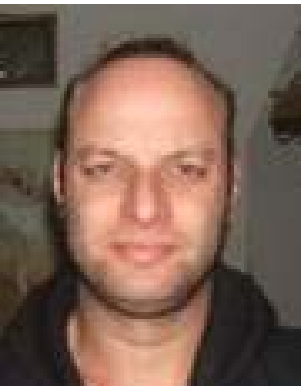
Gur Yaari

Andrzej Nowak

Simona Cantono

Damien Challet



Yaniv Dover

Nadav Shnerb

Sonia Emsalem

Yoram Louzoun

Science and Policy Making

Sorin Solomon

Karl Popper

"In so far as a **scientific statement** speaks about reality, it **must be falsifiable**"

(i.e. the statement can be verified empirically, and if it turns out to be false, the scientific theory on which it is based, should be discarded).

This is not only an epistemological requirement but a crucial demand for **real life relevance**.

Complementary remark :

"Science may be described as the art of systematic **over-simplification**"

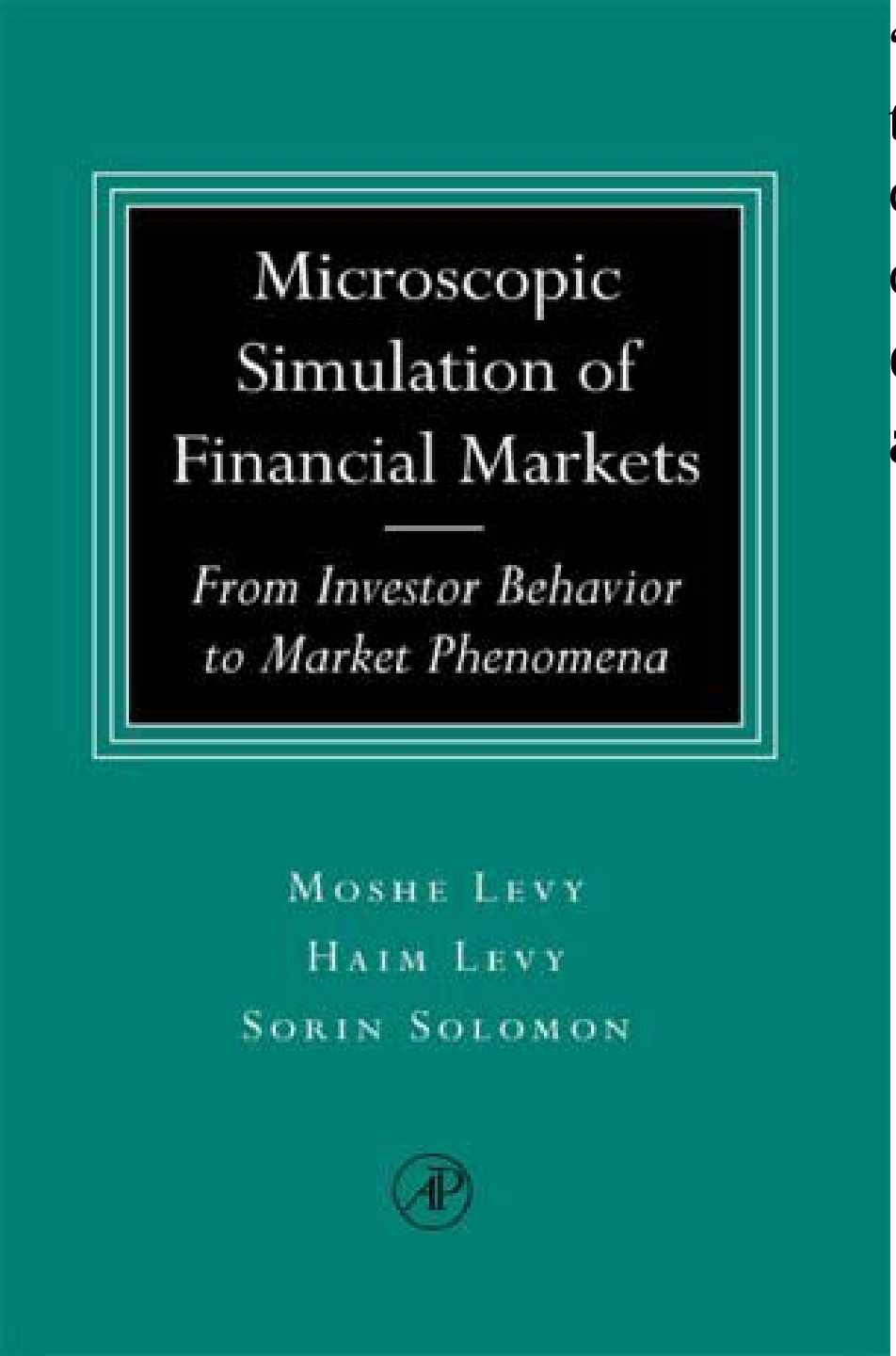
Is it possible in social / political / organization sciences with so many particularities and interferences to reconcile these 2 requirements.?

In this talk

- I argue that “yes”
- I will explain “why”

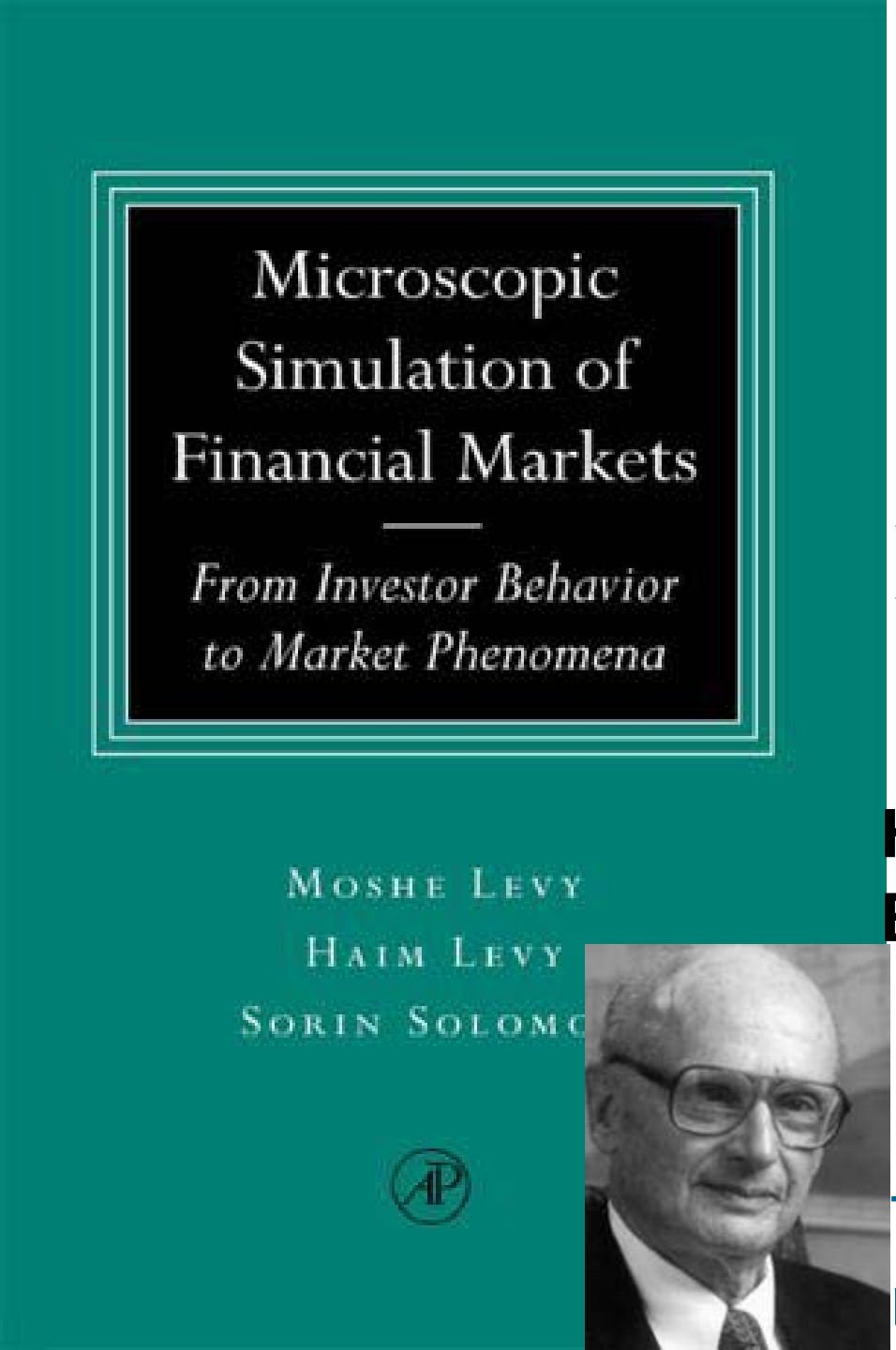
And

- I will demonstrate “how”



"The authors make a compelling case that this **[Agent Based]** technique originally used in physics to solve otherwise intractable problems, **is destined to become a standard tool in finance**."

Richard Roll,
former president of the
American Finance Association



"Levy, Levy and Solomon's
'Microscopic Simulation of Financial Markets'
points us towards the
future of financial economics.
If we restrict ourselves to models which can be solved analytically, we will be modelling for our mutual entertainment, not to maximize **explanatory or predictive power**."

HARRY MARKOWITZ,
Economics Nobel Laureate

But we were able
to even solve analytically
relevant Agent Based Models

- Yes:

over-simplified models can have strong predictive power

- the AUTOCATALYTIC mechanisms necessary to

amplify

individual behavior microscopic interactions

to

mass / collective macroscopic phenomena

are so strong that they

dwarf the interference/noise

by weaker random forces

(which self-average at the micro level).

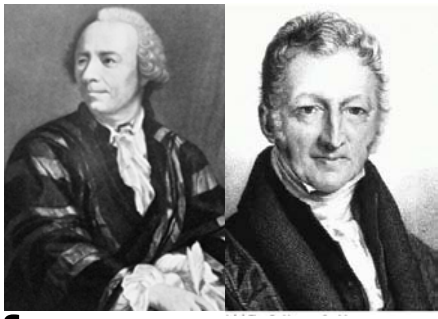
Oldest, Simplest Model:

2 types of diffusing entities / agents / particles A and B

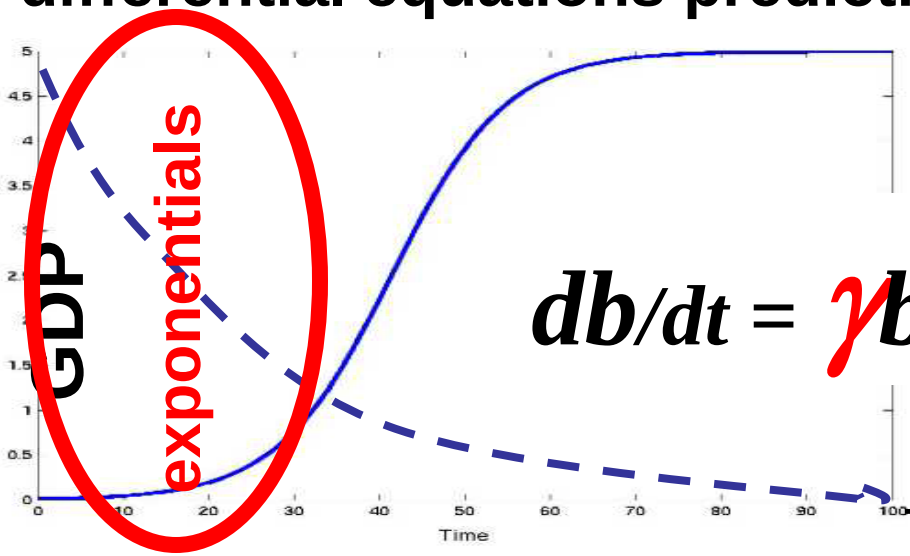
- A+B → A+B+B λ gain

AUTOCATALITICITY

- B → ∅ μ loss
- B+B → B χ competition



Naïve, non-agent , continuous, differential equations prediction: space-time uniform



$$db/dt = \gamma b - cb^2 + diffusion$$

Time

Keeping agent based, autocatalytic discrete dynamics in account

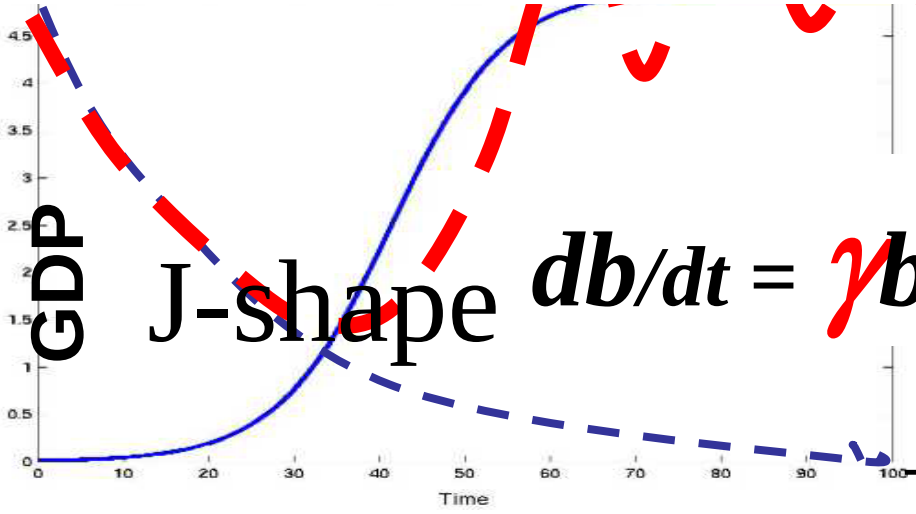
large #A regions – are **very rare** but **fastest growing**

at the beginning irrelevant

eventually taking over

Rigorous theorems : emergence of collective adaptive

in Shnerb, Louzoun, Bettelheim, Solomon (PNAS 2000) EPJ.B (2007) etc

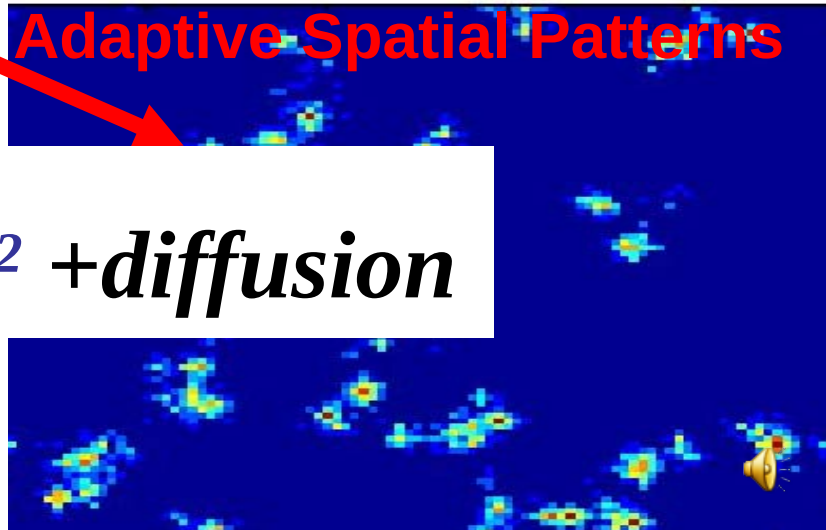


J-shape

$$db/dt = \gamma b - cb^2 + diffusion$$

Time

Adaptive Spatial Patterns



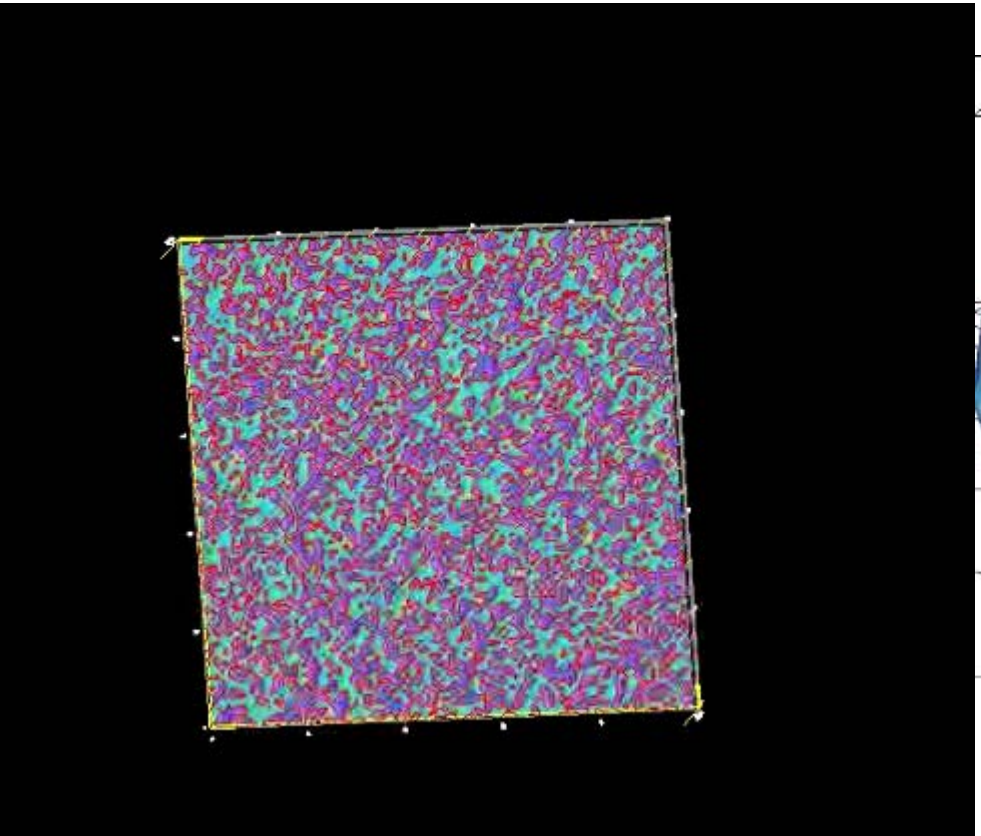
Microscopic Study Reveals the Singular Origins of Growth

G Yaari, S Solomon, K Rakocy, A Nowak,
European Physics Journal B 62 4, 505-513, 2008,.

