DPG Spring Meeting Regensburg 2010

Macro Econophysics and the Laws of Banking *

Putty and clay functions

in production and finance

Jürgen Mimkes, Physics Department, Paderborn University, Germany

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What are putty and clay functions ?
Two dimensional calculus in economic theory
Laws of productive and financial markets

* Physica A 389 (2010) 1665-1676

What are putty and clay* functions?

Putty: an economic property (e.g. income from stocks **Y**)

is flexible, unpredictable, **putty** - at the beginning of the year (ex ante) and

is fixed, **clay** - at the end of the year (ex post).

* Johansen, L., Econometrica 27 (1959) 157

What are putty and clay functions?

Putty: an economic property (e.g. income from stocks **Y**)

is flexible, unpredictable, **putty** - at the beginning of the year (ex ante) and

is fixed, **clay** - at the end of the year (ex post).

Clay: an economic property (e.g. capital **K**)

is fixed, predictable, clay - before going shopping (ex ante) and

is fixed, predictable, clay - after shopping (ex post) :

the sum of money and commodities is constant:

(within a time limit I can get my money back, if I don’t like the item.)

* Johansen, L., Econometrica 27 (1959) 157

The problem

Macro-economics is based on
the **Solow Model:** **$Y = F\ (K, N)$**

But: Income (Y) is putty,
(we can file our tax returns only at the end of the year).

The production function (F) is clay,
(companies want to know beforehand, how much capital (K) and how much labor (N) they have to invest in production)

Putty cannot be equal to clay! **$Y \neq F\ (K, N)$**

Introduction to putty and clay

Calculus of n variables

1 dim. theory: F(x)	Riemann integral	
2 dim. theory: F(x, y)	Riemann integral	
	Stokes integral	
3 dim. theory: F(x, y, z)	Riemann integral	(el. potential)
	Stokes integral	(magnetism)
	Gauss integral	(el. charge)

Introduction to putty and clay

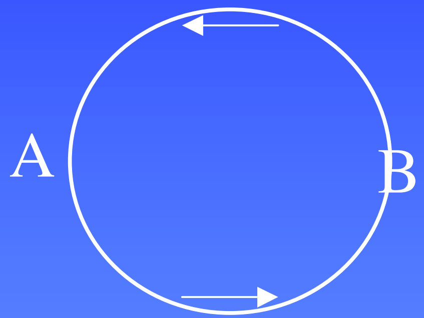
Calculus of n variables

1 dim. theory: F(x)	Riemann integral	
2 dim. theory: F(x, y)	Riemann integral	(clay)
	Stokes integral	(putty)
3 dim. theory: F(x, y, z)	Riemann integral	(el. potential)
	Stokes integral	(magnetism)
	Gauss integral	(el. charge)

Economics has two variables, capital and labor, F(K, N).
We may expect two different integral laws: Riemann and Stokes,
and two types of functions: putty and clay

Calculus in two dimensions: putty and clay

1. **Riemann integrals** of **exact** differential forms **d F are path independent (clay)**



