International Centre for Theoretical Physics
South American Institute for Fundamental Research

Workshop on Sociophysics: Social Phenomena from a Physics Perspective

GROWING INEQUALITY AND WEALTH REDISTRIBUTION

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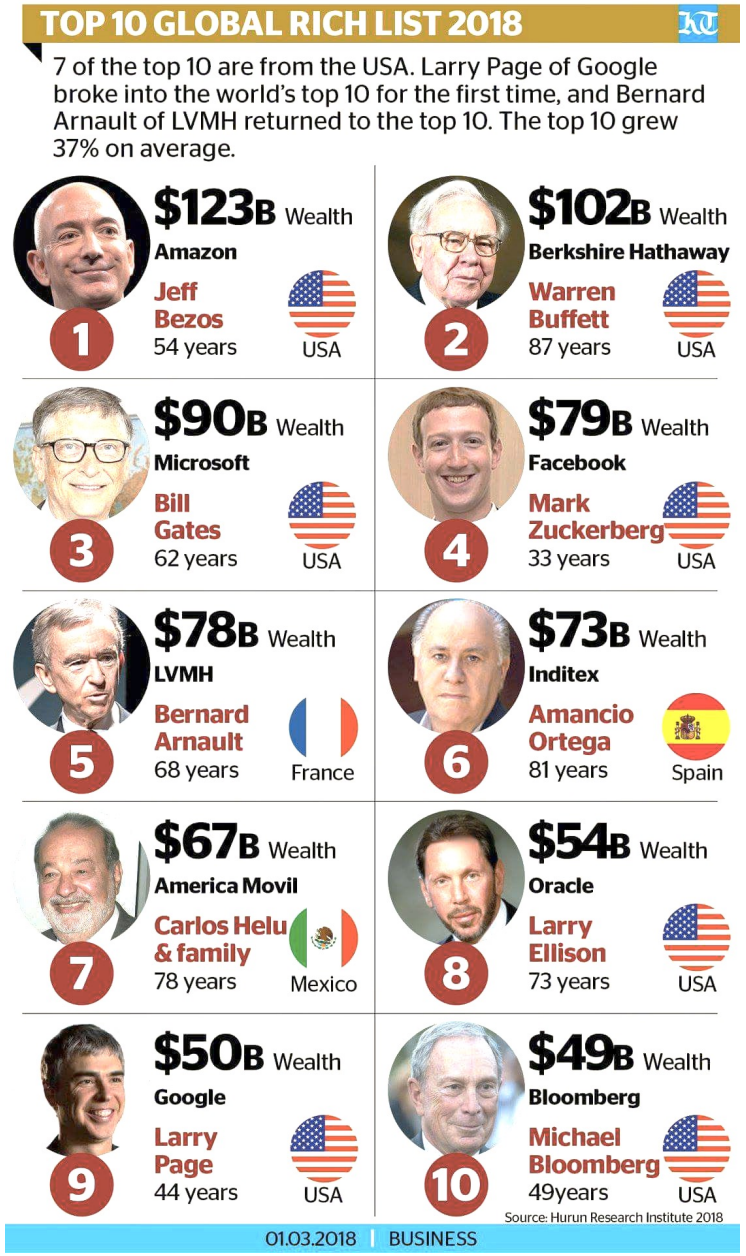
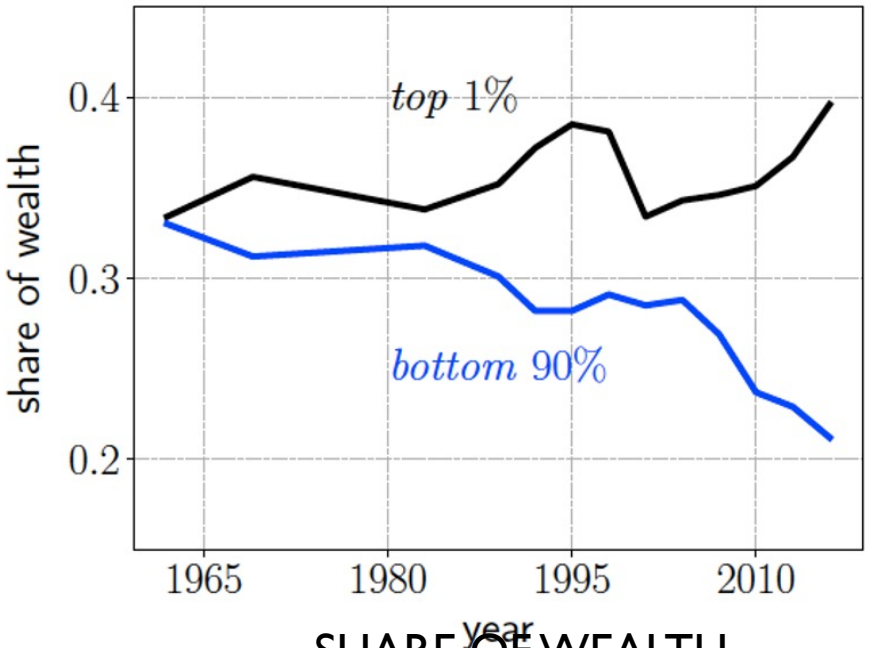
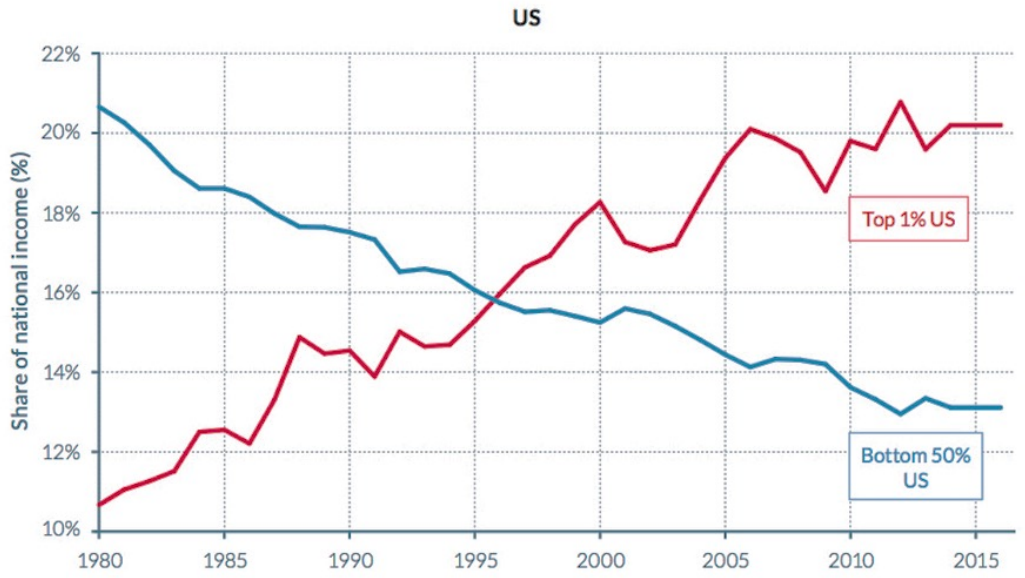
INEQUALITIES AND WEALTH DISTRIBUTION