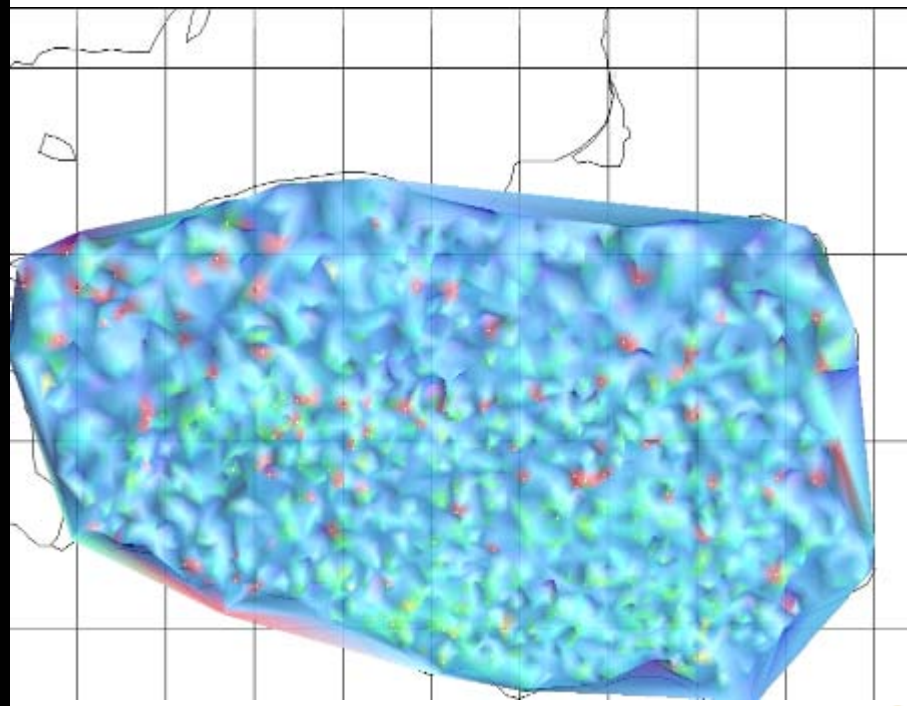
Simulation with $\gamma < 0$

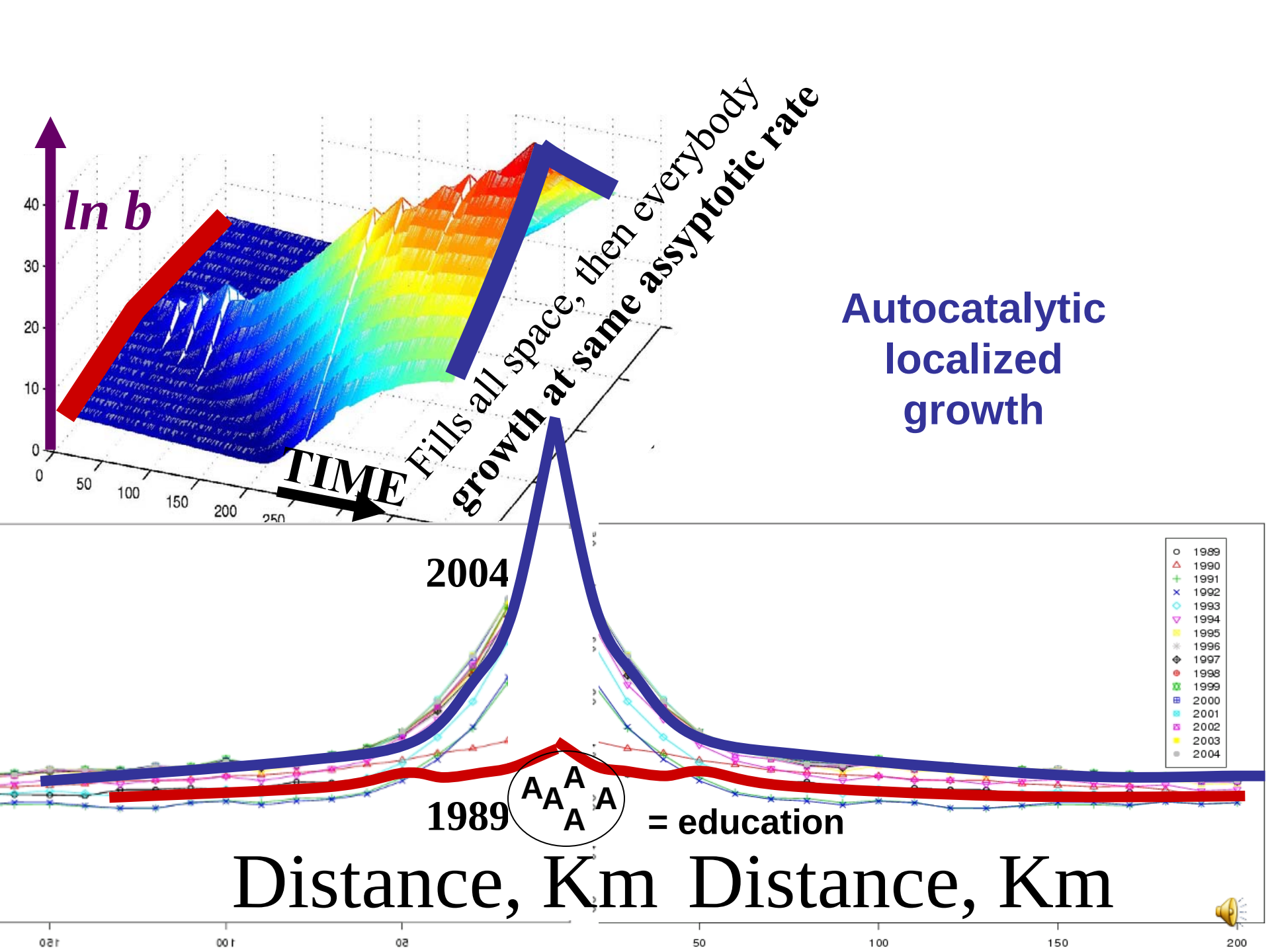
Red areas below: "no B's"

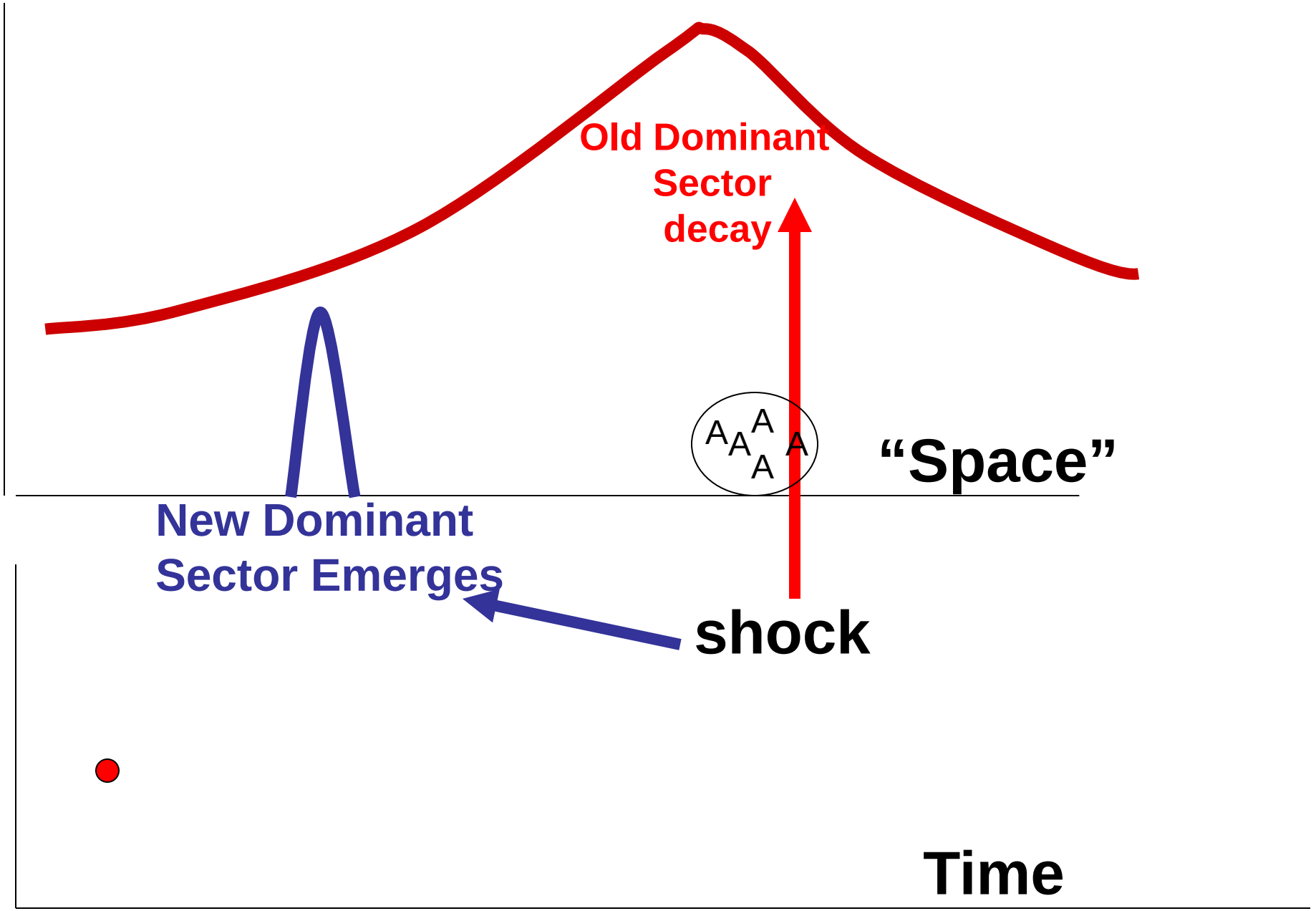
The scale is logarithmic

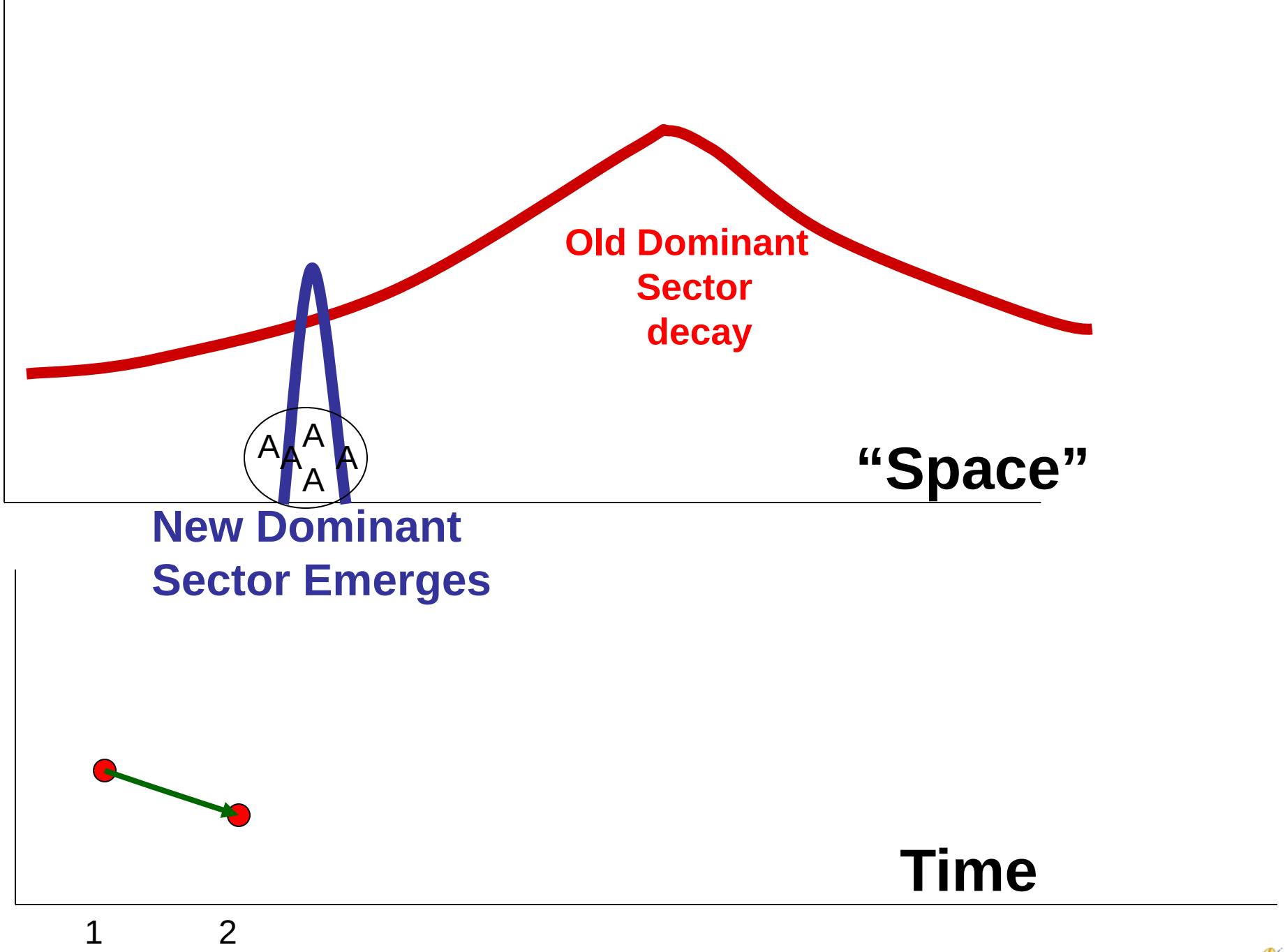


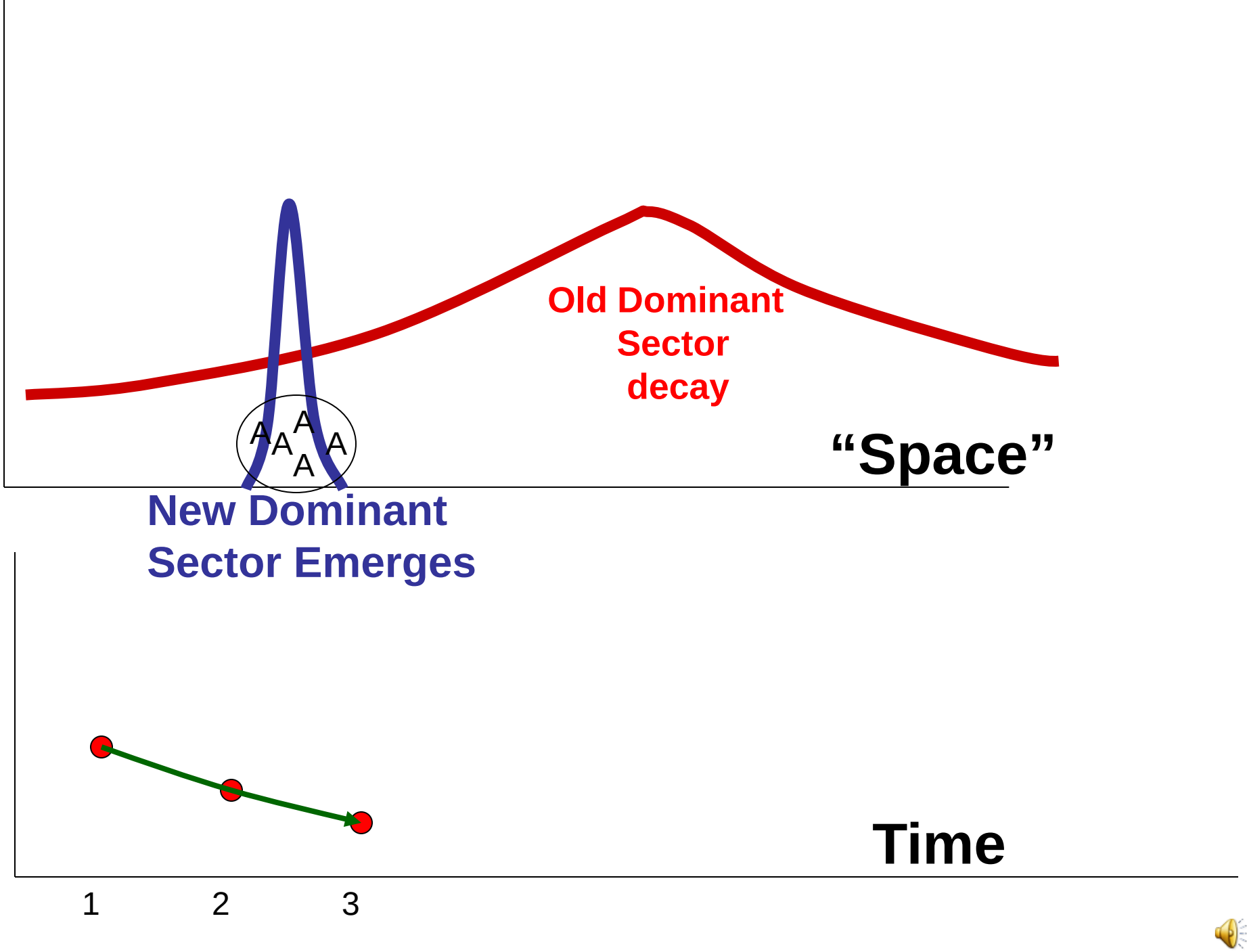
Evolution of the Number of enterprises per capita in the 3000 Polish districts after liberalization; Logarithmic Scale

