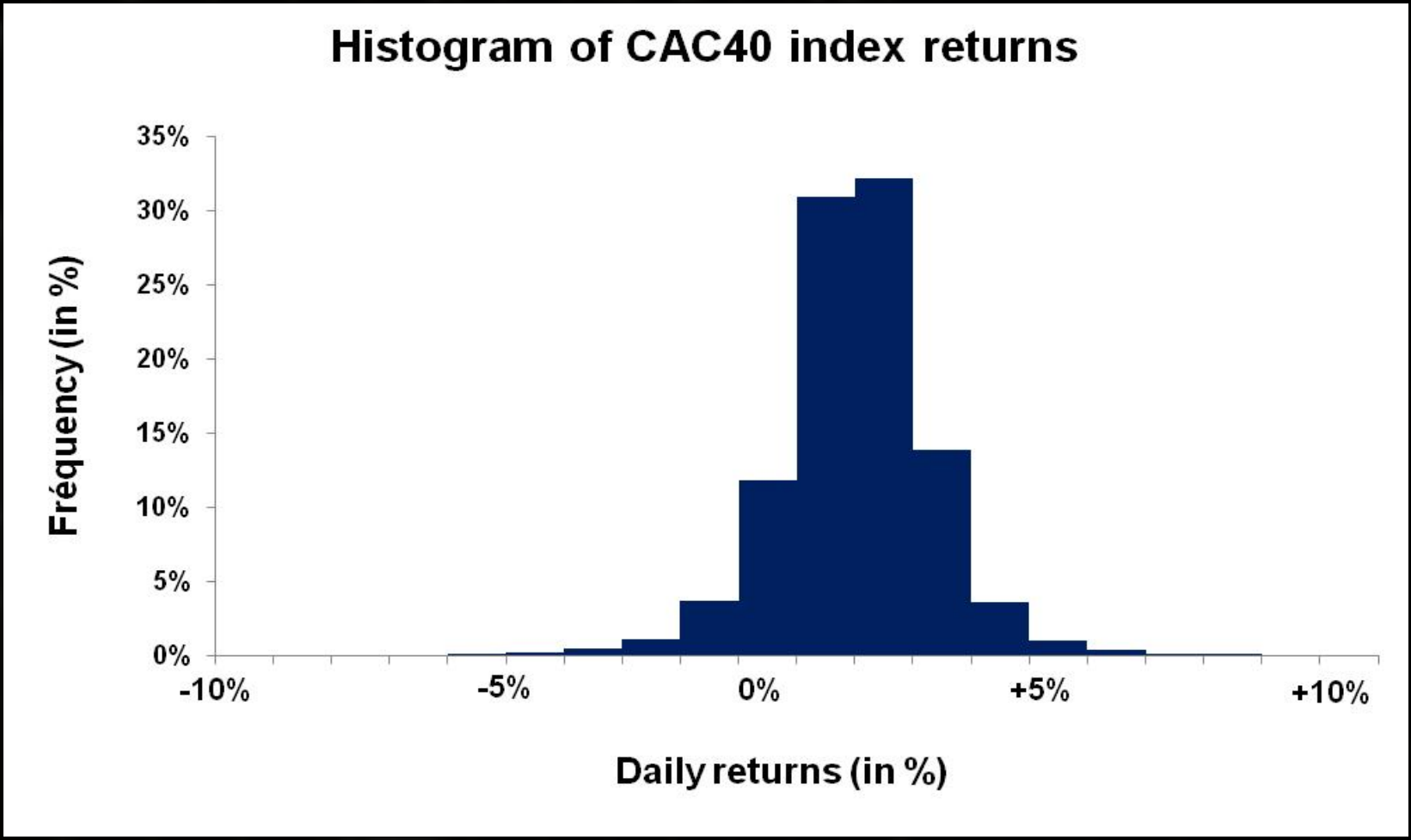
Persistence of volatility



High auto-correlation of squared returns



Fat-tailed distribution of returns (1)