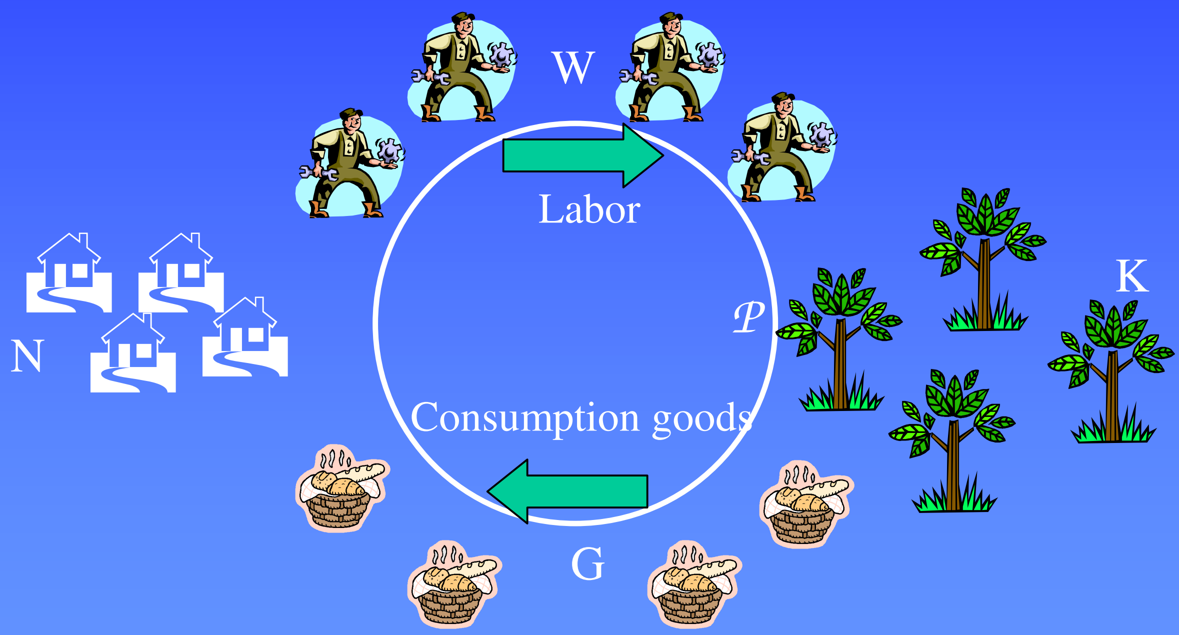
$$\oint dF = 0$$

2. **Stokes integrals** of **not exact** differential forms **δ Y are path dependent (putty)**

$$\oint \delta Y \neq 0$$

integrable (clay) only after the path is known (ex post)

Primitive production cycle ($\mathcal{P}$)



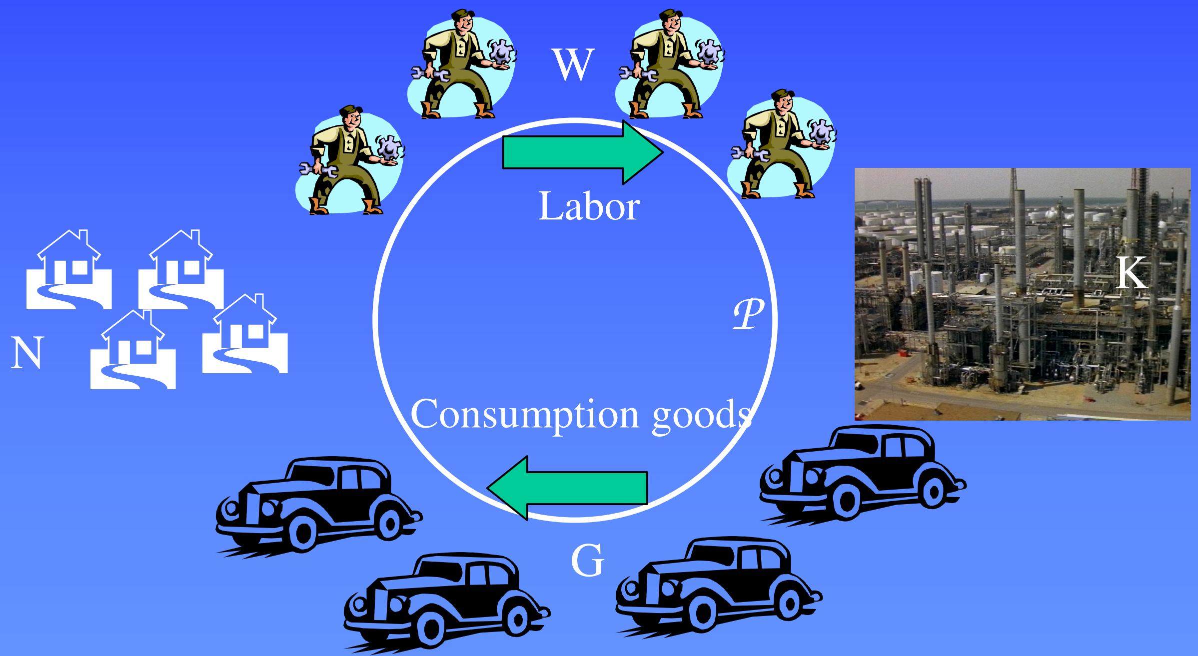
1. Production cycle ($\mathcal{P}$):

⇒ People go to work in agriculture.

⇐ Consumption goods are brought back to households as reward for the work.

Production cycle after F. Quesnay (1694 - 1774)