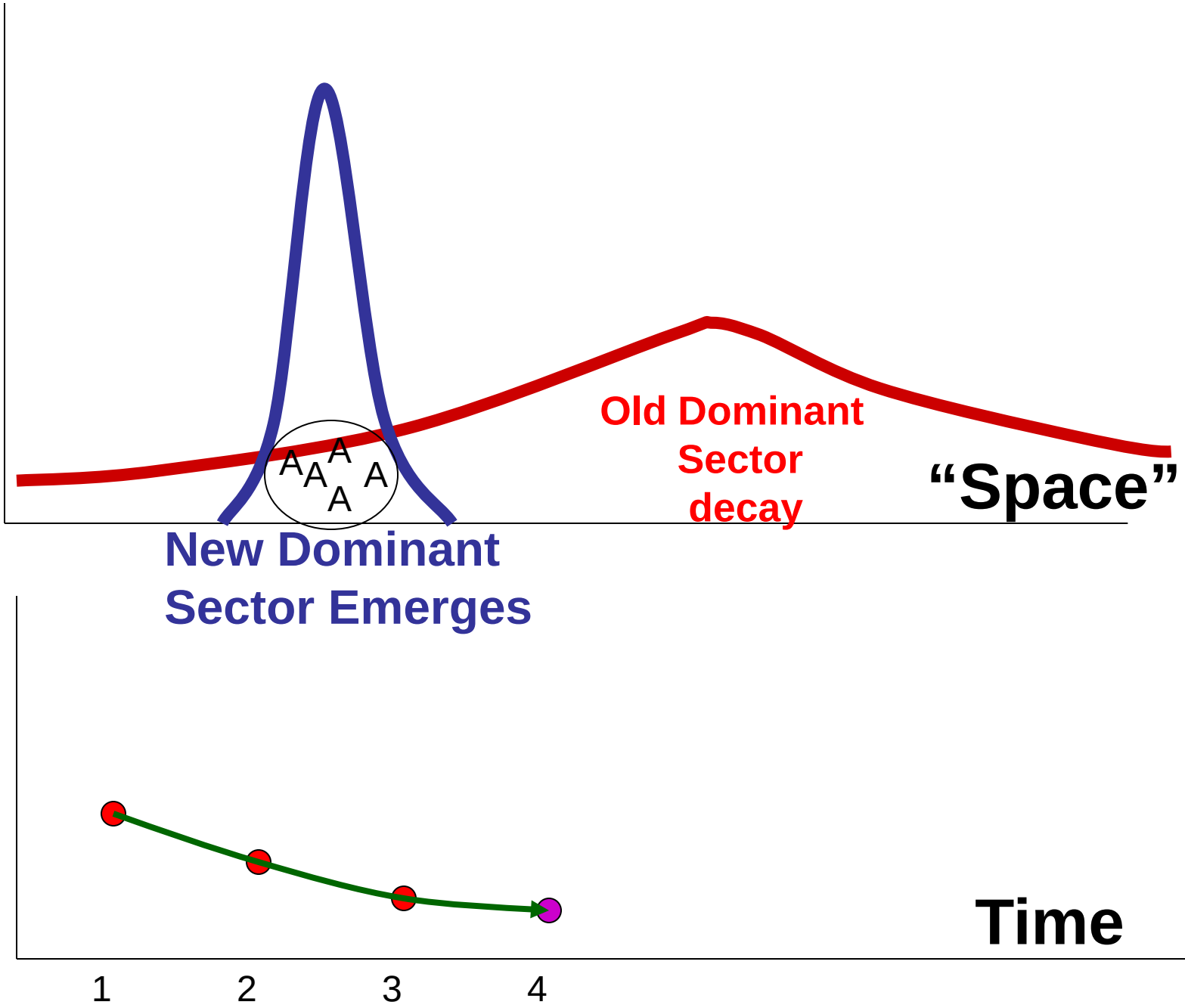


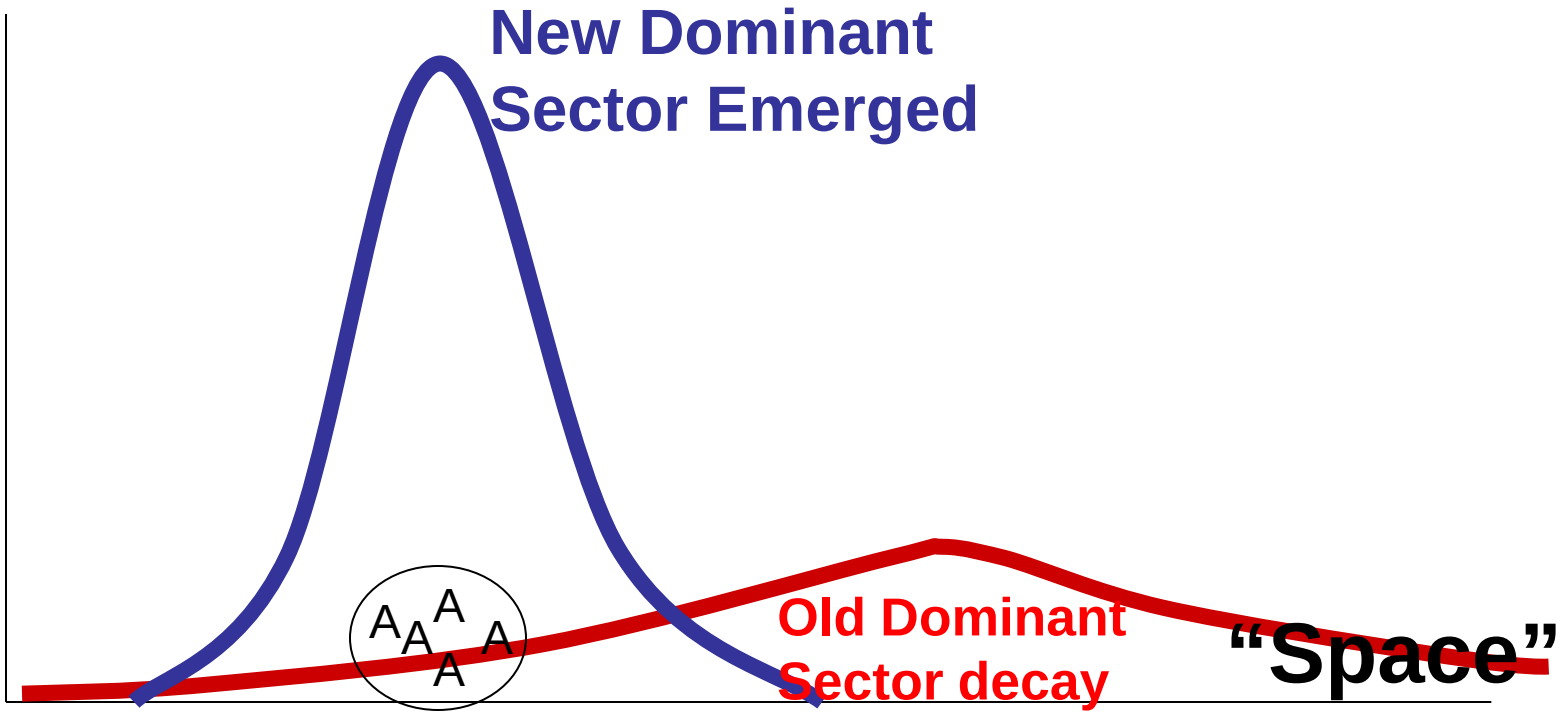

ln b
TIME
Fills all space, then everybody
growth at same assyptotic rate
Autocatalytic
localized
growth
2004
1989
A A A A A
= education
Distance, Km
Distance, Km
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

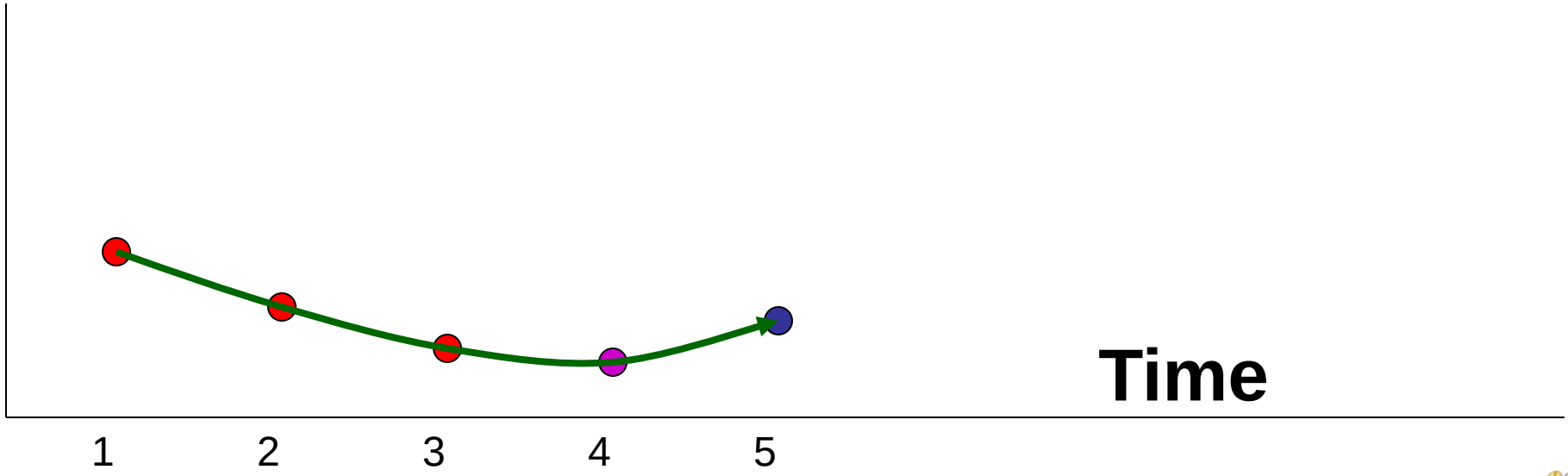

Old Dominant
Sector
decay
A
A
A
A
A
“Space”
New Dominant
Sector Emerges
shock
Time

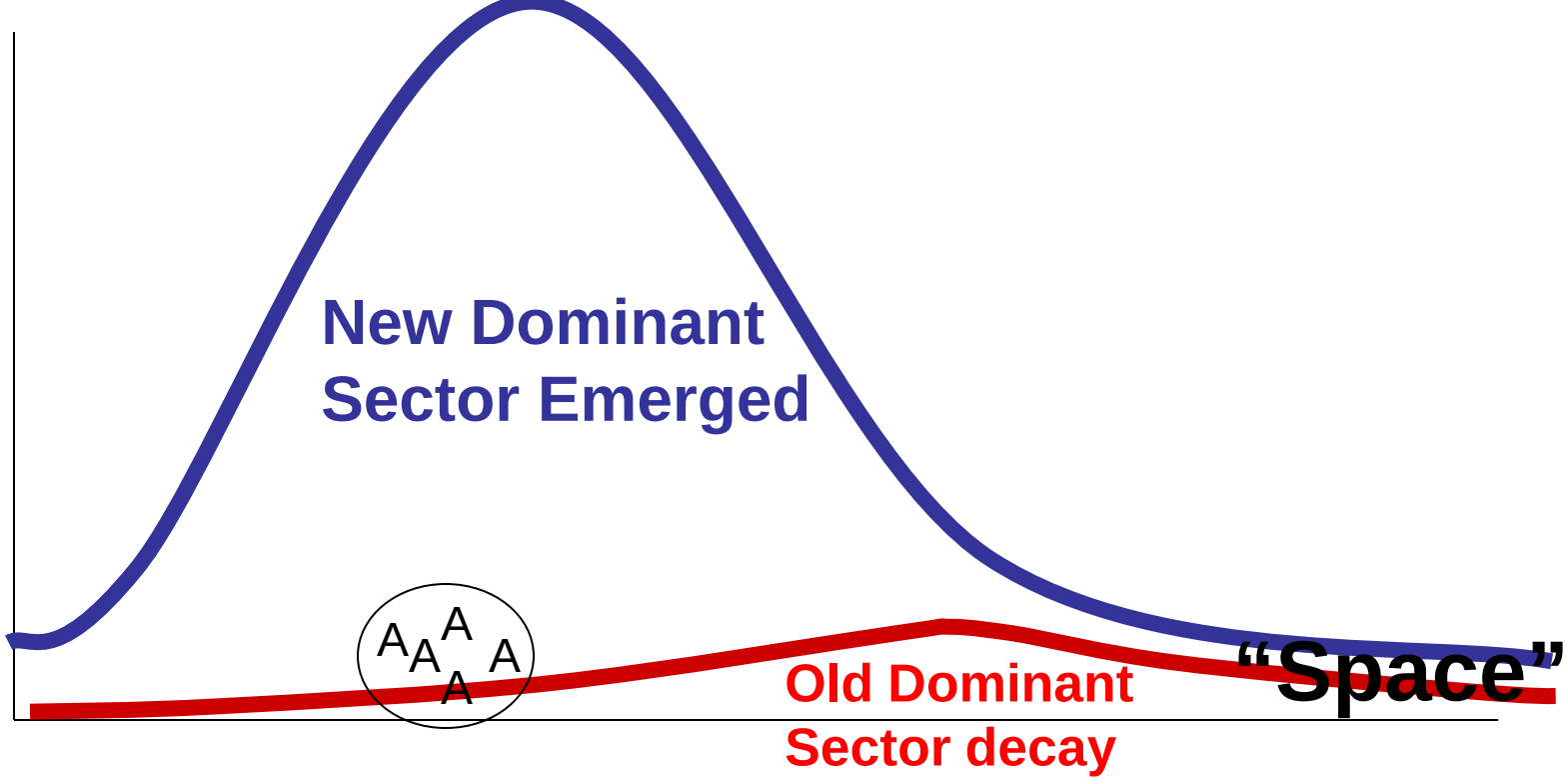

Old Dominant
Sector
decay
A
A
A
A
A
“Space”
New Dominant
Sector Emerges
Time
1
2

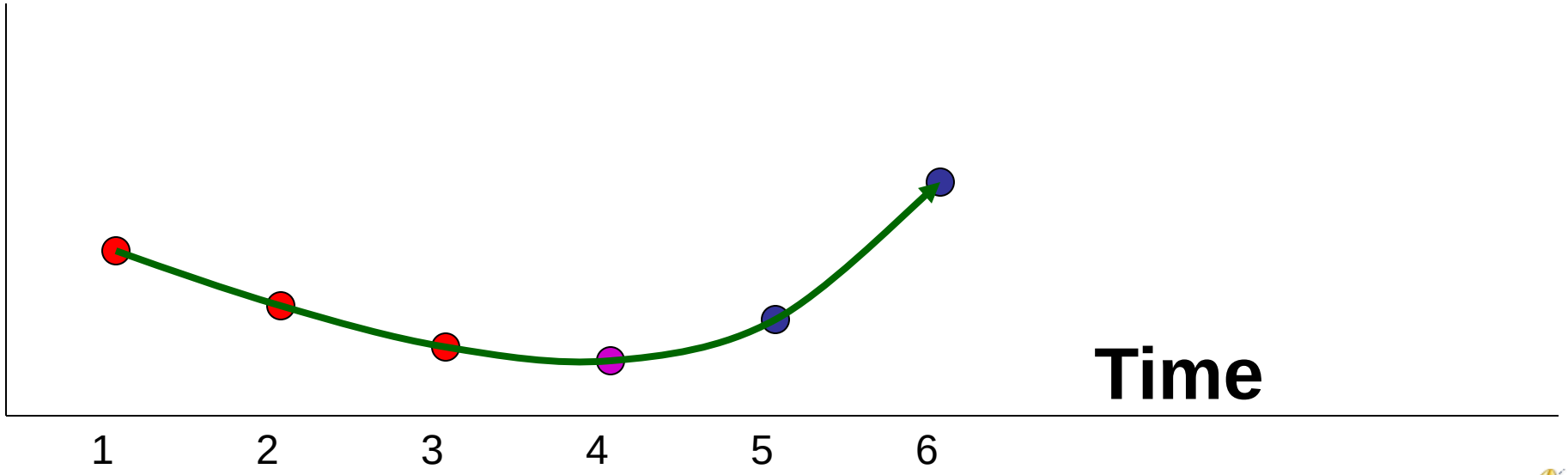

Old Dominant
Sector
decay
A
A
A
A
A
“Space”
New Dominant
Sector Emerges
Time
1
2
3


A
A
A
A
A
Old Dominant
Sector
decay
“Space”
New Dominant
Sector Emerges
Time
1
2
3
4

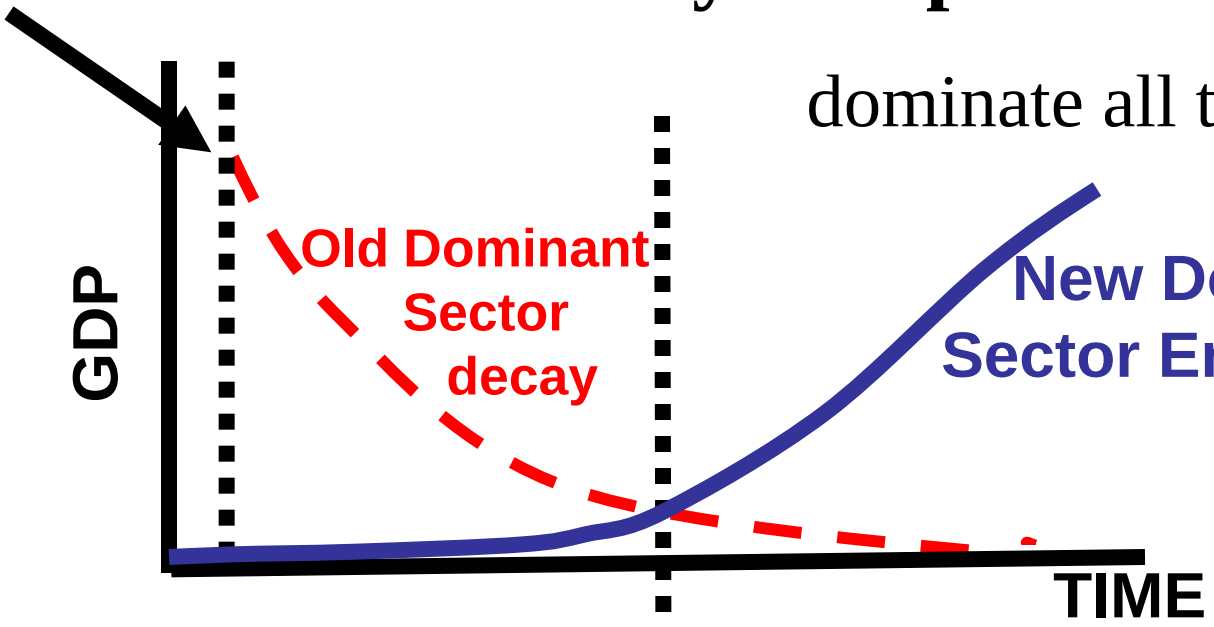

New Dominant
Sector Emerged
A
A
A
A
A
Old Dominant
Sector decay
“Space”


Time
1
2
3
4
5

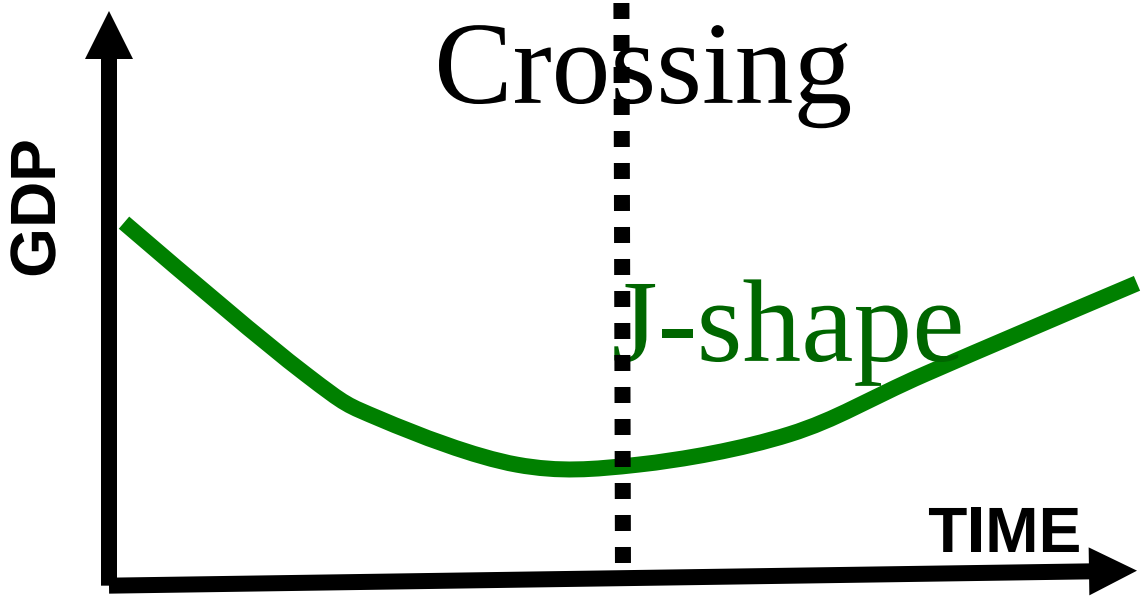

New Dominant
Sector Emerged
A
A
A
A
A
Old Dominant
Sector decay
“Space”