Sum = 765B



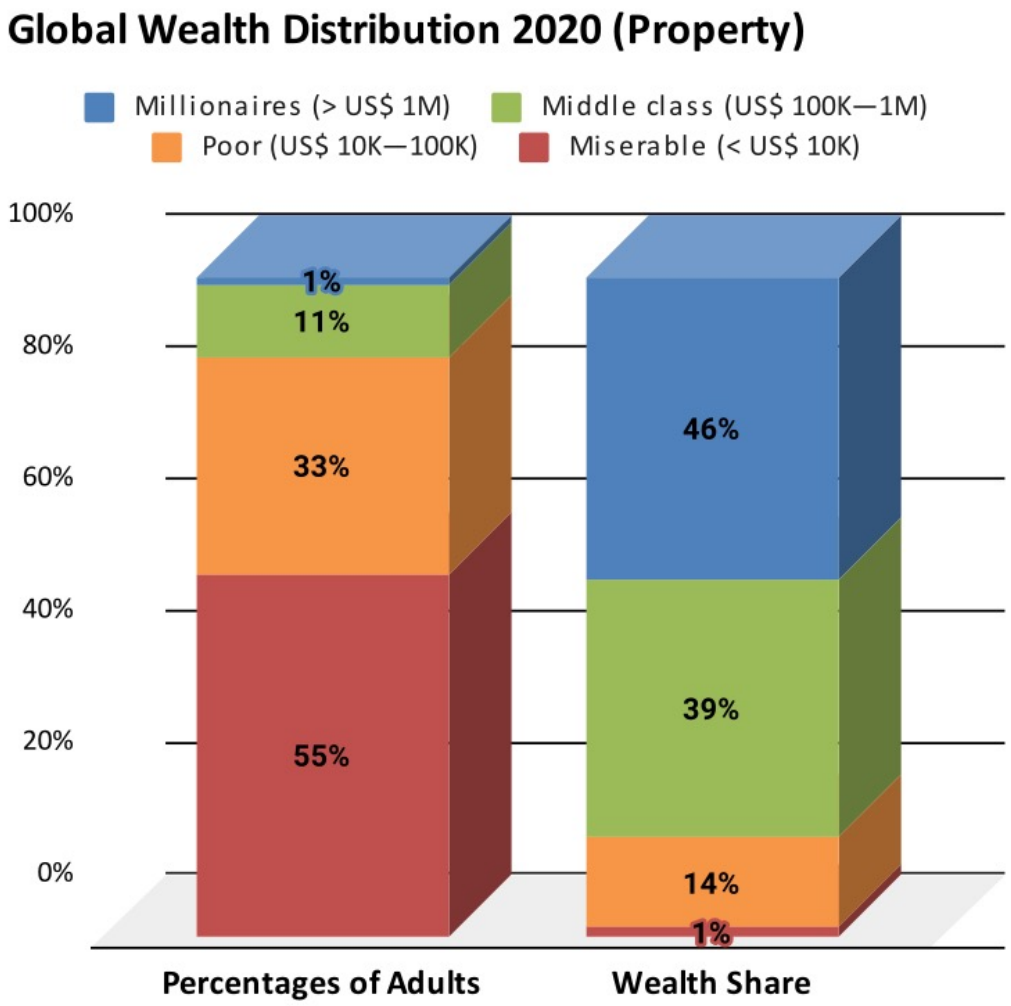
SHARE OF WEALTH



SHARE OF INCOME

SHARE OF WEALTH AND INCOME IN THE US

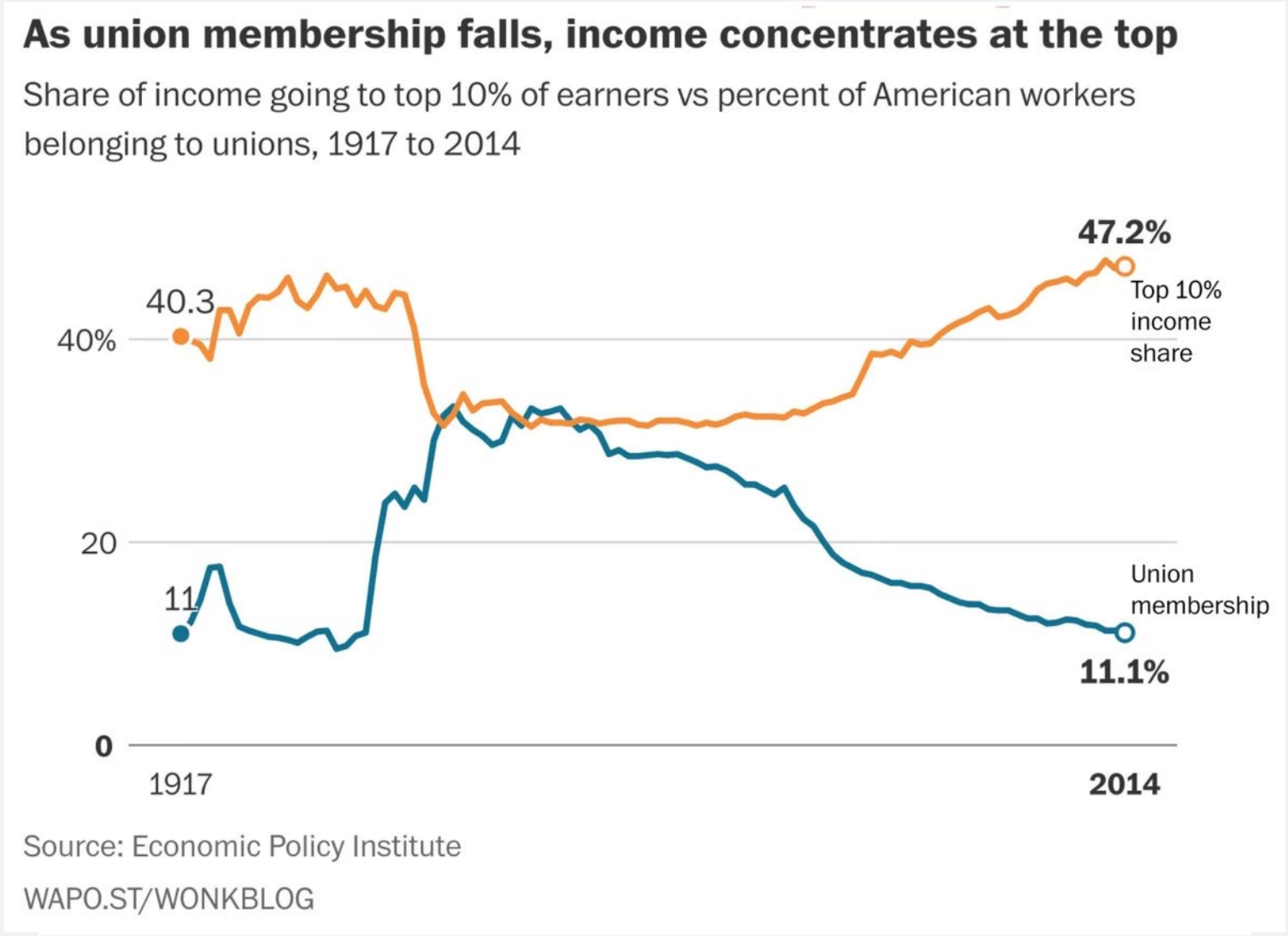
GLOBAL WEALTH DISTRIBUTION 2020 (PROPERTY) SOURCE: CREDIT SUISSE

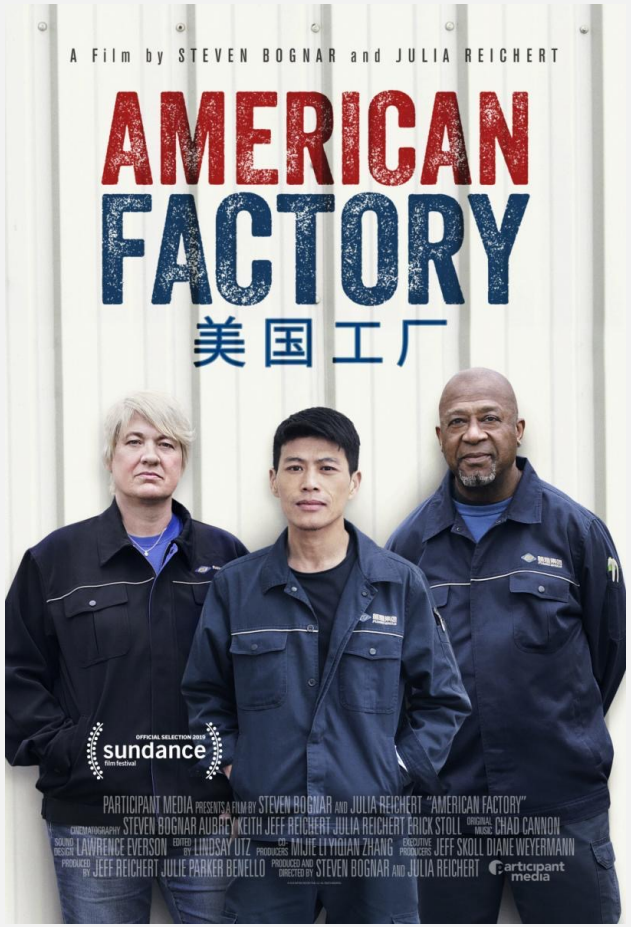


POSSIBLE REASONS

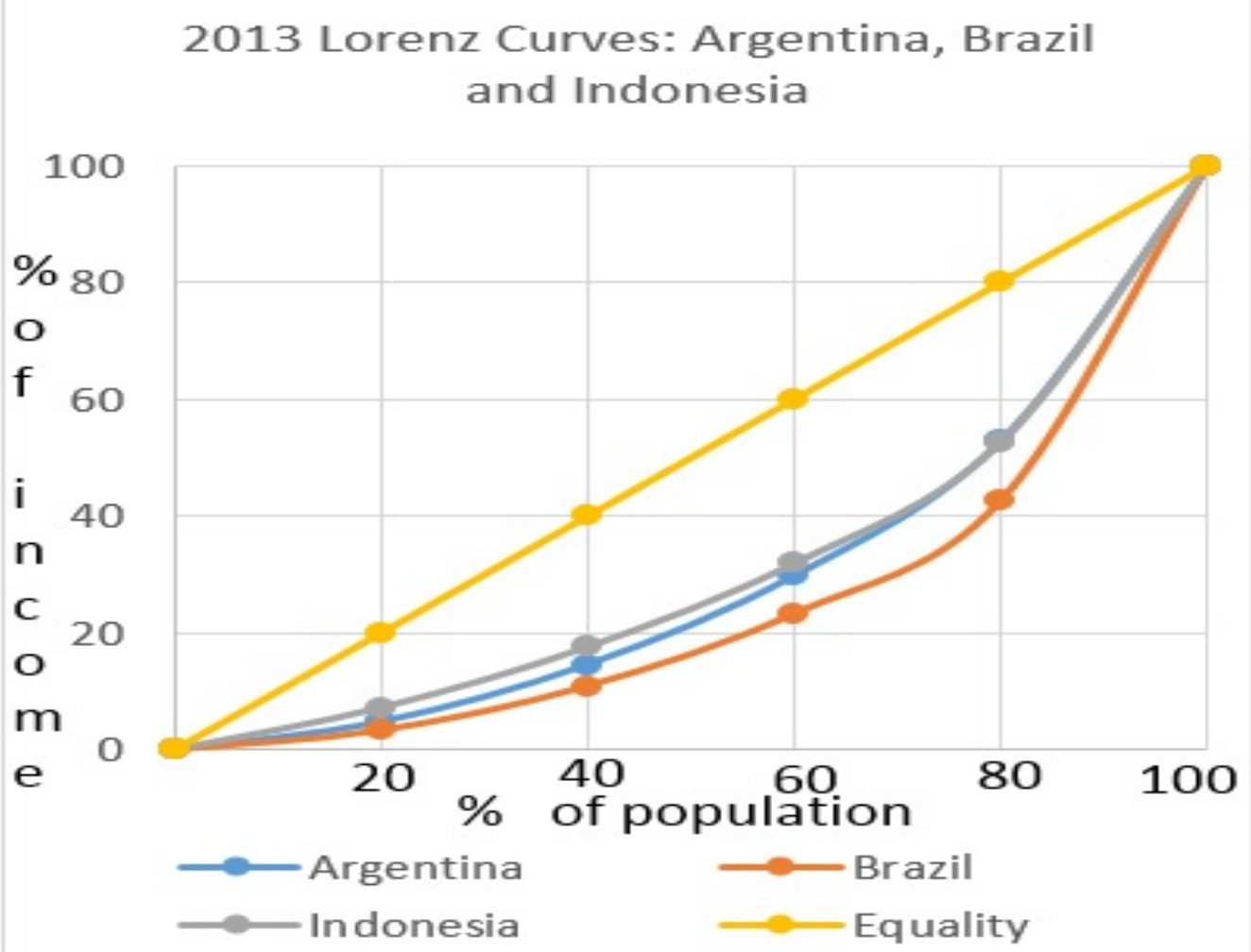
- In the 80's Ronald Reagan, in the US, and Margaret Thatcher, in the UK, succeeded in imposing deregulations in the labor market. Also, both of them broke the power of big workers unions: air traffic controllers in the US and coalminers in the UK. De-unionization contributes much to the increase of inequalities.
- The fall of the Berlin wall and the disaggregation of the Soviet Union by the end of the 80-decade put a final point to the fear of communism and/or socialism in occidental countries. Employers assumed they don't need to make concessions to employees. Neo(?)-liberalism was the magic word of the nineties' and of the new century. Labor conditions are back to the XIX century. Even in "communist" countries like China. End of protection and benefits to workers has been re-baptized as "entrepreneurism".