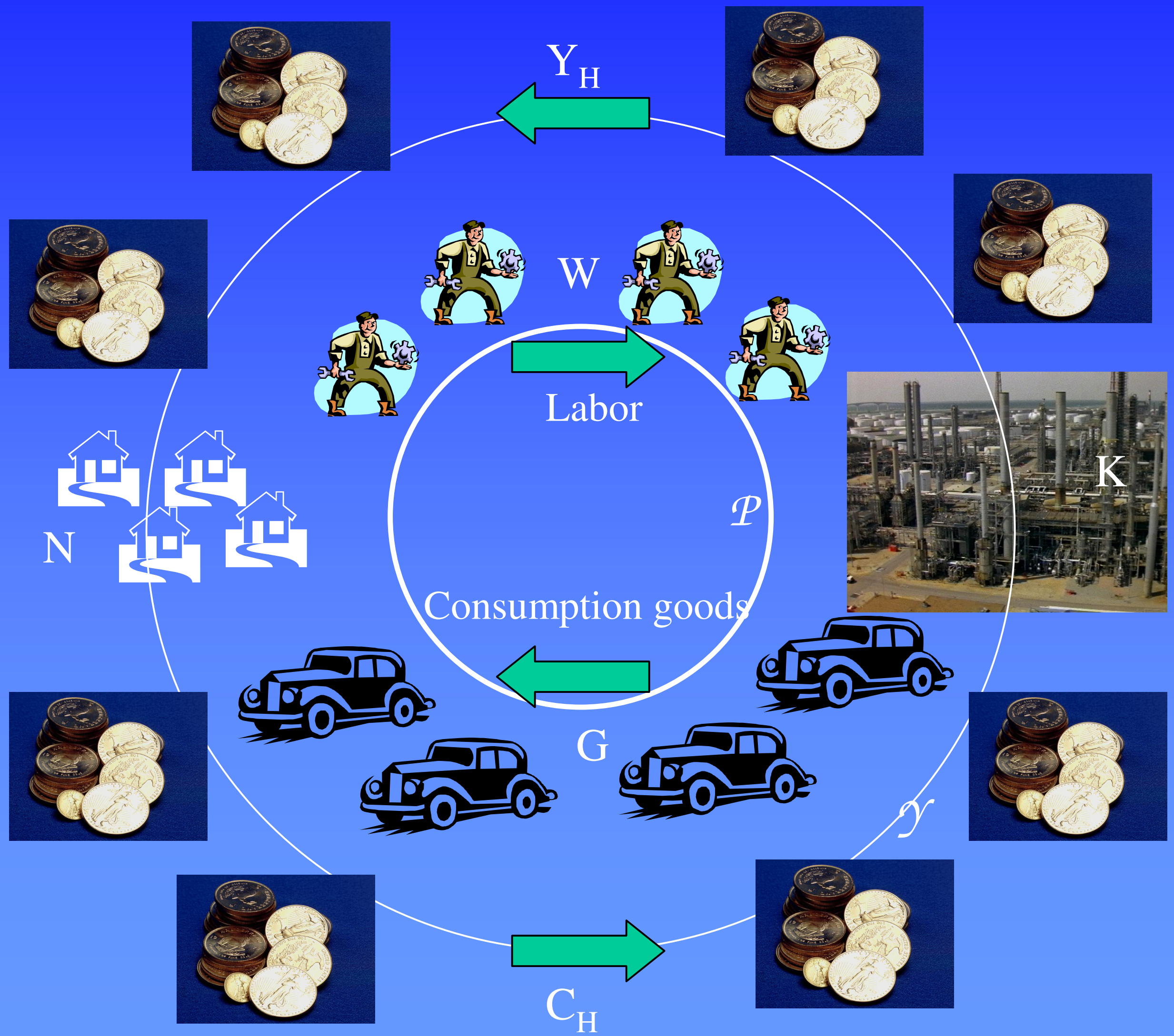
Modern production cycle ($\mathcal{P}$)



1. Production cycle ($\mathcal{P}$):

$\Rightarrow$ People go to work in industry.