Time
1
2
3
4
5
6

After a SHOCK two **autocatalytic exponential** effects dominate all the others



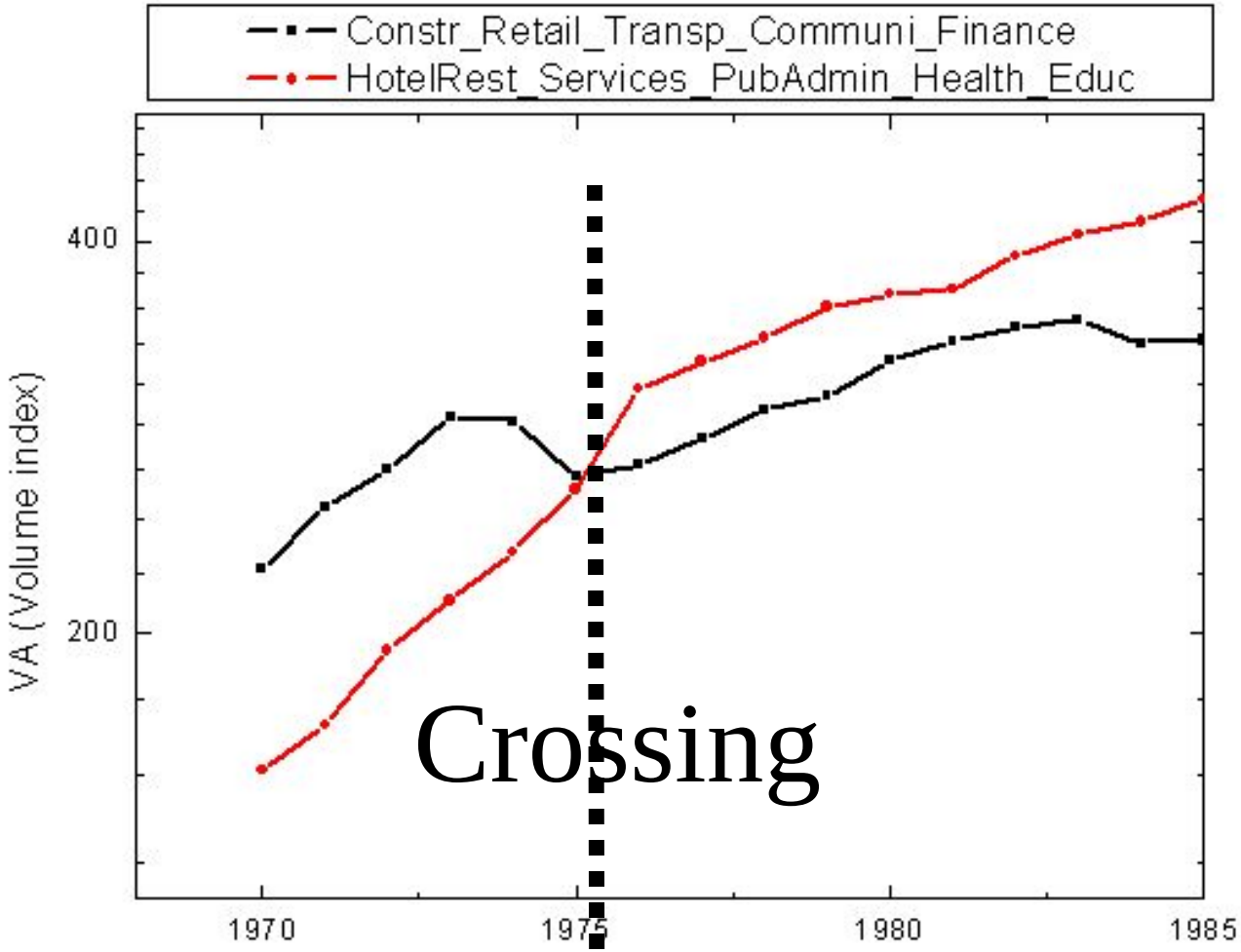
Crossing



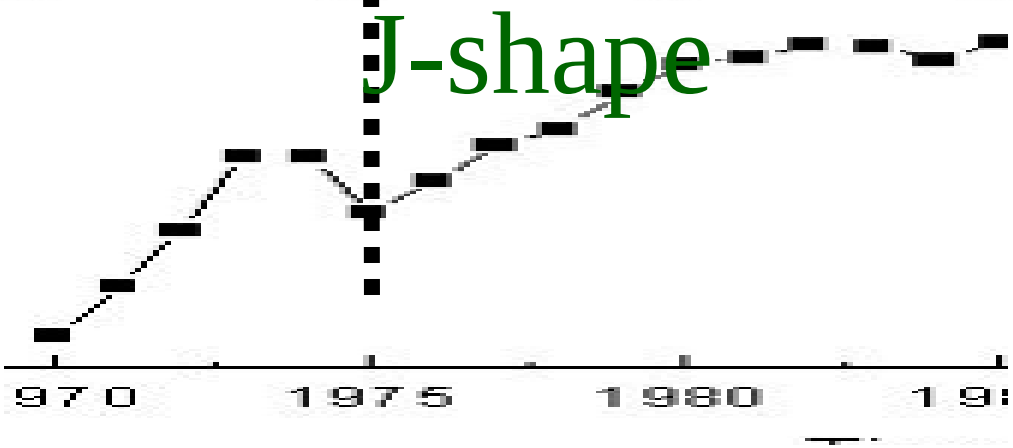
Challet, Yaari, Solomon, ***Economics 2009***

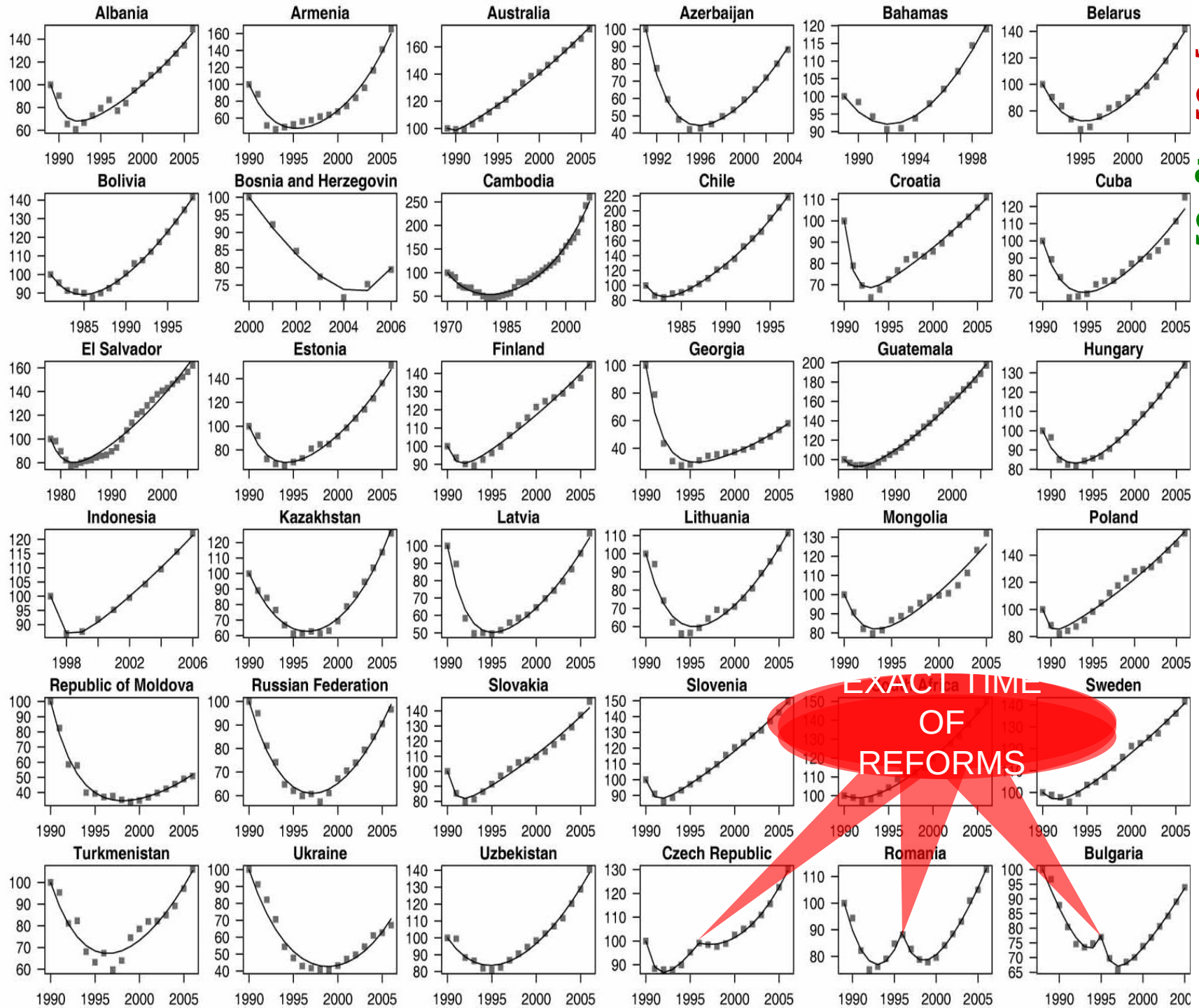
"The Universal Shape of Economic Recession and Recovery after a Shock

Portugal



Dover, Moulet, Yaari,S, Risk and Decision Analysis 2009





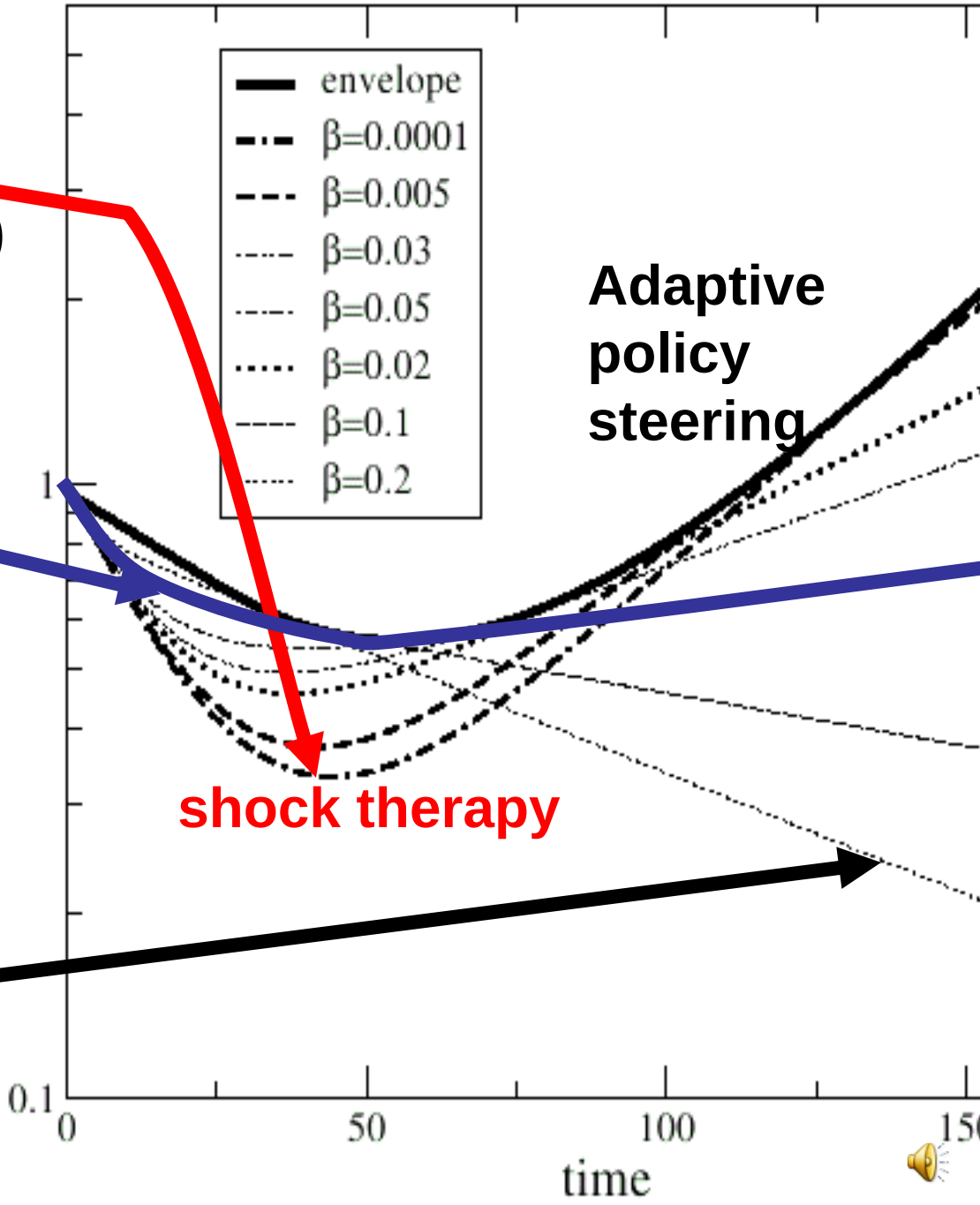
J-Shape after Shock

-Accelerating change to **shorten** the crisis
deepens the crisis
(old decays even faster)

-To **mild** the crisis one may try to subsidize the old sector for a while.

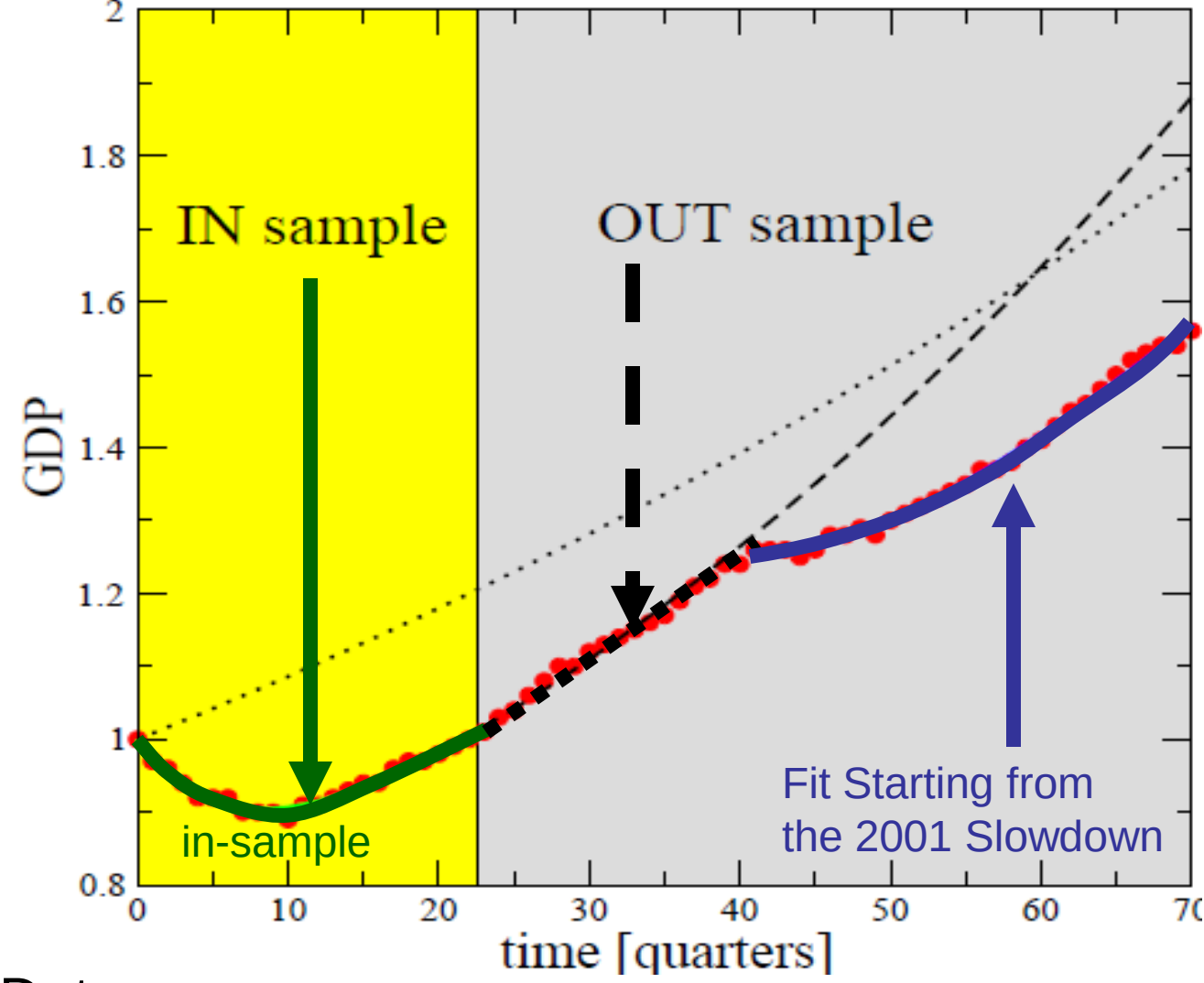
-This may **prolong** the crisis and compromise future development

-and even **worsen the crisis** if it is too drastic



Finland GDP

1990-2008



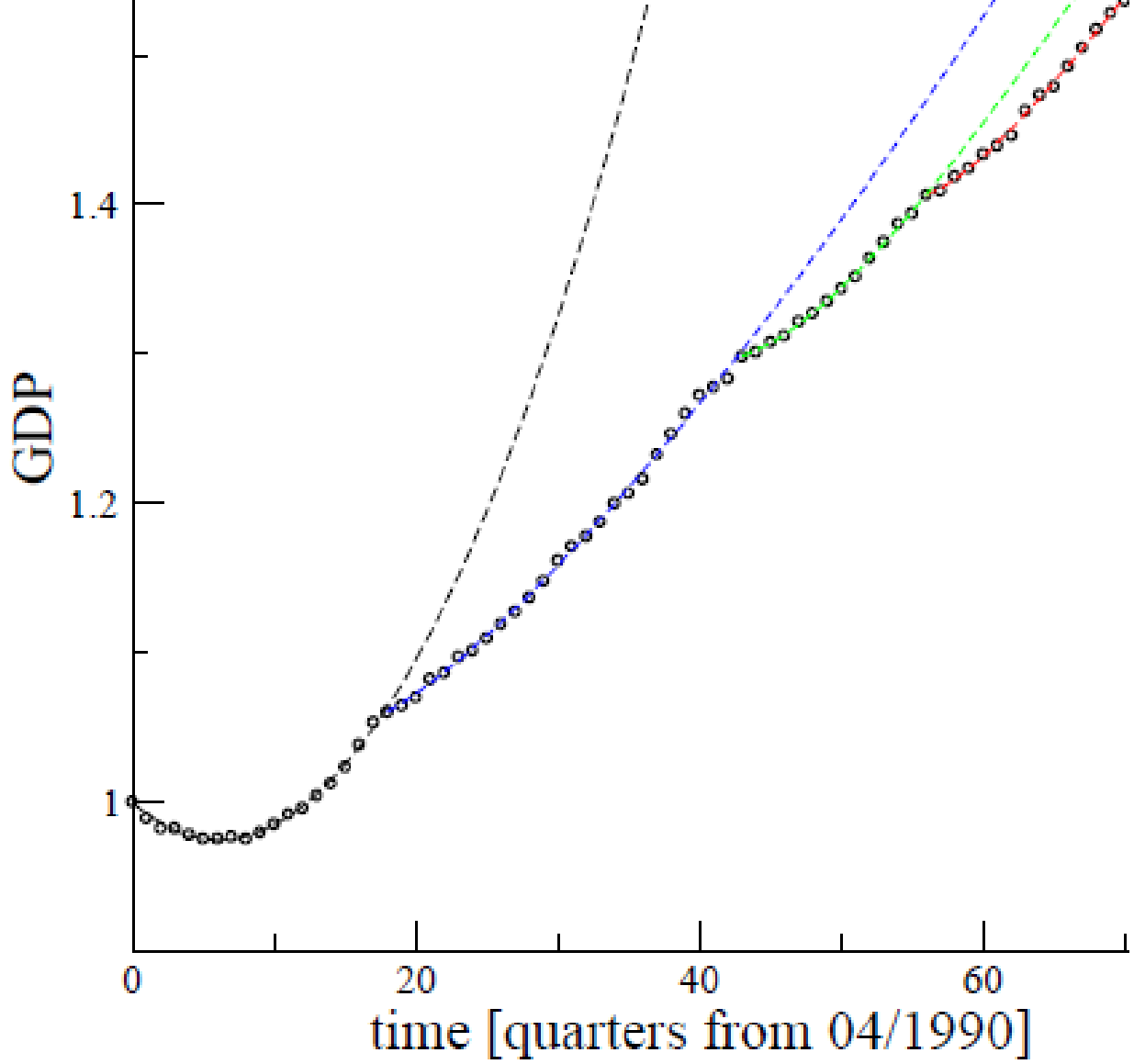
Quarterly Data,

in-Sample Fit,

out-Sample Prediction,

Fit Starting from the 2001 Slowdown,

Continuation of the pre-1990 GDP Trend.