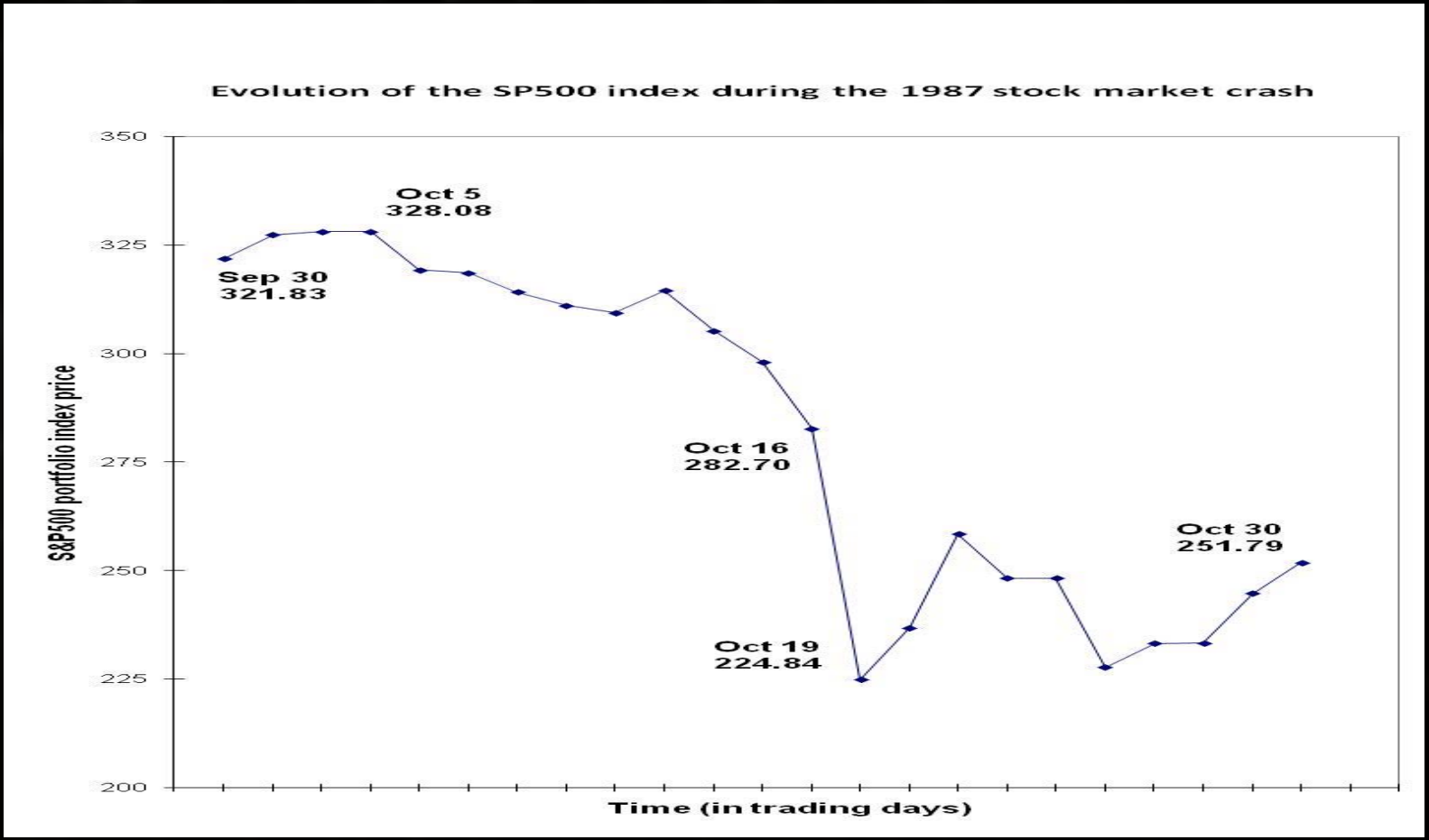
Fat-tailed distribution of returns (2)