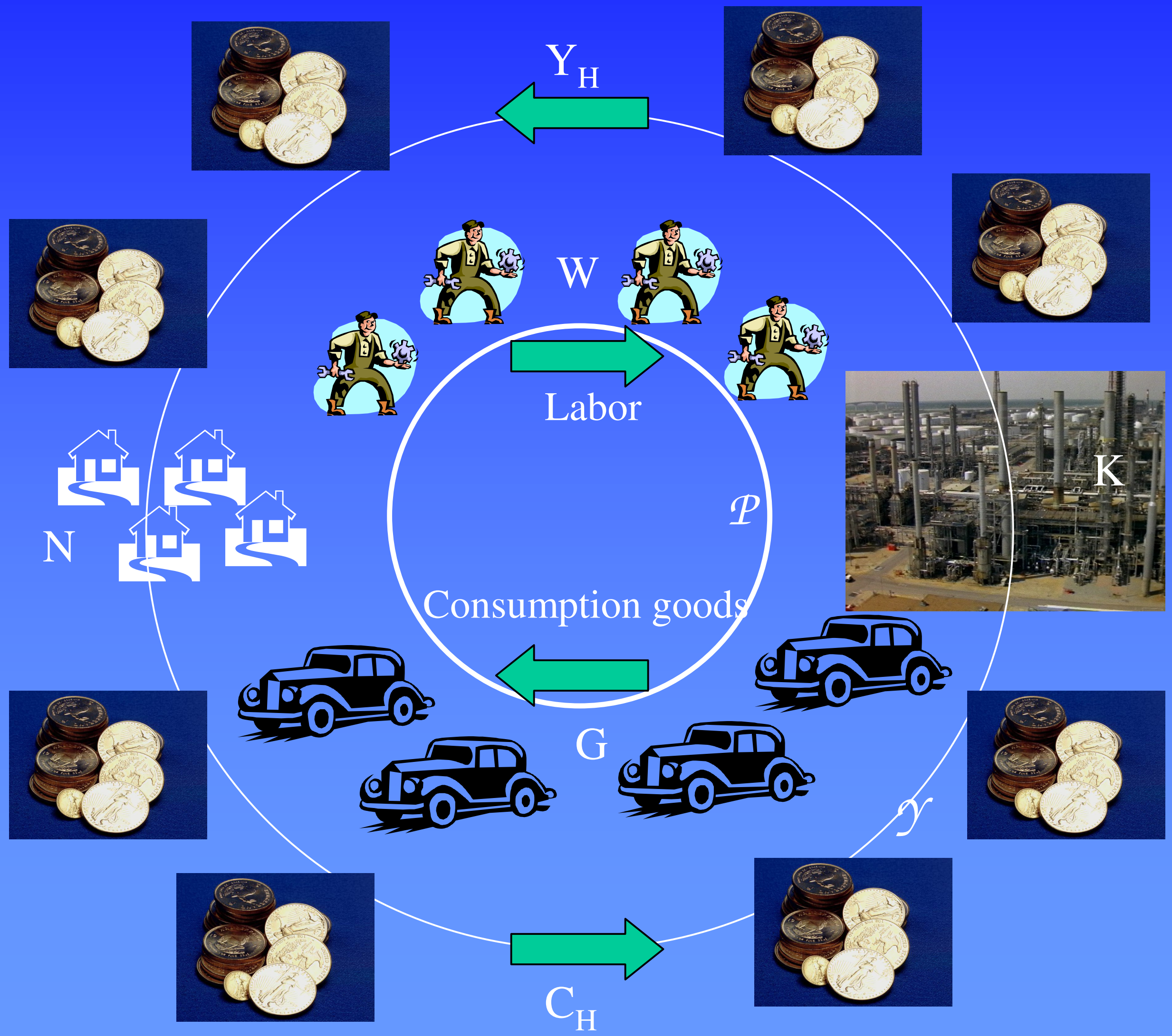
$\Leftarrow$ Industrial goods are sent to households (but not as reward).



2. Monetary cycle ($\mathcal{Y}$):

⇐ Industry pays wages (Y_H) to households for labor (W) .

⇒ Households pay consumption costs (C_H) to industry for consumption goods (G)



2. Monetary cycle ($\mathcal{Y}$):

The monetary cycle (δ Y) measures the production cycle (δ P) in $, €, £.

$$\oint \delta Y = -\oint \delta P \neq 0$$

The closed integrals of (δY) and (δ P) are Stokes integrals or putty functions.

The putty laws of economics

$$\oint \delta Y = -\oint \delta P$$

$$\Rightarrow \quad \delta Y = dK - \delta P$$

Income capital labor (work)

The putty laws of economics

$$\oint \delta Y = -\oint \delta P$$

$\Rightarrow$ 1. law:

$$\delta Y = dK - \delta P$$

Income capital labor (work)

The Stokes laws of thermodynamics

$$\oint \delta Q = -\oint \delta W$$

$$\delta Q = dE - \delta W$$

The putty laws of economics | The Stokes laws of thermodynamics

$$\oint \delta Y = -\oint \delta P \qquad \oint \delta Q = -\oint \delta W$$

⇒ 1. law: $\delta Y = dK - \delta P$ $\qquad \delta Q = dE - \delta W$

Income capital labor (work)

⇒ 2. law: $\delta Y = \lambda \cdot dF$ $\qquad \delta Q = T \cdot dS$

Income ↑ production function

standard of living

Y ≠ F (K, N) as predicted

laws of industry, banks **laws of motors, heat pumps**

Macro- Econophysics

	Economics	↔		Physics
Y	income, profit	↔	Q	heat
K	capital	↔	E	energy
P	production	↔	W	work
F	production function	↔	S	entropy
λ	standard of living	↔	T	temperature
π	equation of state	↔	p	pressure
N	labor force	↔	N	particle number

Micro- Econophysics

F	production function	↔	S	log (probability)
L	Lagrange function	↔	F	free energy

Macro- Econophysics

	Economics	↔		Physics
Y	income, profit	↔	Q	heat
K	capital	↔	E	energy
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F	production function	↔	S	entropy
λ	standard of living	↔	T	temperature
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N	labor force	↔	N	particle number

Micro- Econophysics

F	**production function**	**↔**	**S**	**log (probability)**
L	**Lagrange function**	**↔**	**F**	**free energy**