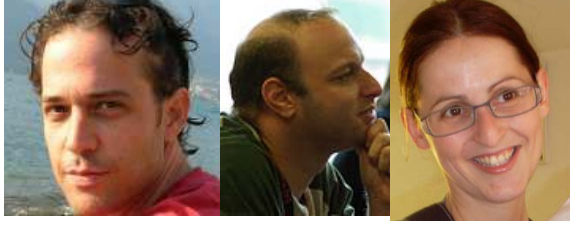


Scaled Real GDP of the United Kingdom

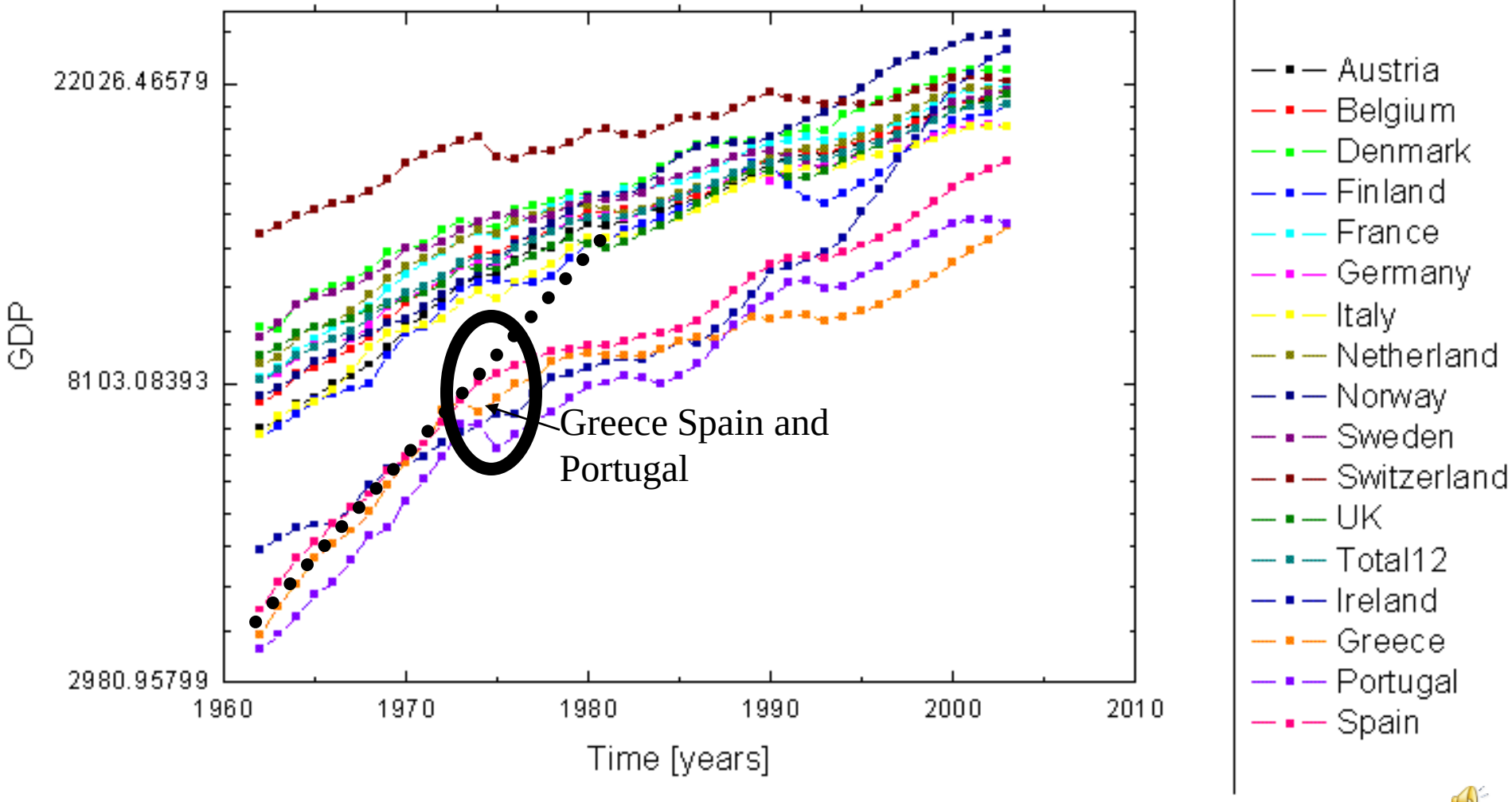
No “end to bust and boom” PM! …Control of it!

Do all economies grow equally fast?

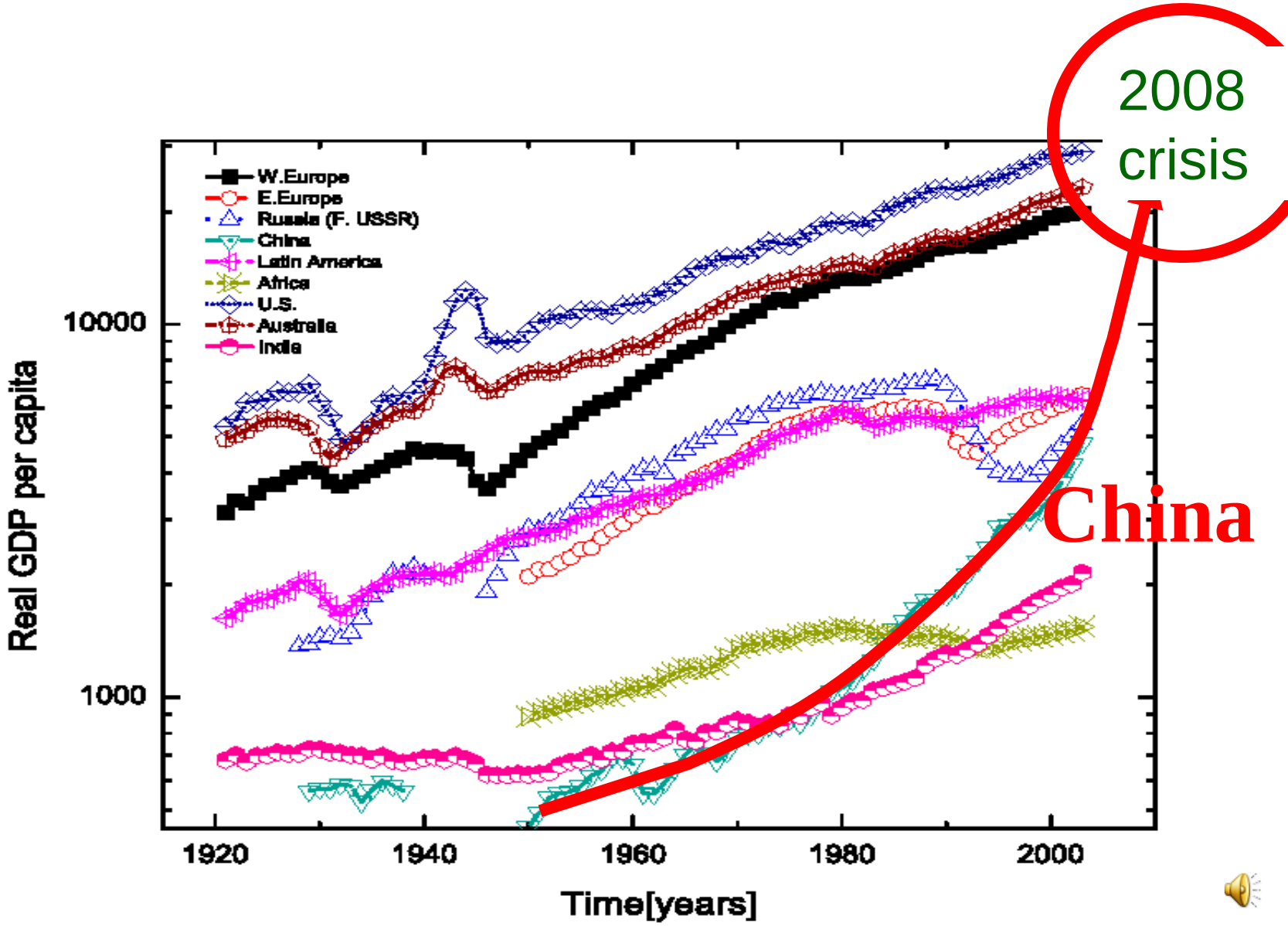
Y Dover, S Moulet, S Solomon and G Yaari;
Risk and Decisions Analysis;1(3):171–185, IOS Press 2009,



Alignment



Even the shock approaching can be **predicted** /guessed (recall Greece, Spain, Portugal) but not its exact nature



Answering the Right Questions

Neo-Classical Economic

Search for convergence:

Solow (β conv), Durlauf (σ conv) ,

β and σ convergence NEVER FOUND:

- Mistake: looked for convergence in the **production absolute values per capita**
- rather than our **growth rates alignment**

As predicted by the autocatalytic model

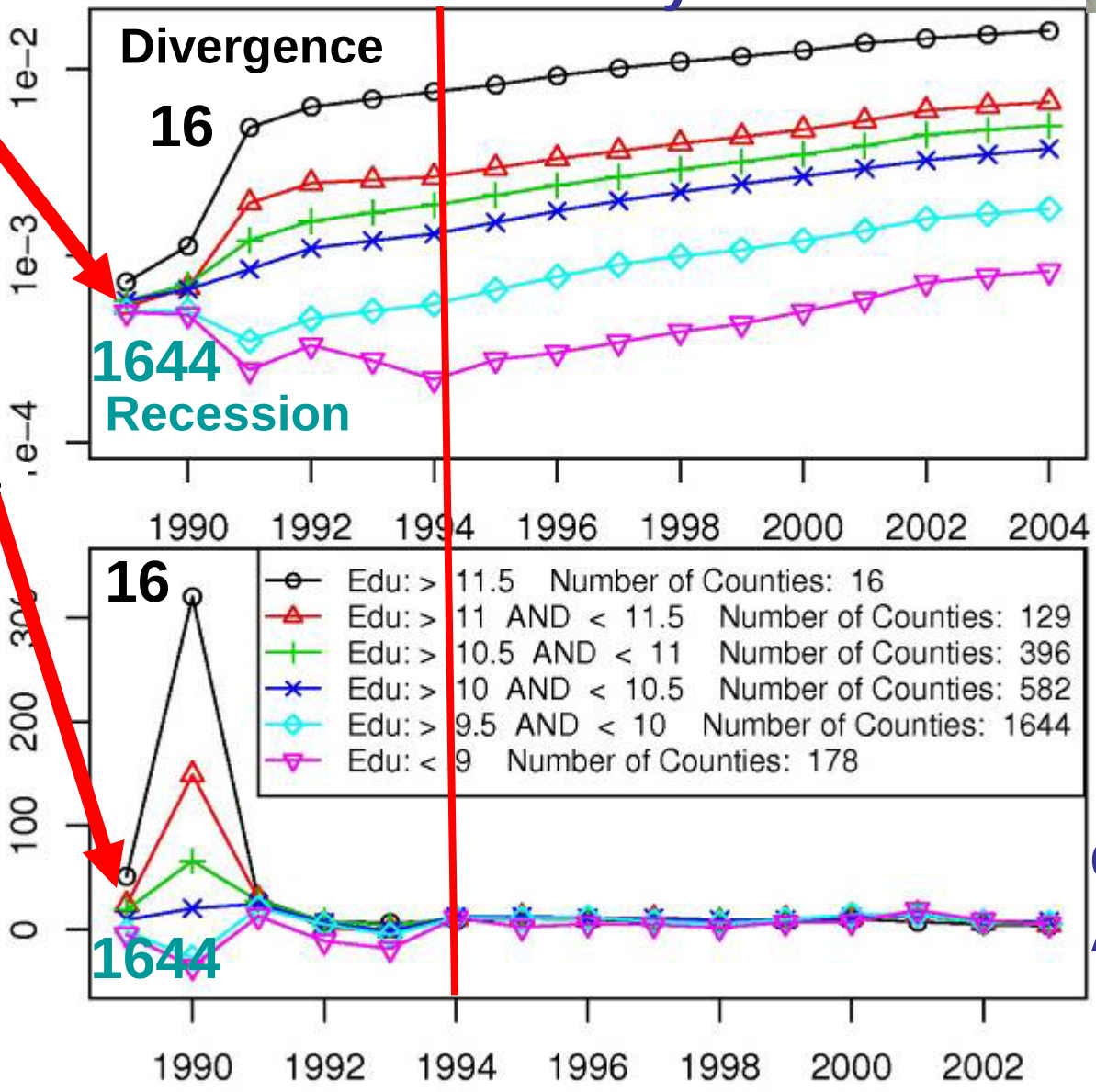
Shock Liberalization

Immediately
After shock

Steady state

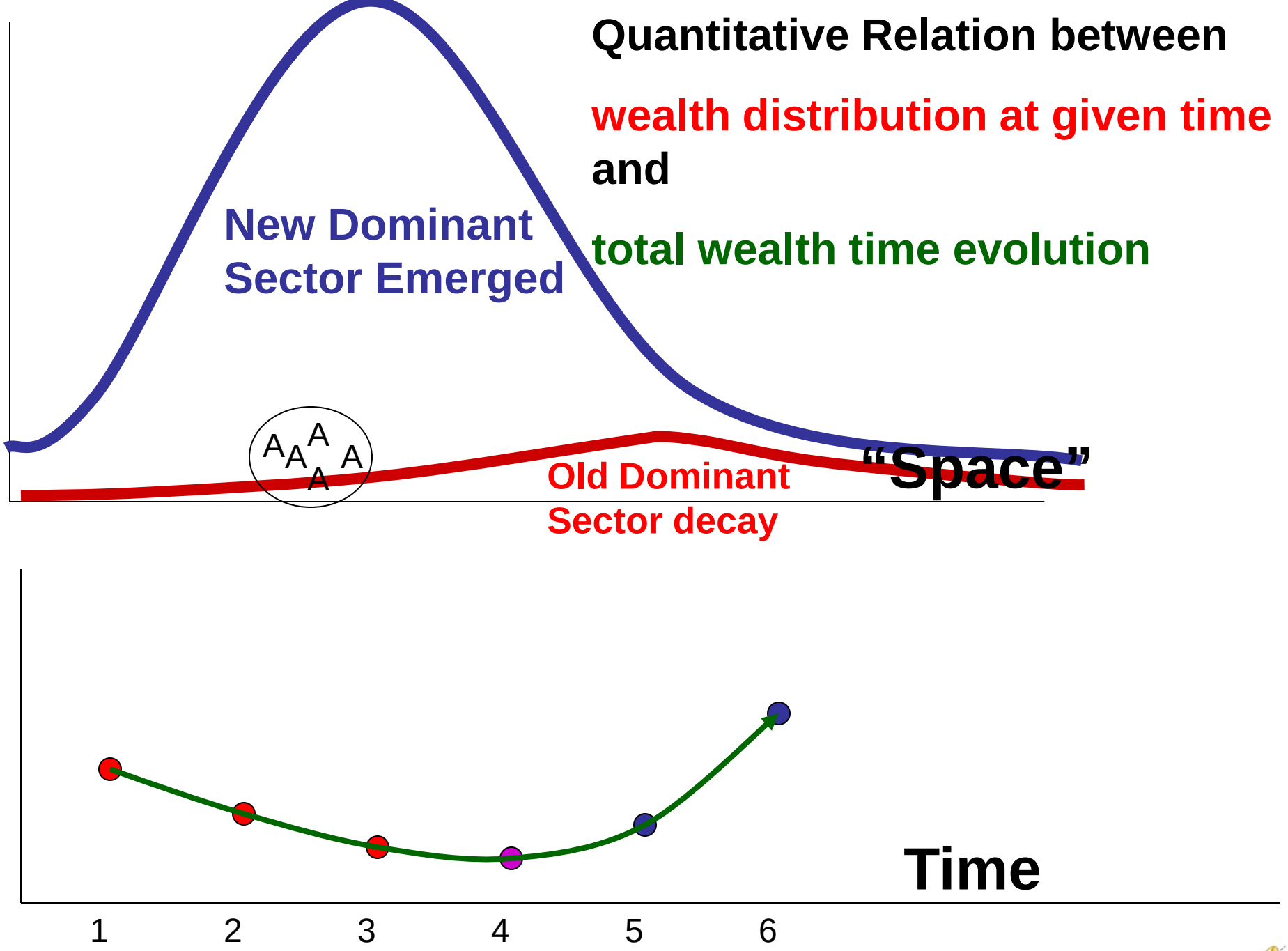
Ln (enterprizes /capita)

RATE of Growth



Growth rate Alignment

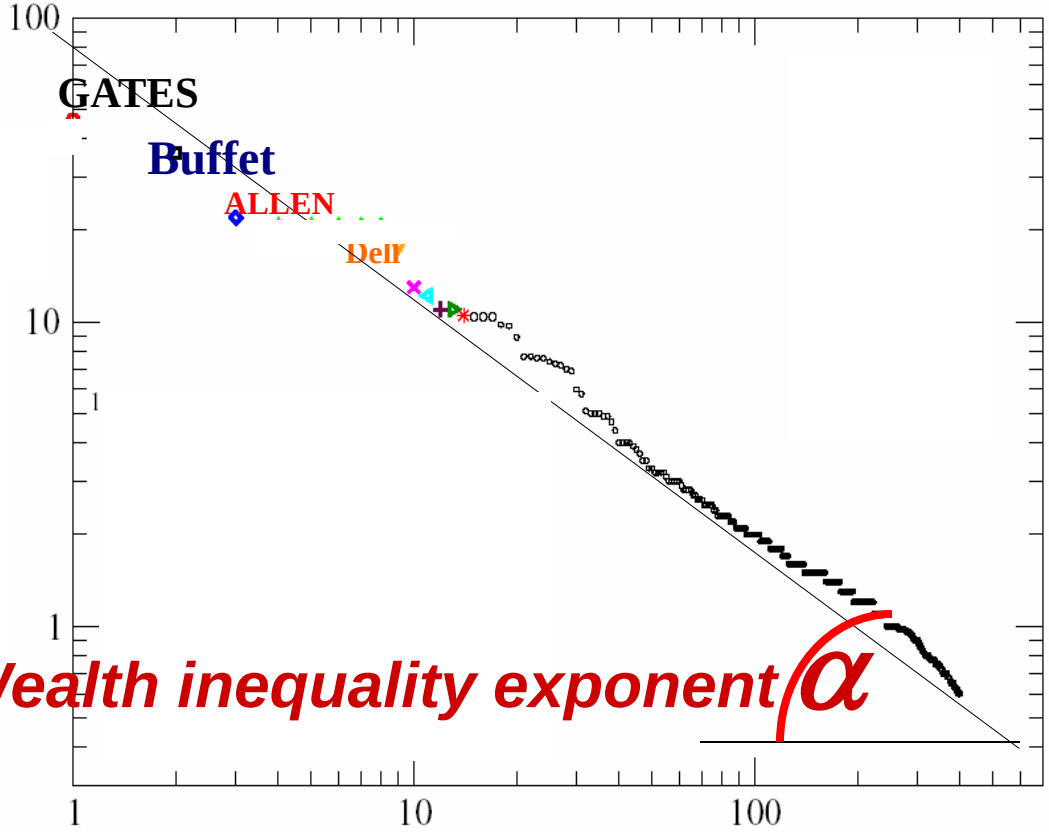
Growth rate Alignment


Quantitative Relation between
wealth distribution at given time
and
total wealth time evolution
New Dominant
Sector Emerged
A A A A A
Old Dominant
Sector decay
"Space"
Time
1
2
3
4
5
6

More reality tests: Pareto?