INEQUALITY AND UNIONS





THE LORENZ CURVE AND THE GINI COEFFICIENT



Gini, C. (1936). "On the Measure of Concentration with Special Reference to Income and Statistics", Colorado College Publication, General Series No. 208, 73–79.

Income share held by Country	lowest 20%	second 20%	third 20%	fourth 20%	highest 20%
Argentina	4.8	9.8	15.2	23.0	47.2
Brazil	3.3	7.6	12.4	19.3	57.4
Indonesia	7.2	10.4	14.3	20.7	47.4

Database: World Development Indicators, 2013

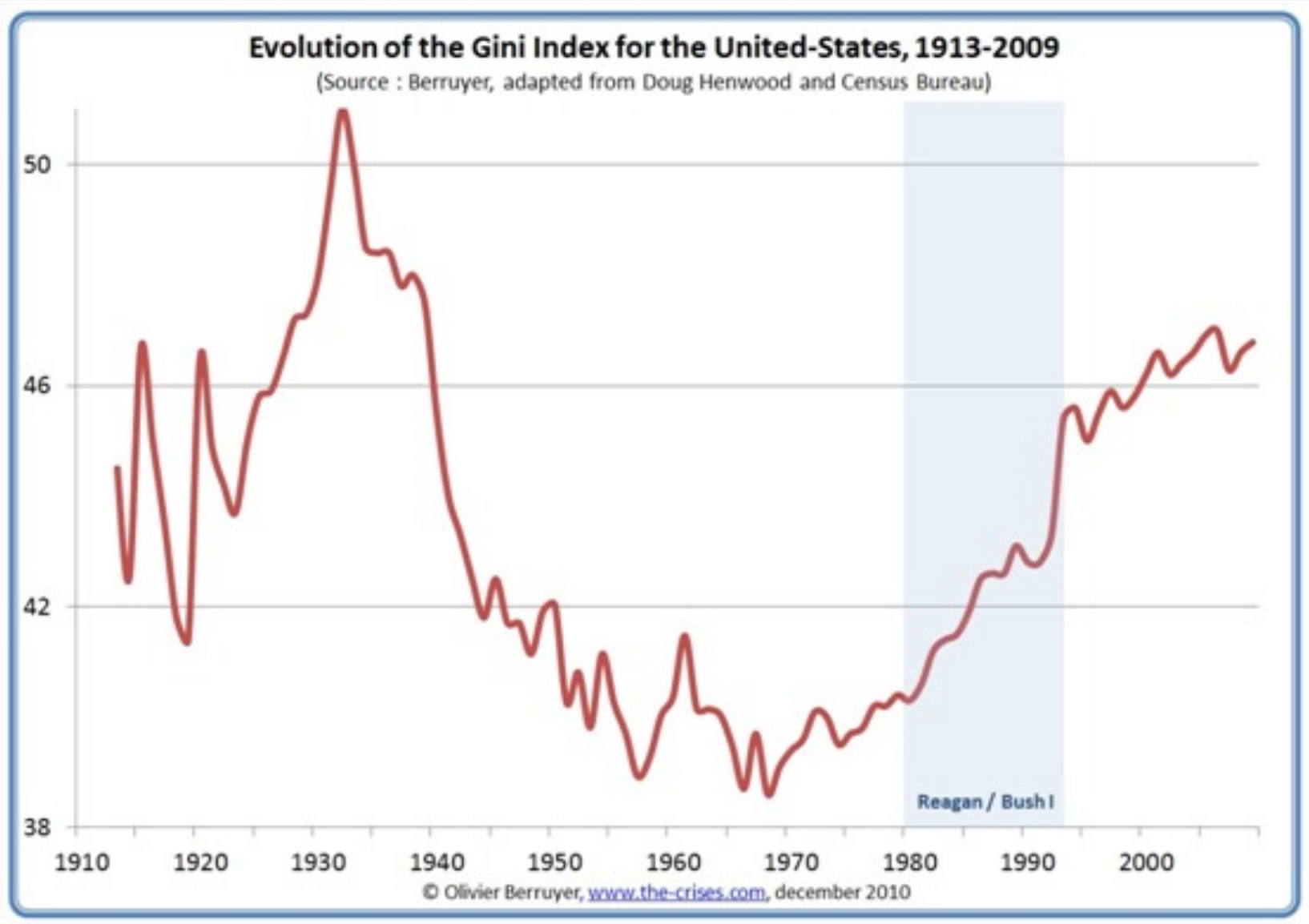
THE GINI COEFFICIENT

$$G = 1 - \alpha \int_0^1 L(p)dp$$

$$G = \frac{1}{2} \frac{\sum_{i,j} |w_i - w_j|}{N \sum_i w_i}$$


Corrado Gini (1884-1965))

http://iglesiassicardi.blogspot.com.ar/2015/11/la-desigualdad-en-el-siglo-xxi.html



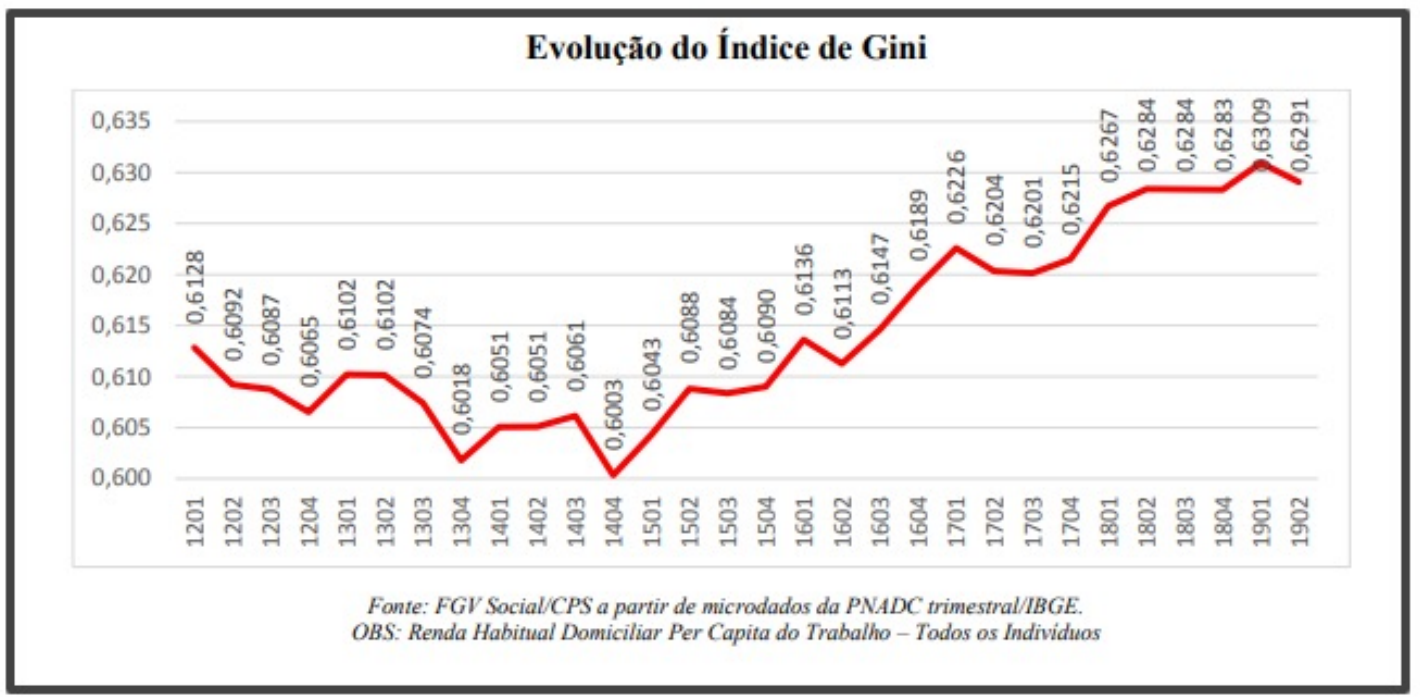
GINI USA
(PIKKETY)