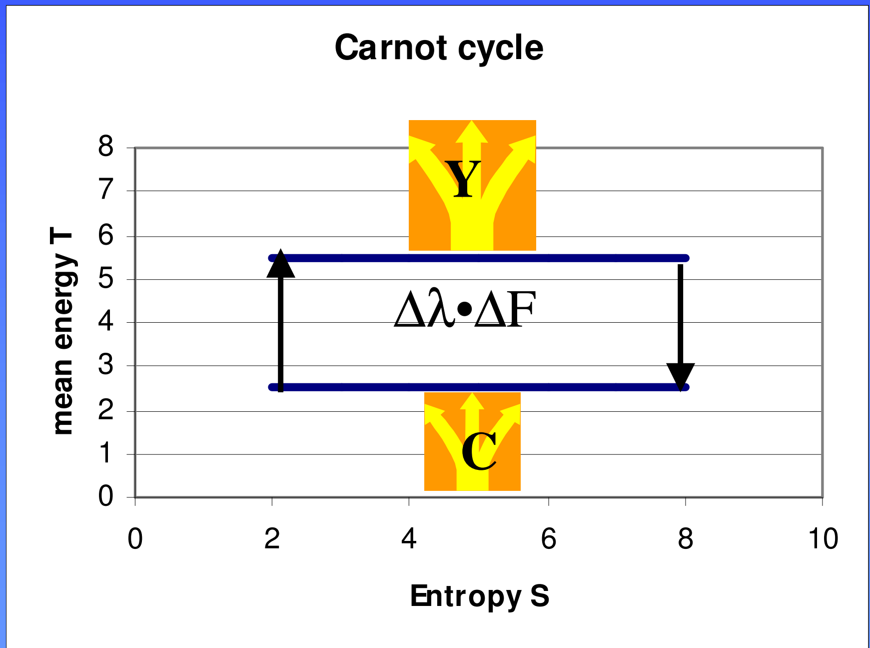
Application: Carnot process of production

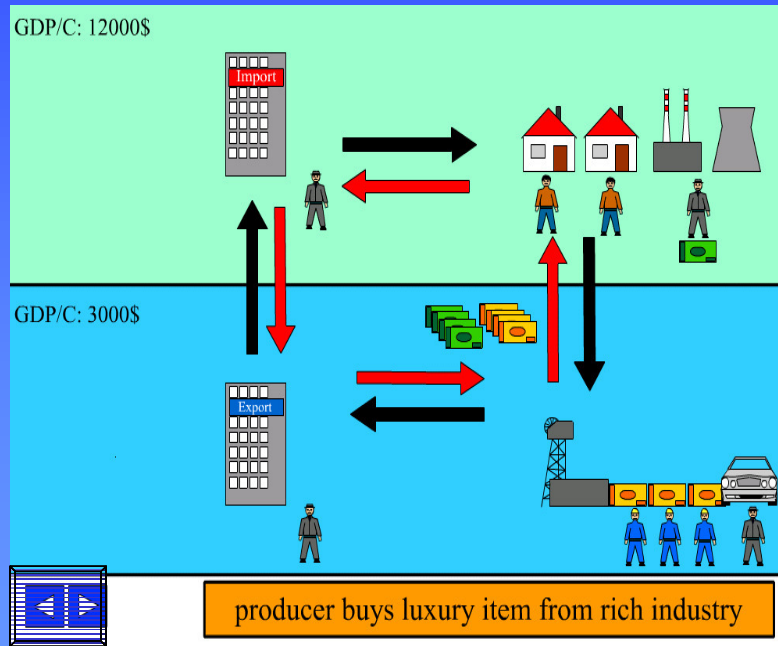
$$\delta Q = T \cdot dS$$

$$\oint \delta Y = \oint \lambda dF \neq 0$$

λ_2

λ_1





Carnot Process of industry, farms, markets, banks and foreign trade

Application: Banking

Banks invest in financial (d K) and in productive (δ P) markets.

$$\delta Y = dK - \delta P \quad \Leftrightarrow \quad \oint \delta Y = \oint dK - \oint \delta P > 0!$$