No one however, has yet exhibited a stable social order, ancient or modern, which has not followed the Pareto pattern.

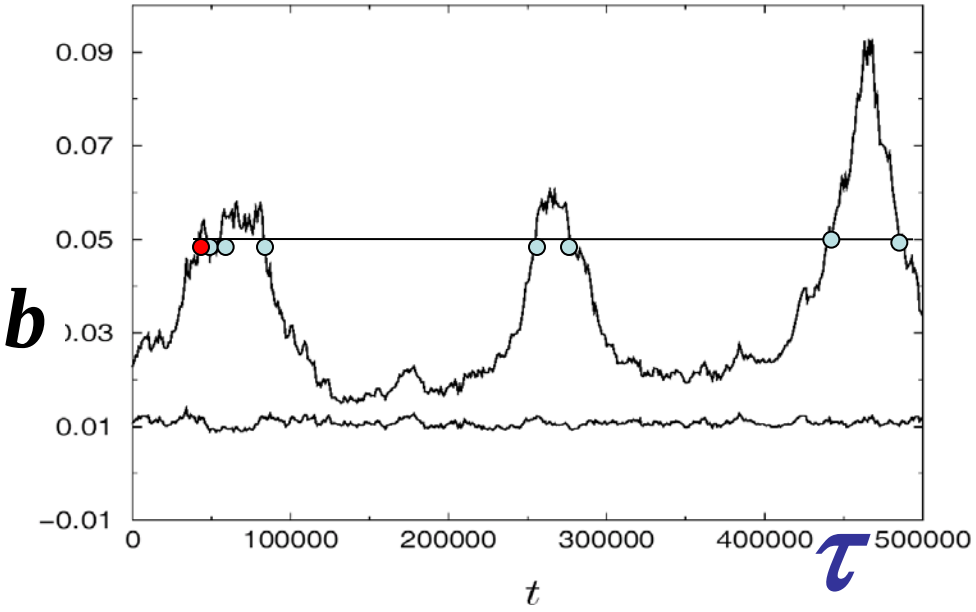
Harold Davis; Cowles Commission for Research in Economics 1941



Wealth inequality exponent α

Pareto's curve
one of the
great generalizations of human knowledge.

Snyder 1939



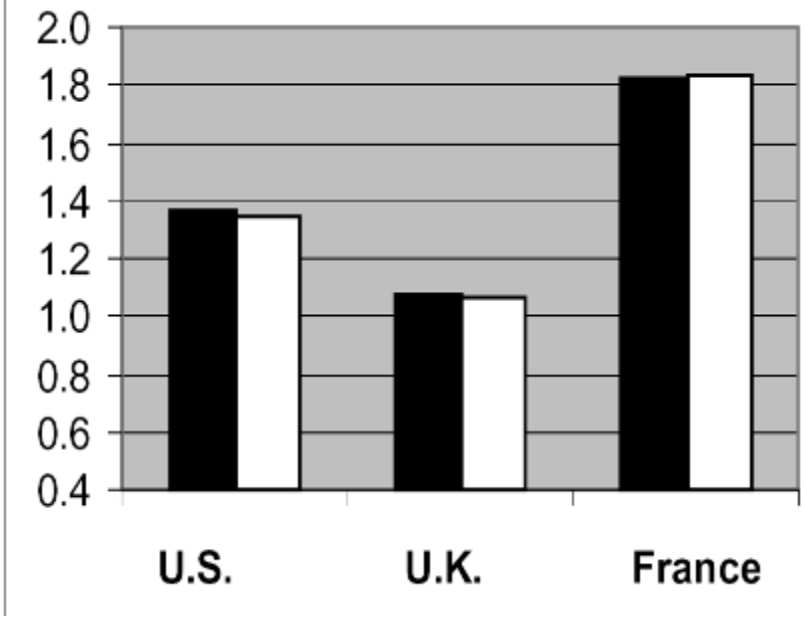
Probability of market to return to the same value

after a time τ

$$Prob\{ b(\tau) = b(0) \} \sim \tau^{-\beta}$$

β = *financial instability exponent*

Wealth inequality exponent α



Quantitative Finance,

M Levy and S S 2003

Strongly Validated by subsequent empirical measurement

Autocatalytic Model Prediction

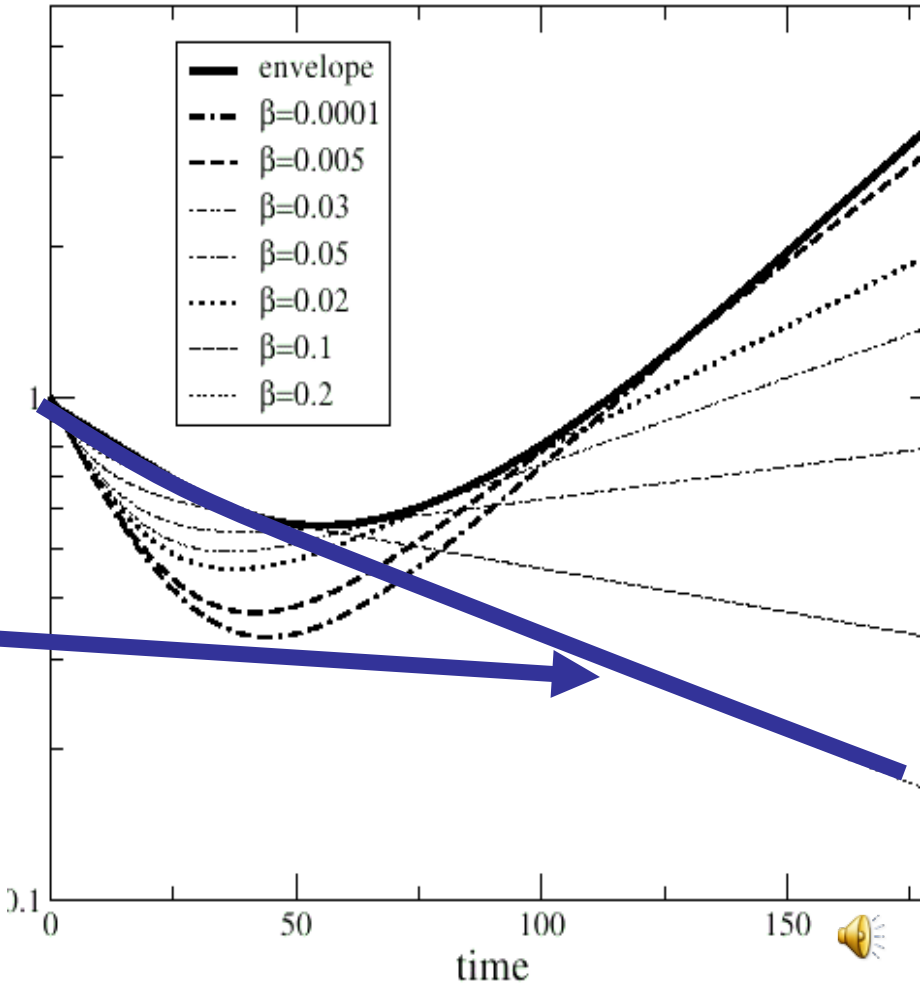
β ***financial instability exponent***

=

Wealth inequality exponent α

$\alpha = \beta$ policy implications

- Globalization of competition,
- ➔Localization of wealth
- ➔Inequality
- ➔Markets instability
- **➔sustainable economy requires fair wealth redistribution.**
- **BUT not exagerated:**



Autocatalytic Percolation

(Cantono and Solomon, New Jou. of Phys 2010)