Comparison between normal / historical distributions

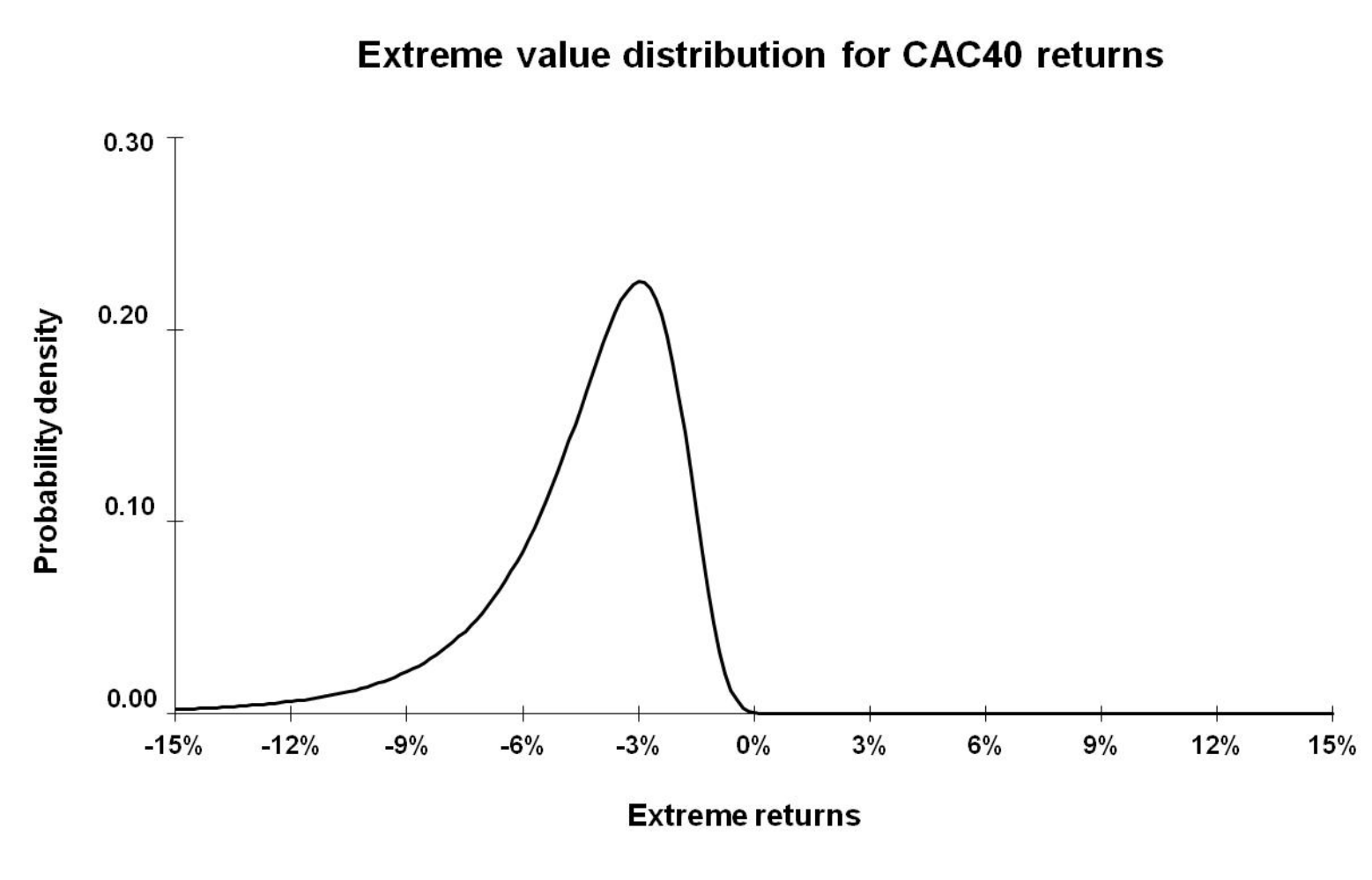
Negative returns - Left tail			Positive returns - Right tail		
Probability	Quantile Normal	Quantile Historical	Probability	Quantile Normal	Quantile Historical
0,1%	-4,24%	-6,67%	90%	1,80%	1,51%
0,5%	-3,53%	-4,57%	95%	2,30%	2,06%
1%	-3,18%	-3,96%	97,5%	2,73%	2,64%
2,5%	-2,68%	-2,78%	99%	3,24%	3,60%
5%	-2,24%	-2,12%	99,5%	3,58%	4,34%
10%	-1,74%	-1,50%	99,9%	4,30%	7,18%

Fat-tailed distribution of returns (3)

Apparition of extreme events



Fréchet extreme value distribution



SimTrade

What is SimTrade?

What are the objectives of SimTrade?

What is the originality of SimTrade?

SimTrade: 3 key points

- SimTrade: website for trading simulations
- Objective of SimTrade: teaching / learning / research
  - To understand financial markets
  - To learn to act in financial markets
- Originality of SimTrade
  - Complete simulation: markets and firms
  - Advantage: impact of SimTrader on markets

www.simtrade.com

What is SimTrade ambition?