$$\oint dK = 0, \qquad \oint \delta P \neq 0$$

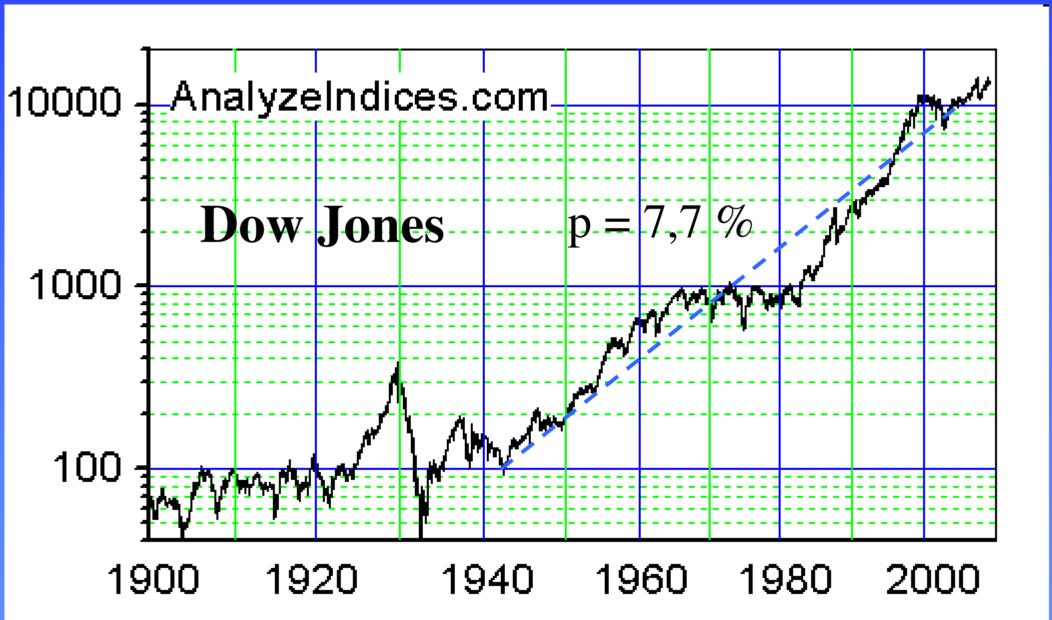
Income	capital	production
putty	clay	putty

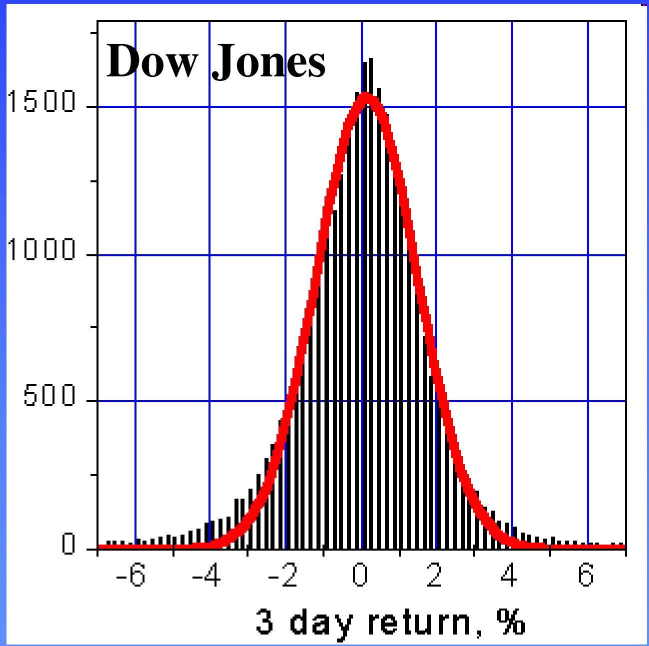
a) Only investments in productive markets (δ P) lead to economic growth

b) **Capital (d K) by itself does not create capital!**
Investing only in financial markets (d K) is like gambling or playing roulette

Application: Banking

$$\delta Y = -\delta P + dK$$





a) **- δ P:** Long time returns lead to growth in productive (stock) markets (7,7 % p. a for 60 y)

b) d K: Short time returns lead to symmetric volatility – no growth - in financial (stock) markets

Application: Banking

Bank

Why do banks keep investing in financial markets ?