- **(Solomon at al 2000)**:
  Self-organized Social Percolation Phase transition

Peer-To-Peer

Social

Percolation

Phase

Transition

Fragile

Firms

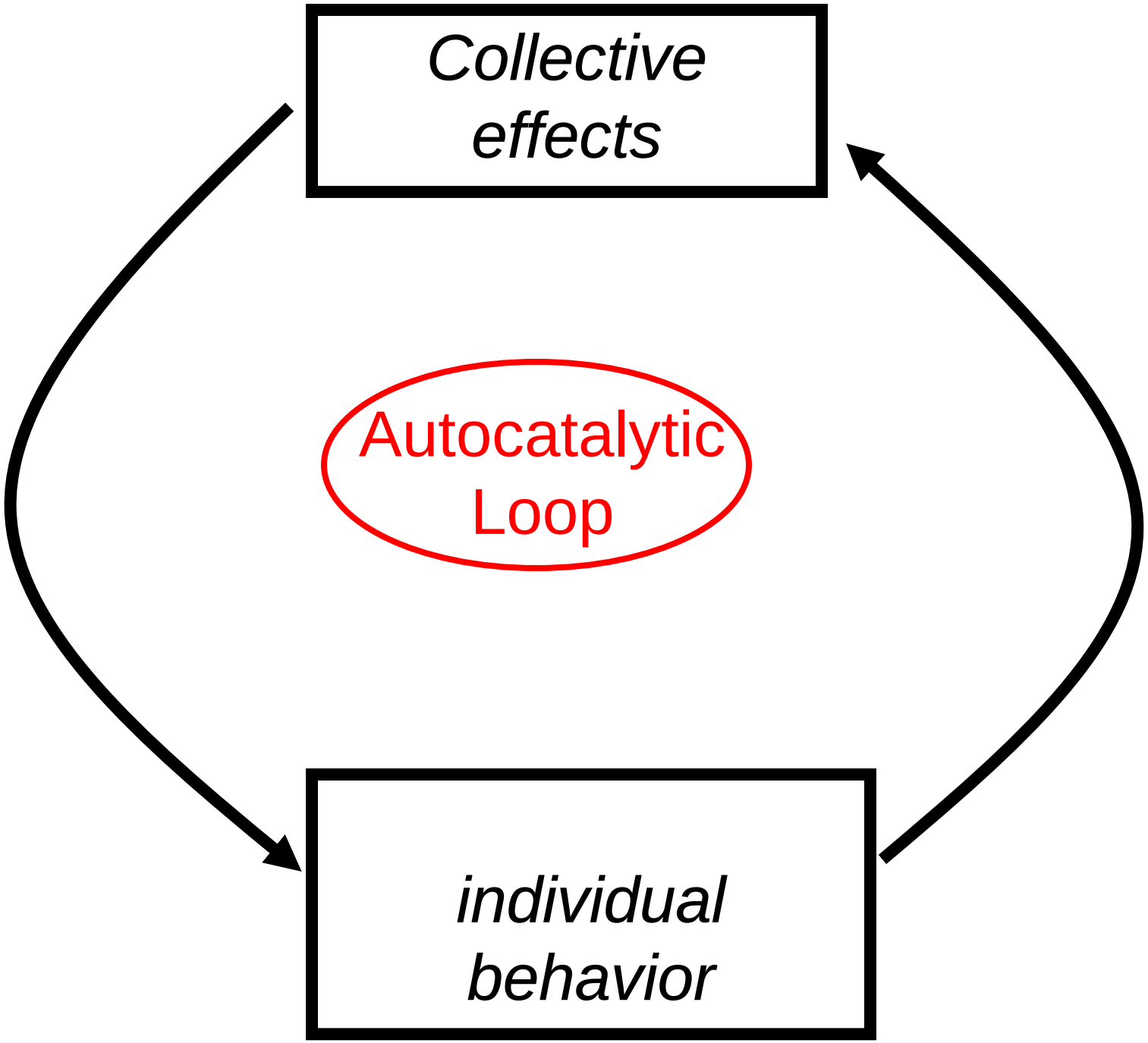
Density ρ_c

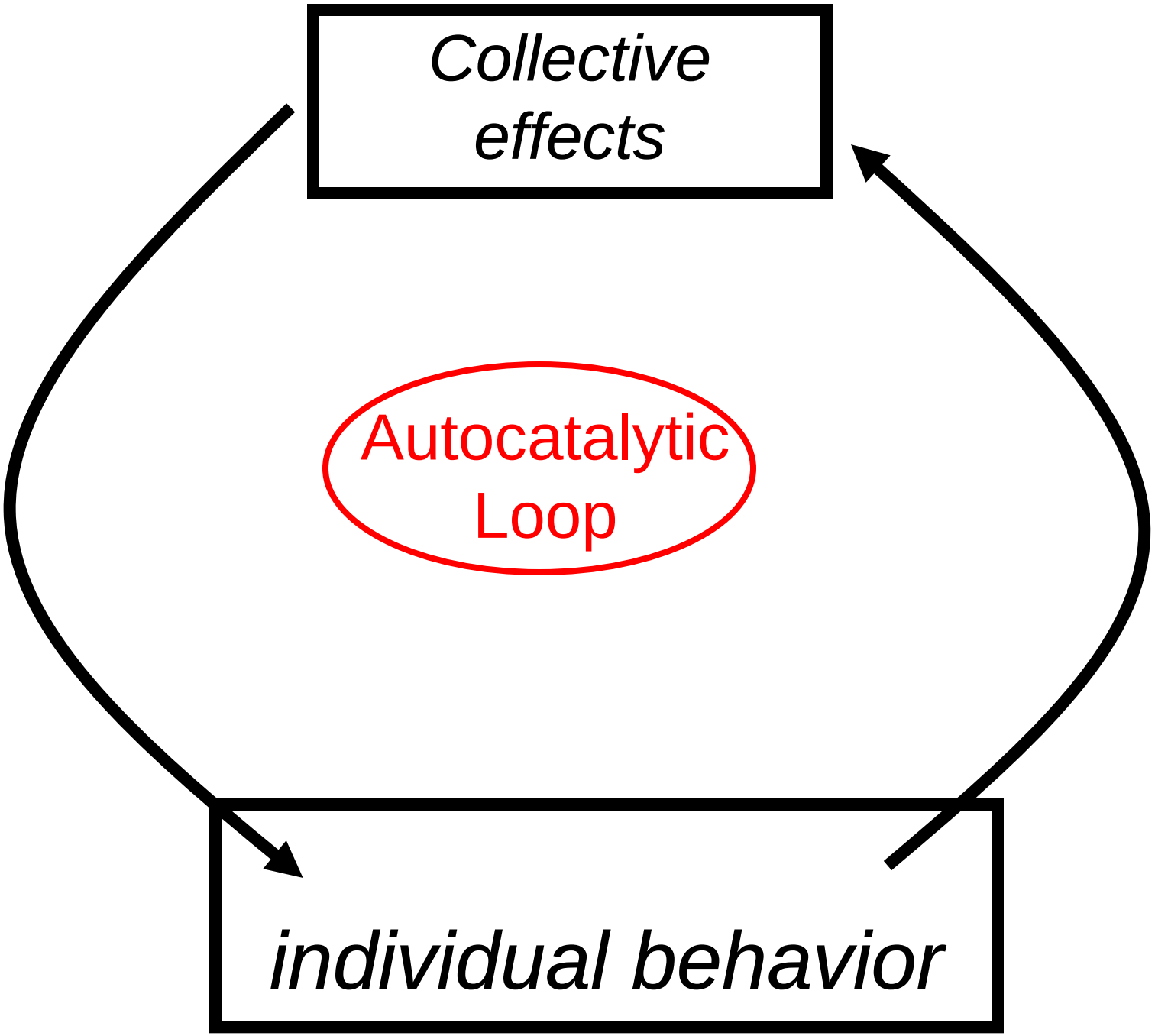
Actual

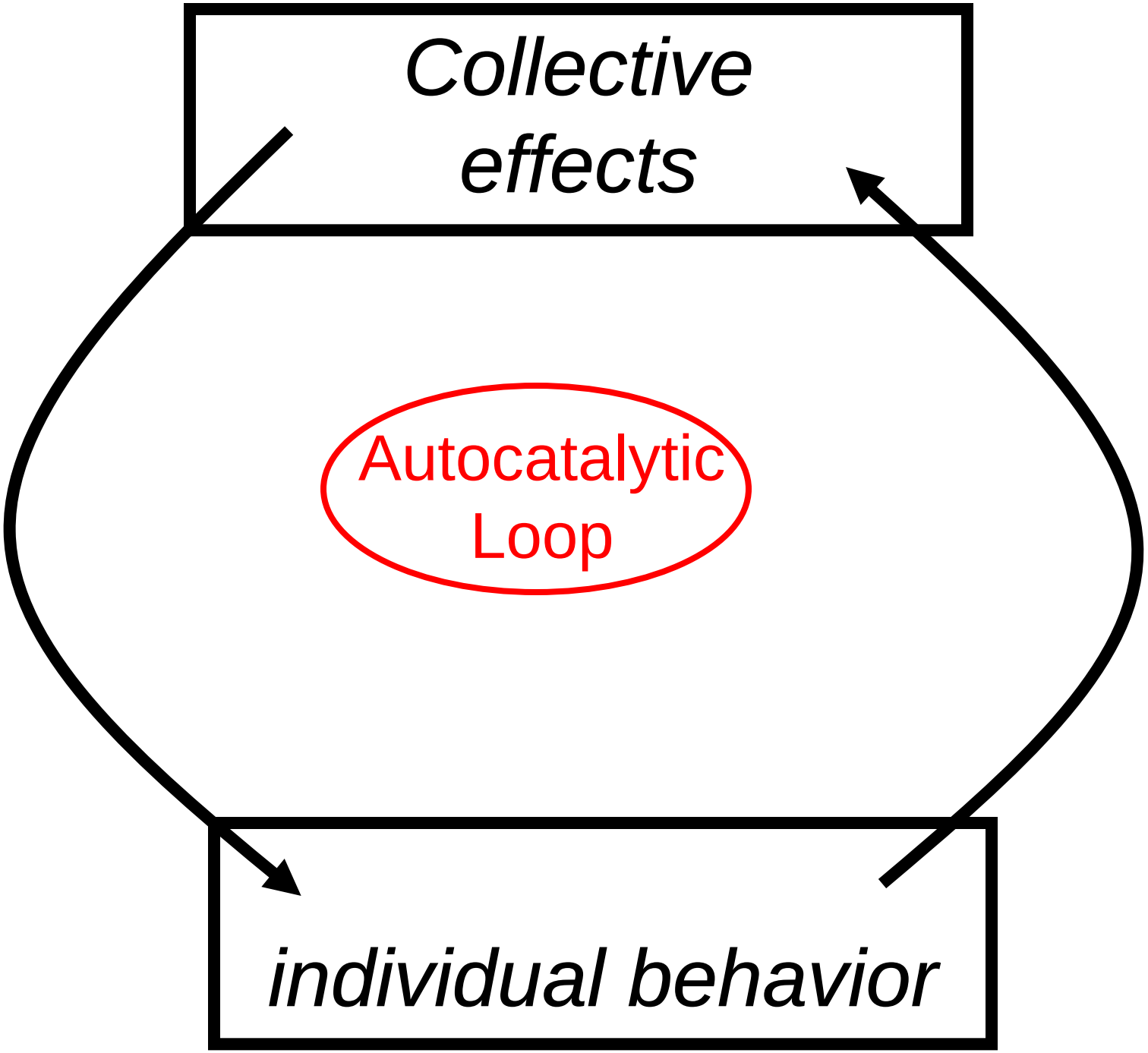
Bankruptcies

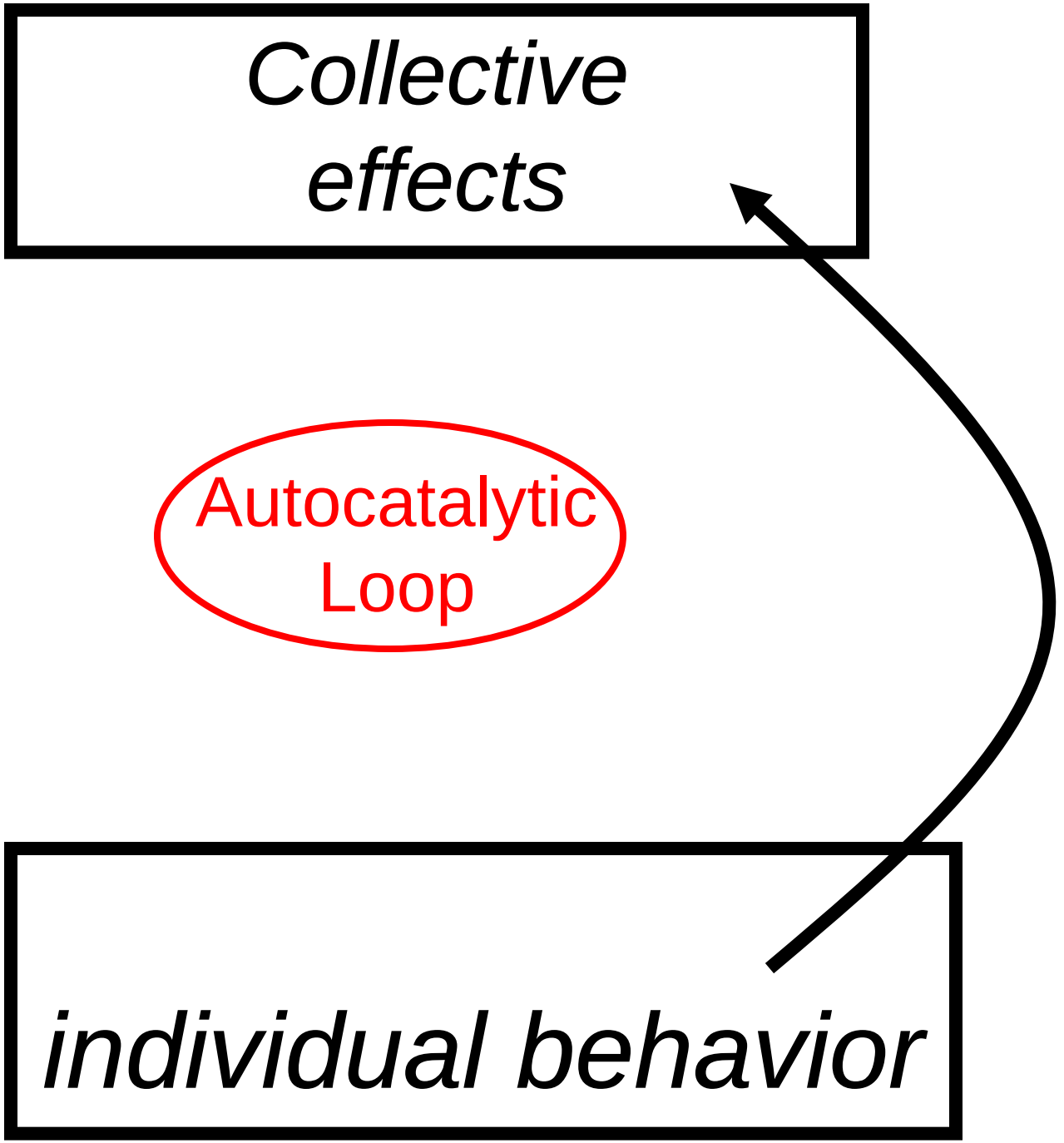
$N \longrightarrow \infty$

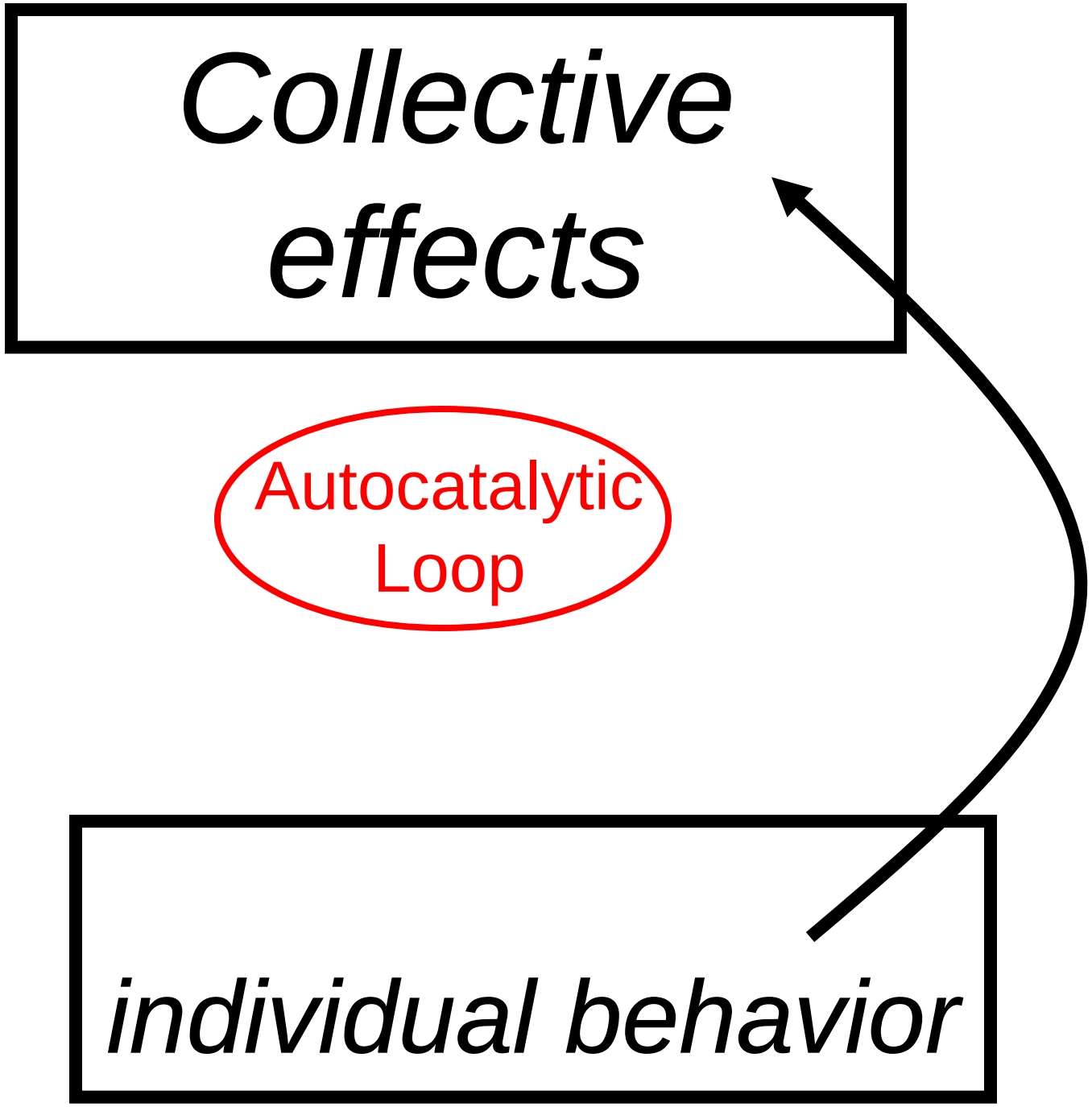
- **2010** MASSIVE TRADE DATA indicate:
  Neglected Autocatalitic
  Top-Down <-> Bottom-Up effects