- To allow everybody to understand how financial markets work
- To develop skills in both financial markets and corporate finance
- To better understand the behavior of individuals in terms of financial decisions (behavioral finance) and to explain the origin of stylized facts in asset prices

What is the public of SimTrade?

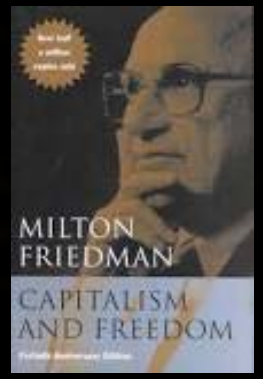
- Beginners: to discover financial markets
- Clients of financial institutions: to learn to trade in markets (basic products) and to master sophisticated products (MIF)
- Students and professors: to use a learning environment closed to their future working environment
- Practitioners: to master difficult market conditions (high volatility, low liquidity, confrontation to innovative trading strategies)

Demonstration of SimTrade

www.simtrade.com

Mission statement

- « SimTrade mission is to train individuals to act freely in financial markets. »
  - Reference : « Capitalism and Freedom » by Milton Friedman (1962).



- Objectives of SimTrade:
  - Demystify financial makets
  - Reconcile (French) people with financial markets

Origin of the project

- Teaching in line with reality
  - Use of new technologies (internet / sreens / automatic trading)
- Importance of financial investments in wealth management
  - Need to train individuals
- Understanding of financial markets
  - Necessity to have a tool

SimTrade: 4 simulation tools

- Life of a trading day
- Simulations *à la carte* / Trading on Demand
- On-line trading courses
- SimTrading contests

www.simtrade.com

Simulations *à la carte* (1)

- Trading on Demand (ToD)
  - Technical: to master sendeing orders to the markets
    - Series Byzantium
  - Sector: to understand the fundamentals of a sector / to analyze the news flow of firms of the sector
    - Series Blé de France
  - Economics: to understand the impact of economic and financial indicators

Simulations *à la carte* (2)

- Trading on Demand (ToD)
  - Objective: to accomplish a mission
    - To buy / sell to maximize trading profit (classical)
    - To liquidate / build a position
    - To profit private information

SimTrade: a teaching tool

- To understand how financial markets work and react
- To learn how to act in financial markets
- To test trading strategies
- To master trading under different market conditions in terms of trend, volatility and liquidity
  - Added value of SimTrade: analysis of the simulation for the SimTrader

SimTrade: a research project

- Data base
  - Simulations launched by SimTraders and SimTraders' profiles
  - Workable format (parameters of a simulation)
  - Open database
- Laboratory of experimental economics
  - Simulation = experiment / test of a theory

www.simtrade.fr

About research and data (in finance)

- Two strategies:
  - You use public data: SP500, FTSE100, CAC40
  - You create your own data (experimental economics) that you make public

Subjects of research (1)

- At the micro-level: study of the behavior of individuals in terms of financial decisions (behavioral finance)
  - Use of privileged information
  - Treatment of probabilities

Subjects of research (2)

- At micro / macro level: study of the behavior of financial asset prices from the behavior of individuals
  - Satisitical properties of financial asset prices
    - Statistical distribution of extreme events
  - Apparition of extreme events

Subjects of research (3)

- At the organisational level: market rules
  - Impact of price limits on volatility

SimTrade: a three-pillar project

1. Trading plateform
   - Important computer developments
2. Mathematical-financial model for simulation
   - Academic research: market micro-structure, price foramtion process, statistical properties of financial asset prices, behavioral finance
3. Scenarios
   - Stories of firms and markets

- Added value of SimTrade: integration of the 3 pillars

Basic element: the scenario

1. Simulate a firm
   - Its history, sector, products, employees, managers, etc.
   - The story during simulation
2. Simulate the market
   - Behavior of markets participants: traders, financial analysts, reporters, etc.
3. Define an objective for the SimTrader

SimTrade values (1)

- Openess
  - Users of the application
    - Free
    - Will to target a large public
    - User-driven approach
  - Producers of scenarios
    - Expression of diversity of points of view

SimTrade values (2)

- Openess
  - Professors and students
    - Organization of courses
    - Participation to courses
  - Researchers
    - Free access to the database

Conclusion

- Main issue

  Relationship between the behavior of individuals and statistical properties of asset prices

- A new approach based on (wide-scaled) simulations

SimTrade

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- Know more about SimTrade:

- Thank you very much for your attention.

www.simtrade.com