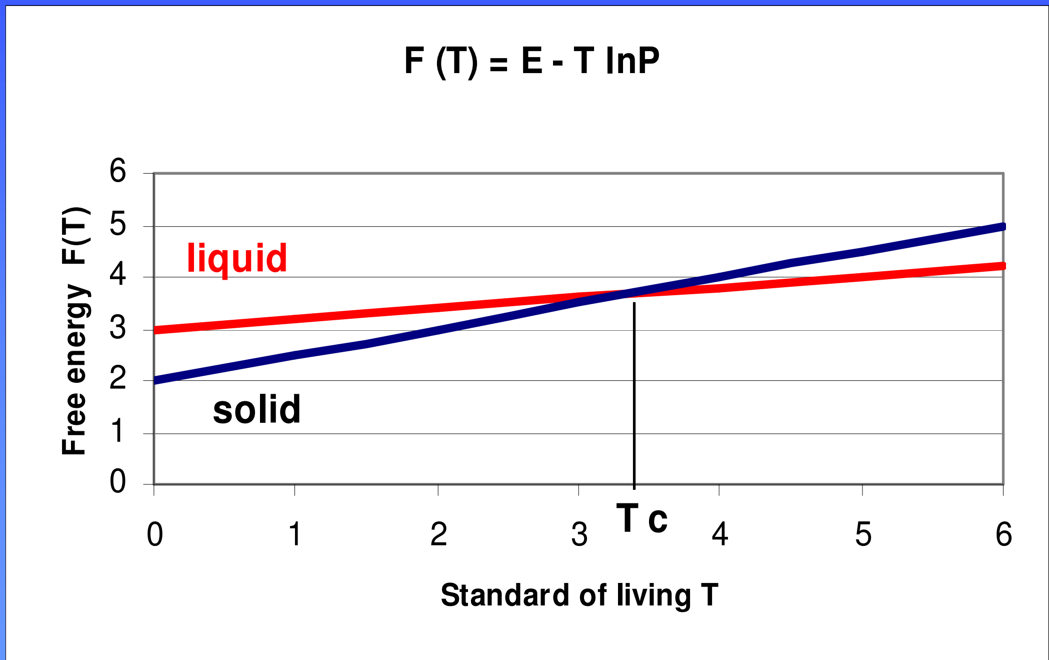
Like in roulette banks take transition fees and will profit from all transactions in the financial market, whether investors win or lose.

Will investors take the risks again, which may lead to a global crisis?

Yes:

Application: Free energy of atomic systems

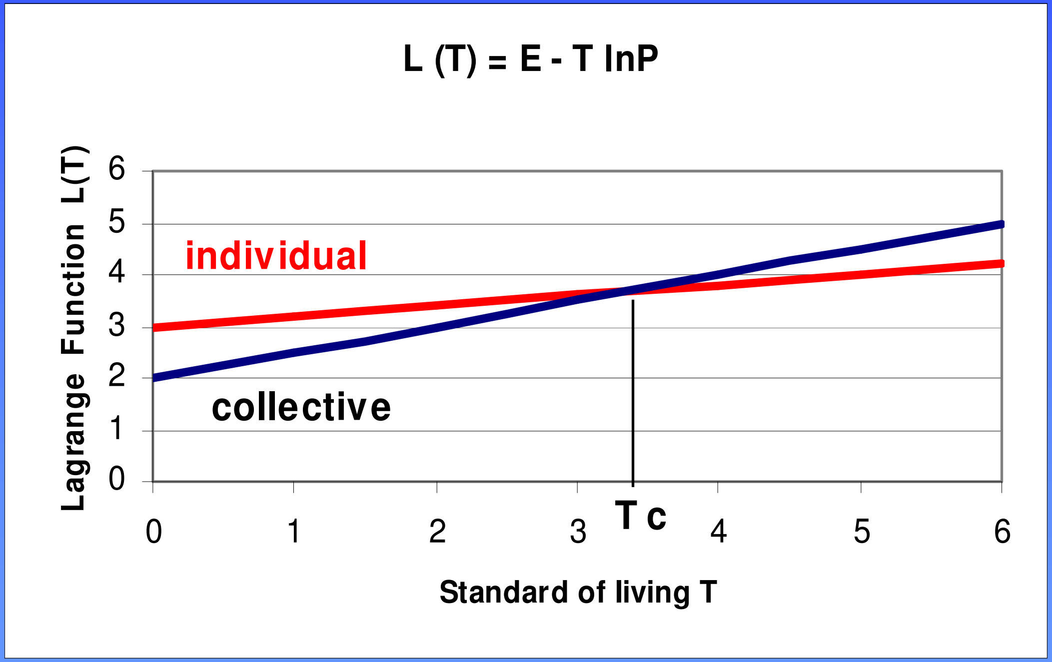
$$F\,(T) = E - T\,S \rightarrow \min!$$



solid – liquid transition

Application: Lagrange function of social systems

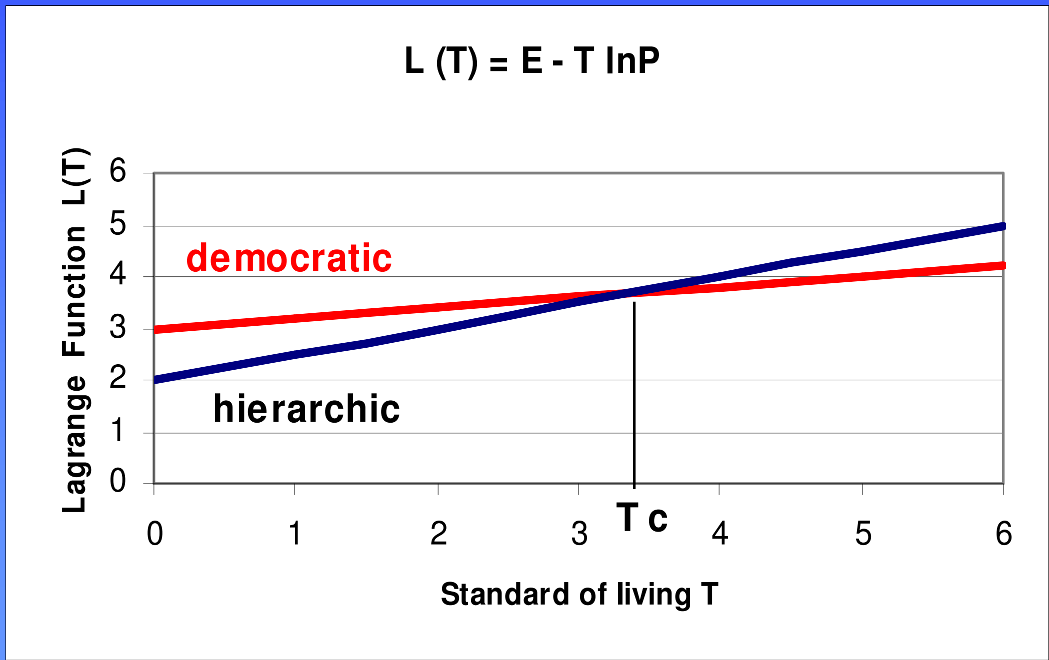
$F\,(T) = E - T\,S \rightarrow \text{min!}$ $\qquad$ $L\,(\lambda) = K - \lambda\,F \rightarrow \text{min!}$



collective – individual transition

Application: Lagrange function of political systems

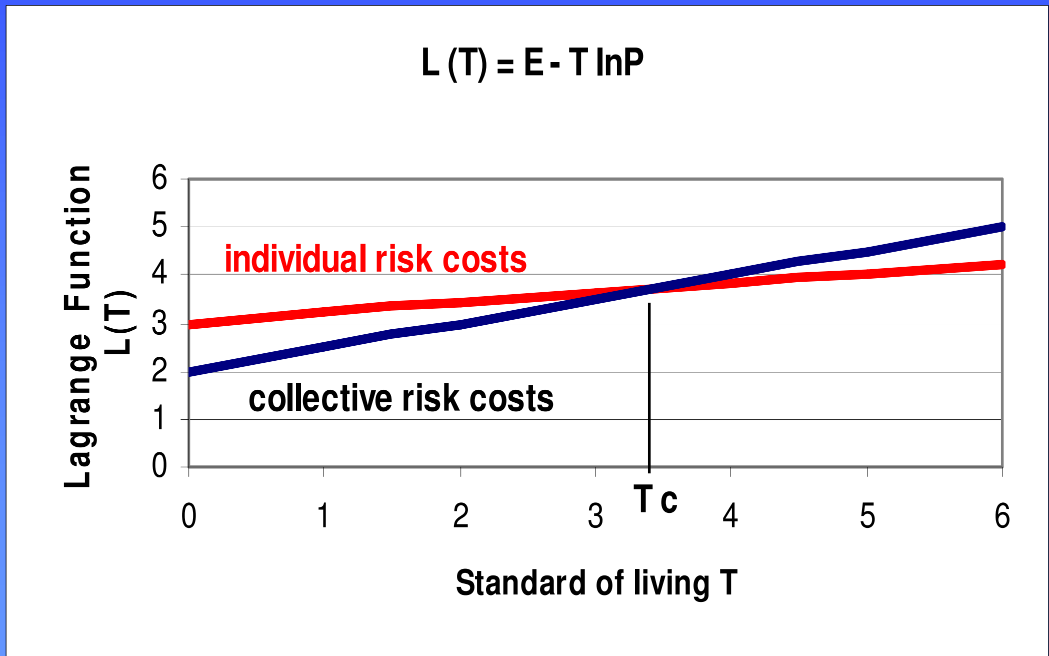
$F\,(T) = E - T\,S \rightarrow \text{min!}$ $\qquad$ $L\,(\lambda) = K - \lambda\,F \rightarrow \text{min!}$



hierarchic – democratic transition

Application: Lagrange function of financial systems

$F(T) = E - T\,S \rightarrow \min!$ $\qquad$ $L(\lambda) = K - \lambda\,F \rightarrow \min!$



collective risk costs – individual risk costs transition

Results of macro-econophysics in banking:

Rich people will continue to gamble in financial markets at high risk.

What can legislation do to prevent global financial disasters?

1. Banks can be divided again (like before 1980) into
a) Savings banks (public) for productive investment
b) State banks (public) for monetary regulation
c) Credit banks (private) for financial markets (and production)

2. Credit banks must work on their own risk and should operate under state supervision like Casinos.

3. States can introduce taxes for financial transactions, to regulate high frequency and high volatility of financial markets.

Thank you for your attention