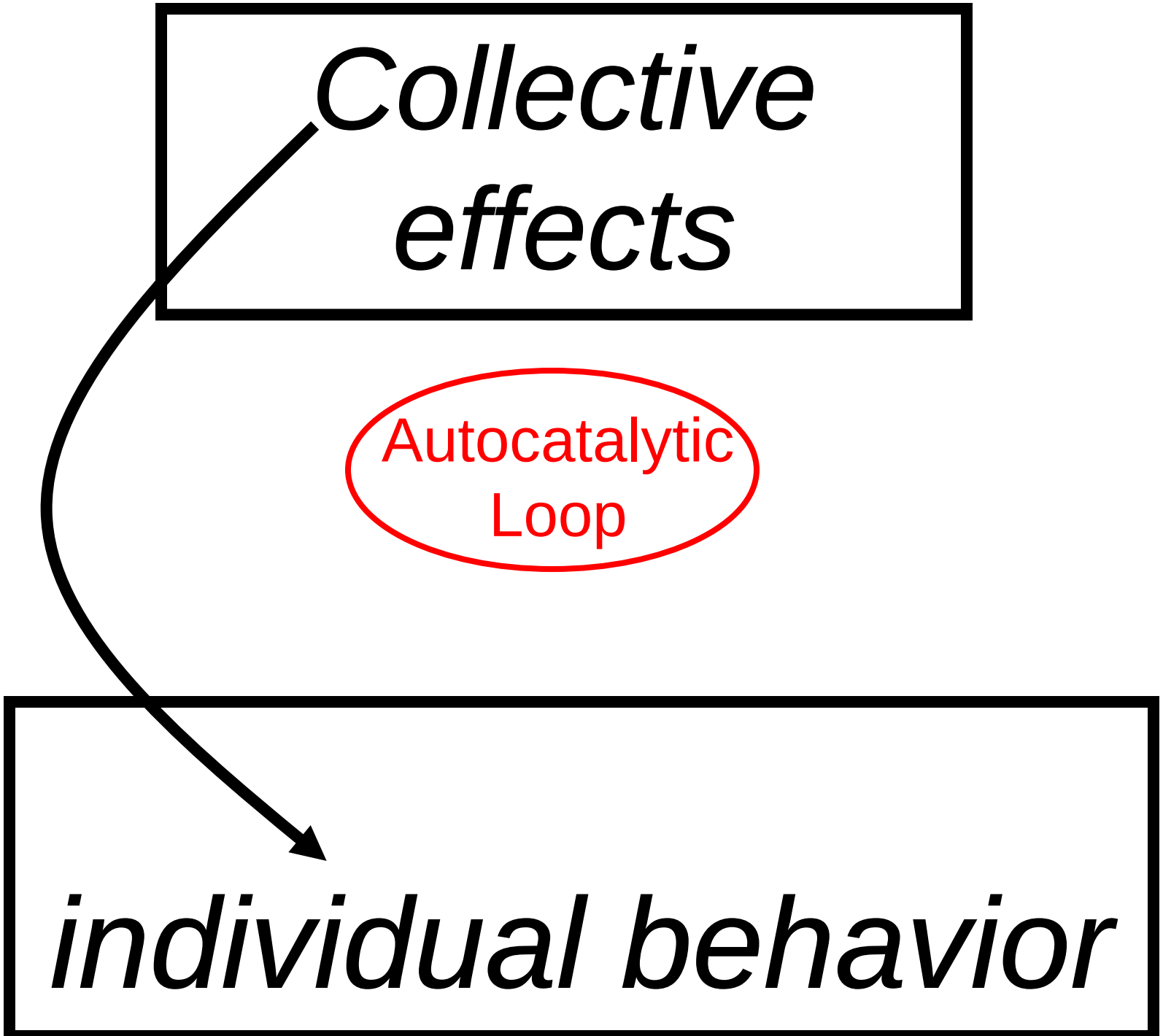

Collective effects
Autocatalytic Loop
individual behavior

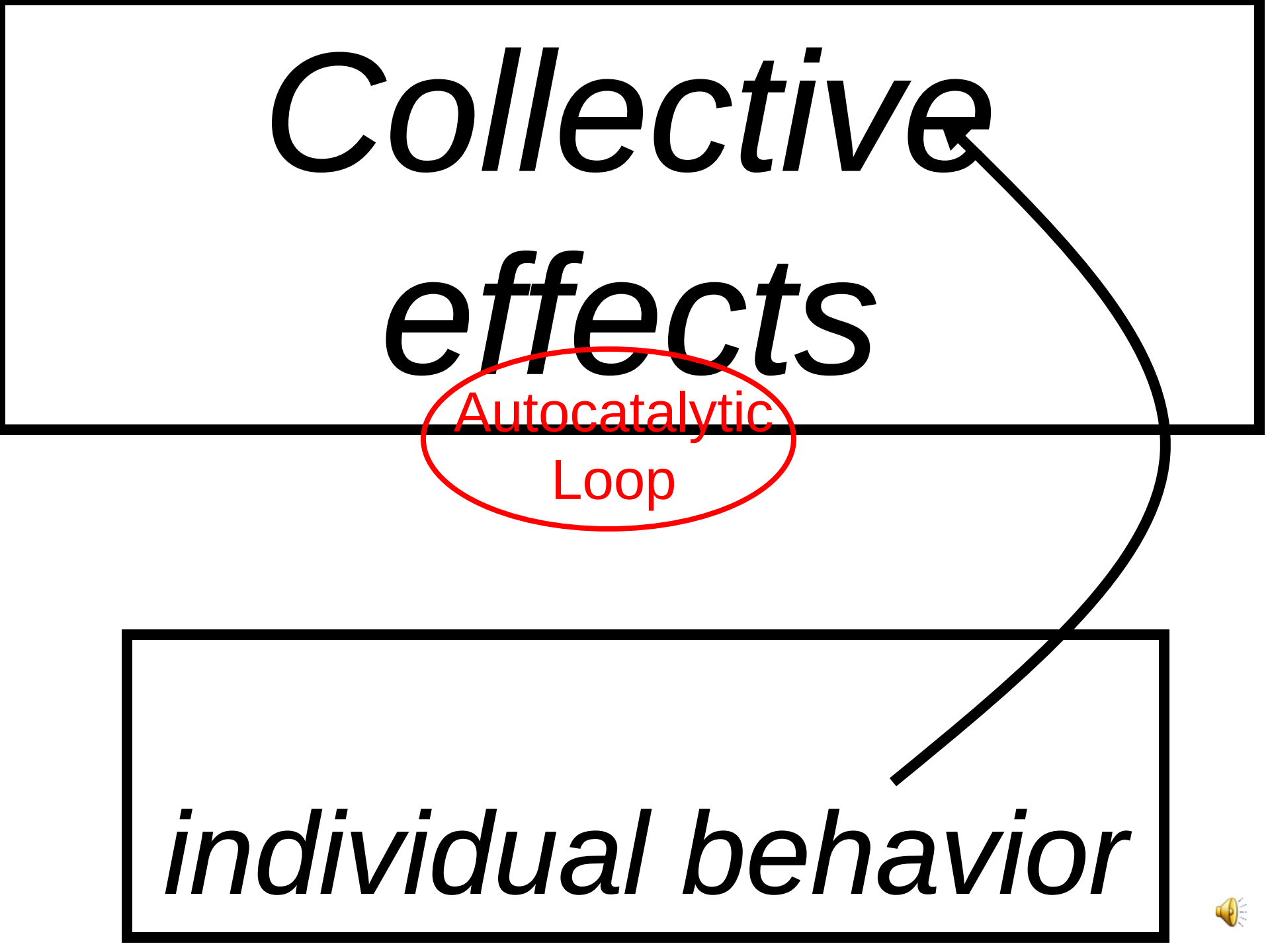

Collective effects
Autocatalytic Loop
individual behavior

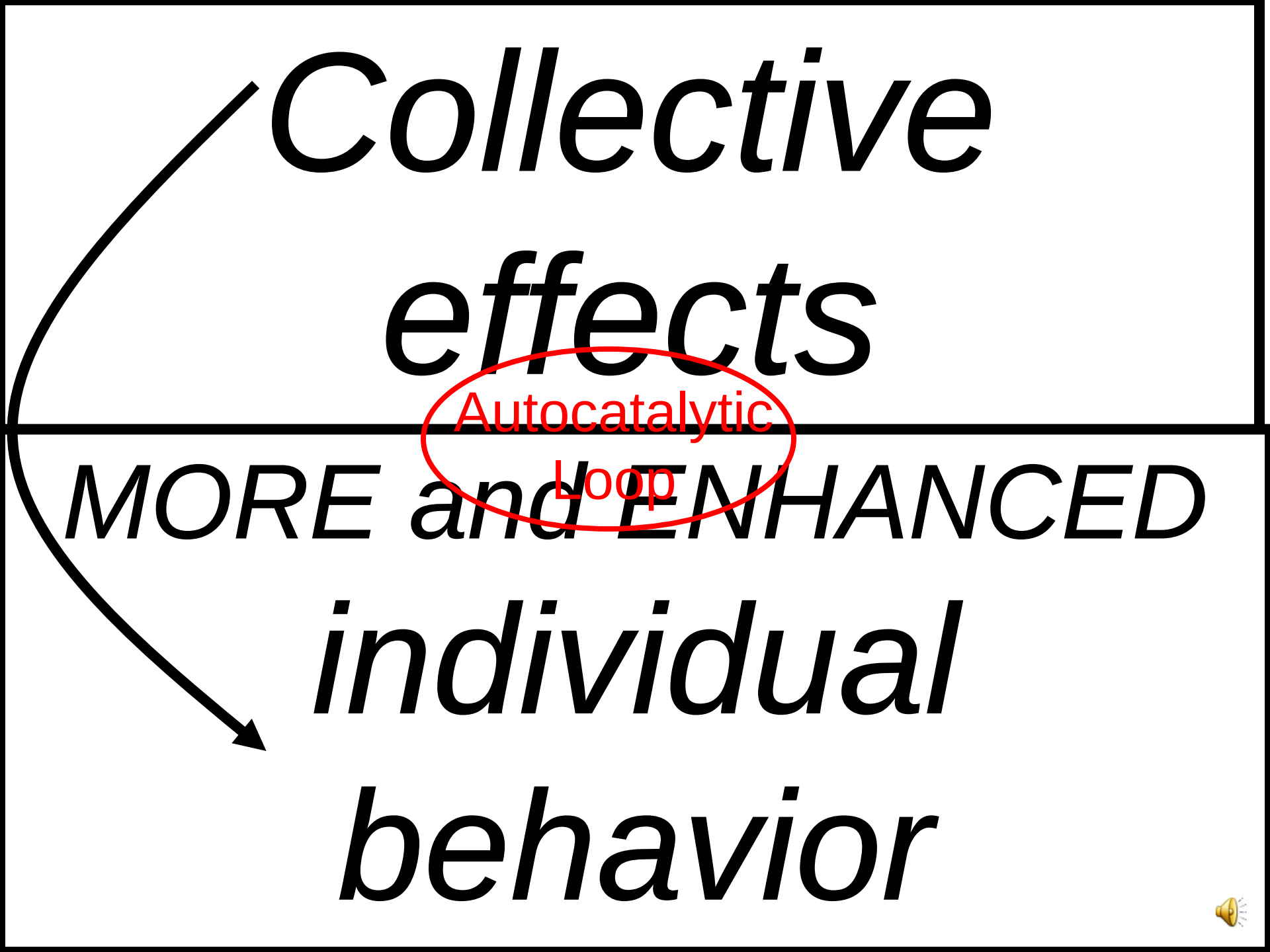

Collective effects
Autocatalytic Loop
individual behavior

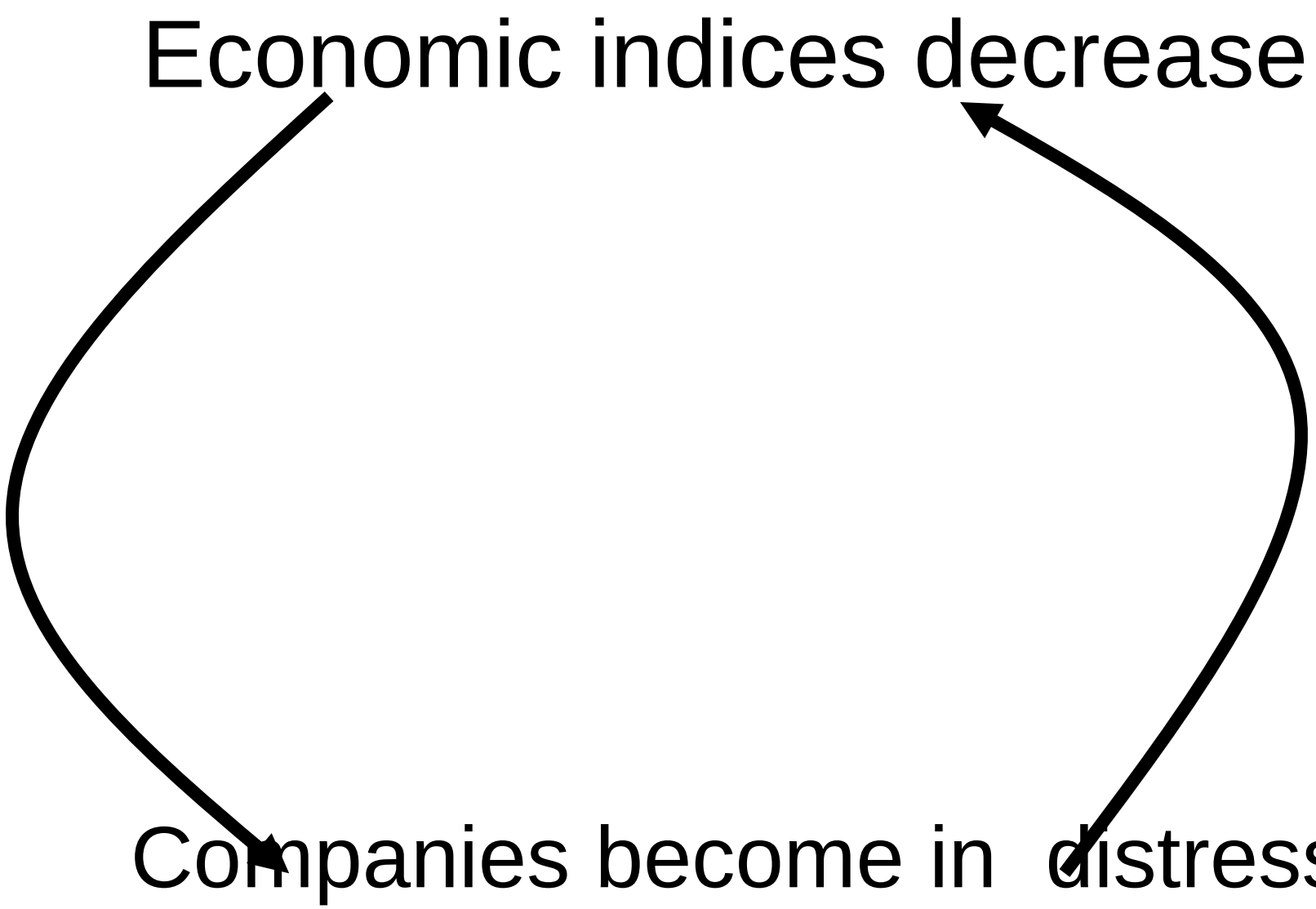

Collective effects
Autocatalytic Loop
individual behavior

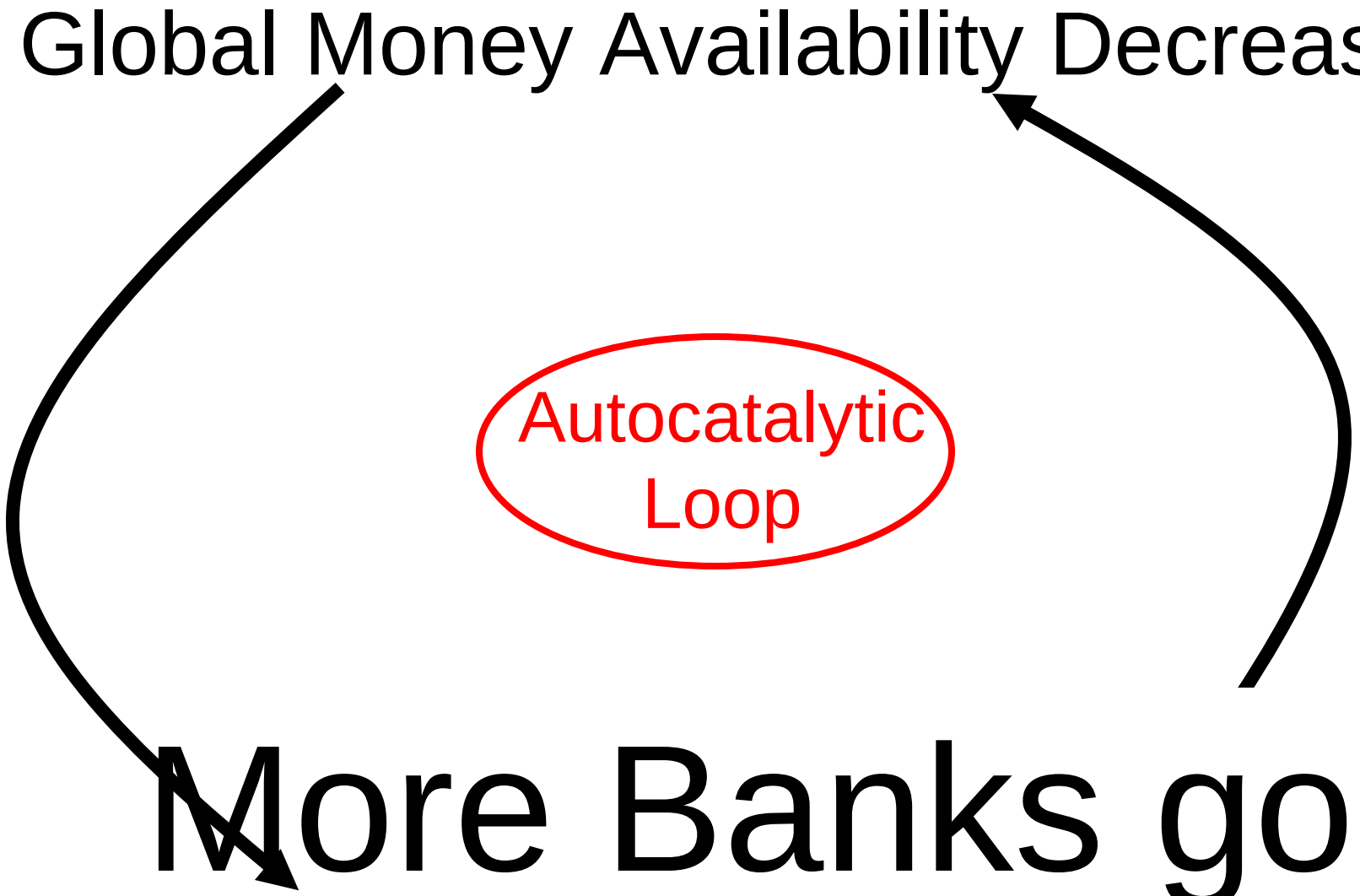

Collective effects
Autocatalytic Loop
individual behavior


Collective effects
Autocatalytic Loop
individual behavior


Collective effects
Autocatalytic Loop
individual behavior


Collective effects
Autocatalytic loop
MORE and ENHANCED
individual behavior


Economic indices decrease
Companies become in distress


Global Money Availability Decreases
Autocatalytic Loop
More Banks go baňkrupť

Autocatalytic Percolation

(Cantono and Solomon, New Jou. of Phys 2010)

Macro State Index p

Top-Down

Bottom-Up

Autocatalytic Loop

Fragile Micro states ρ

Peer-To-Peer Social Percolation

Distressed Micro states N

Autocatalytic Percolation

(Cantono and Solomon, New Jou. of Phys 2010)

Macro State Index p

$\rho = p^{-\mu}$

$p = p_0 N^{-\alpha}$

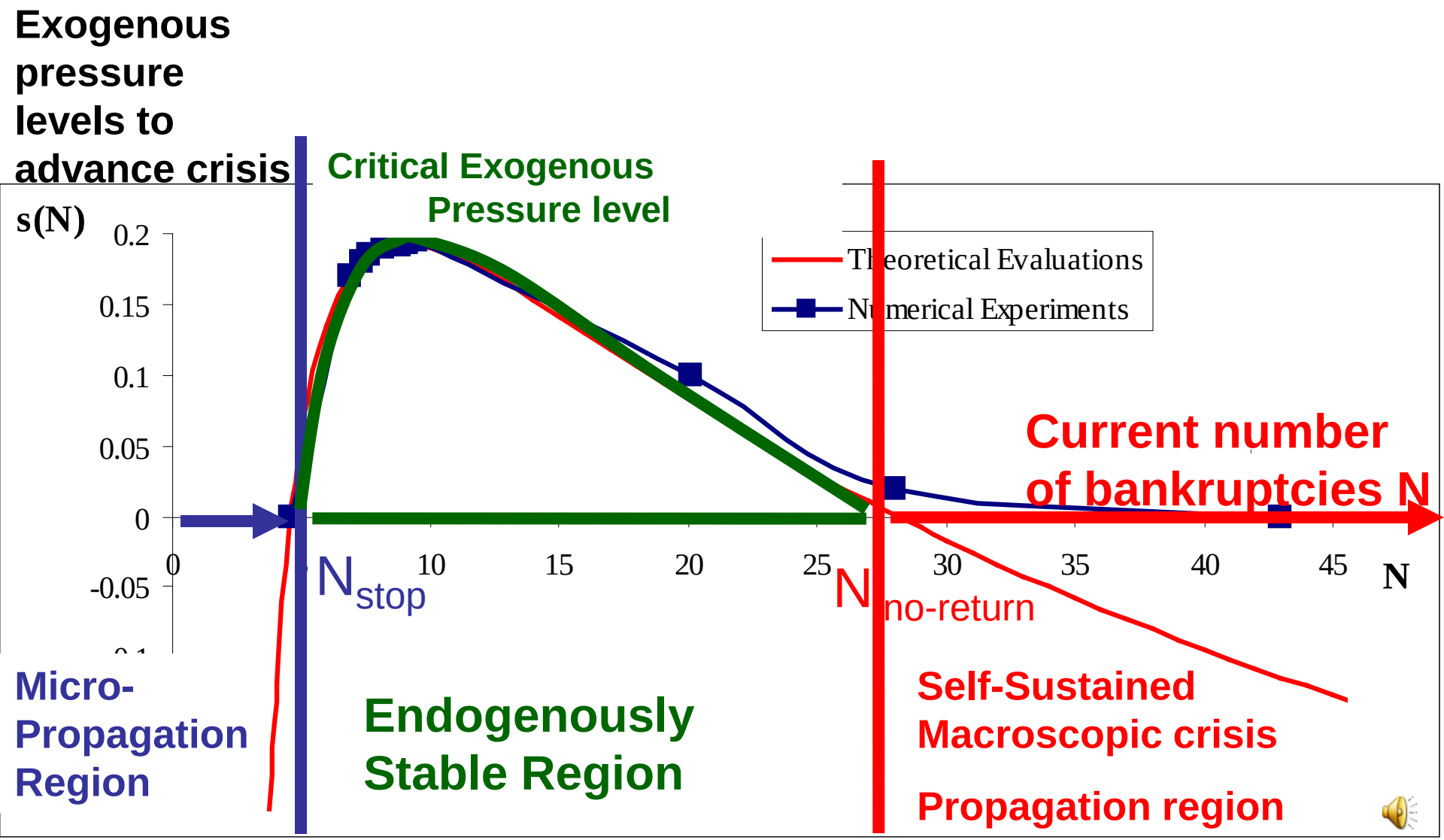
Autocatalytic Loop

Fragile Micro states ρ

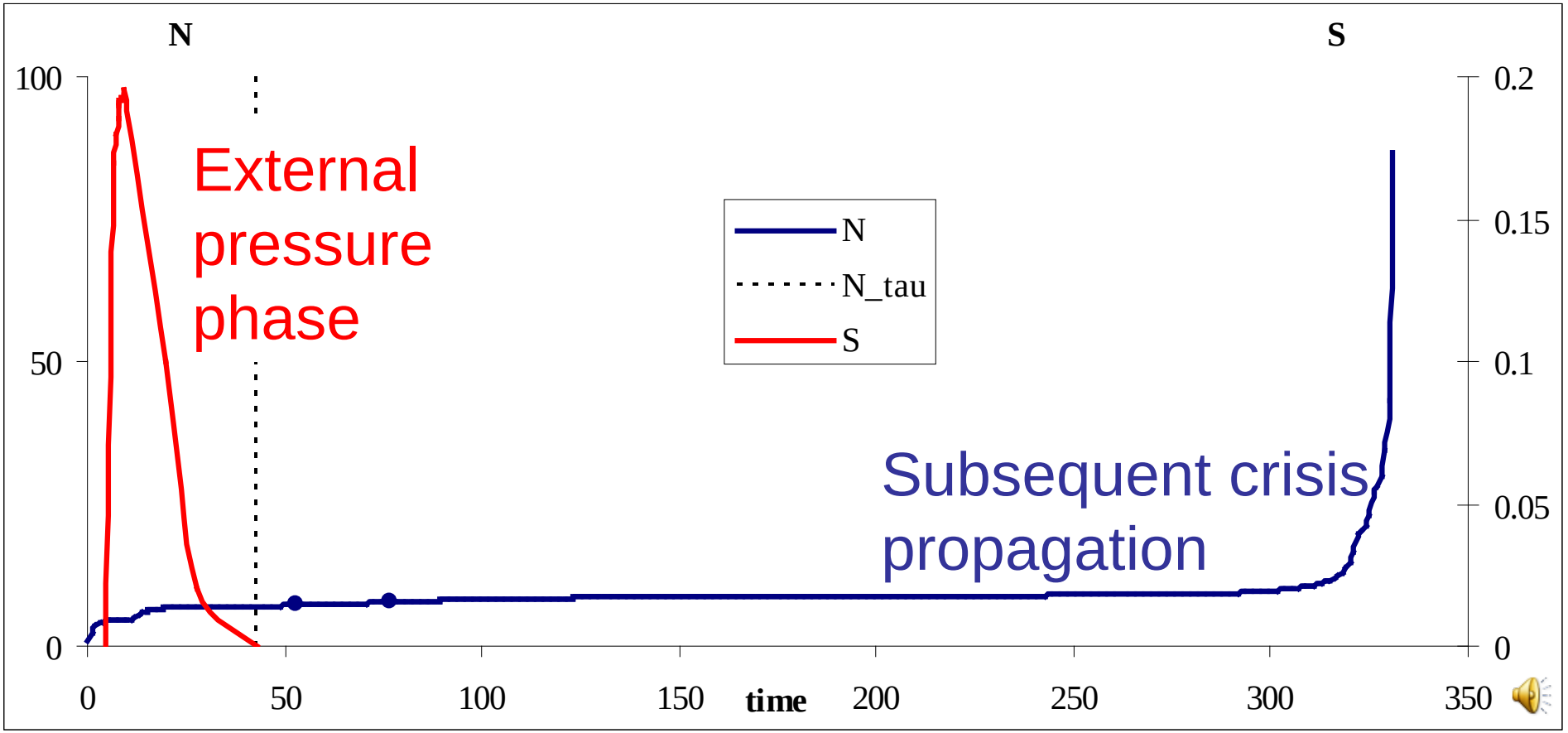
Distressed Micro states N

$N = [1-\rho/\rho_c]^{-\gamma}$

Critical Exogenous Pressure to keep the crisis active

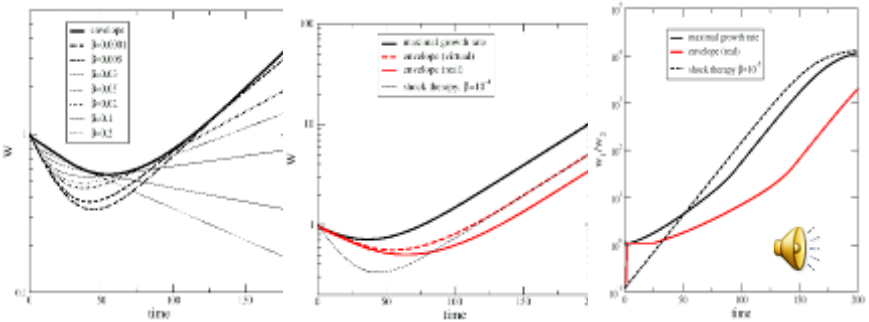


Delayed crisis effect

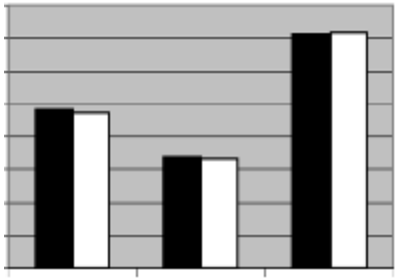


Conclusions

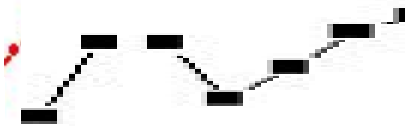
- 200yrs logistic dynamics
- logistic **differential equations** predictions
  ≠ empirical evidence
- **multi-agent** logistic system predictions
  = empirical evidence
- multi-agent logistic system ➔ adaptive, collective objects supporting development and sustainability.
- **Economic Policy Support TOOL**



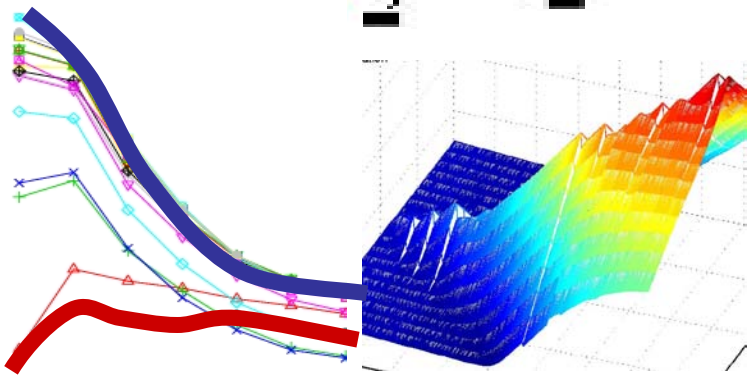
Wealth Distribution < = > Market Fluctuations



J-shape < = > Sectors Crossing



Growth < = > Diffusion



Divergence < = > Alignment