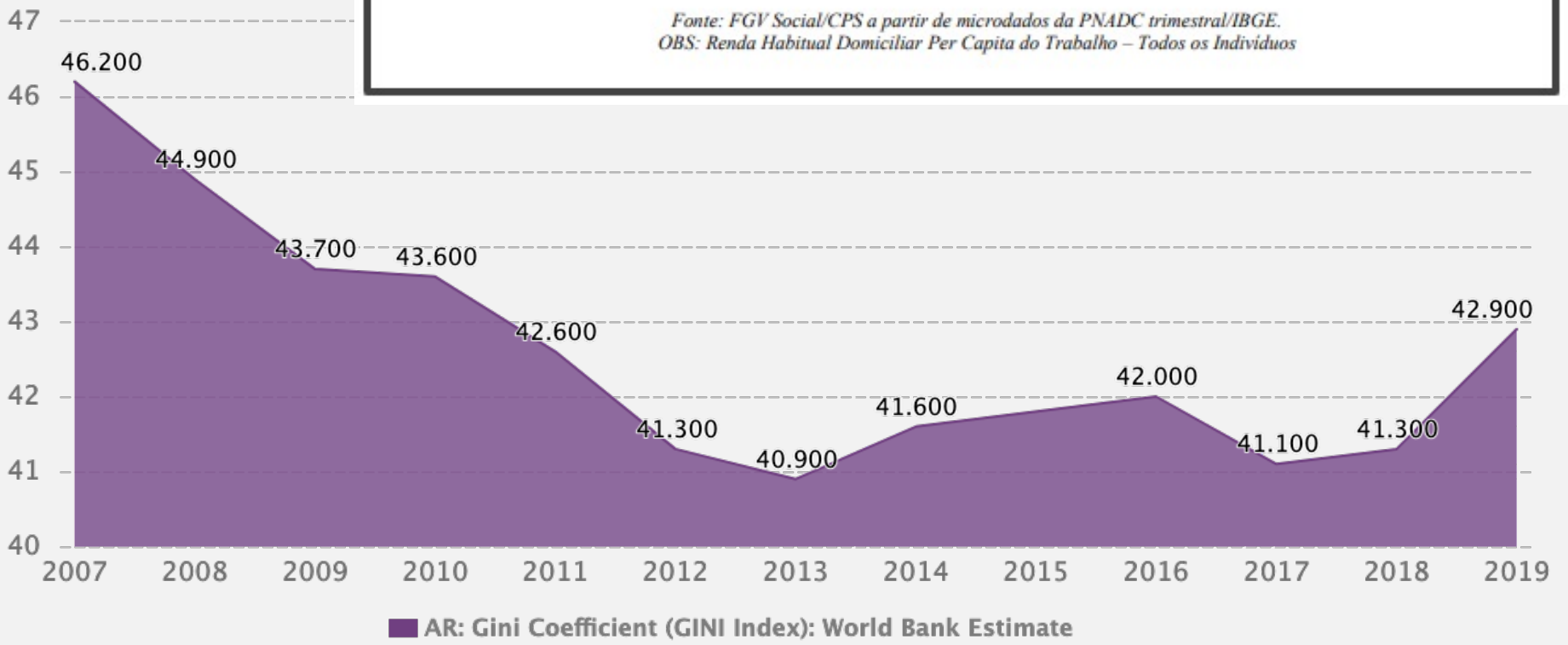
GINI 2021:
0.48

GINI BRAZIL AND ARGENTINA

GINI BRAZIL 2021
0.67
(Historical record)

GINI ARGENTINA 2021
0.45





THEORETICAL MODELS FOR THE EVOLUTION OF THE WEALTH DISTRIBUTION. BINARY EXCHANGE MODELS

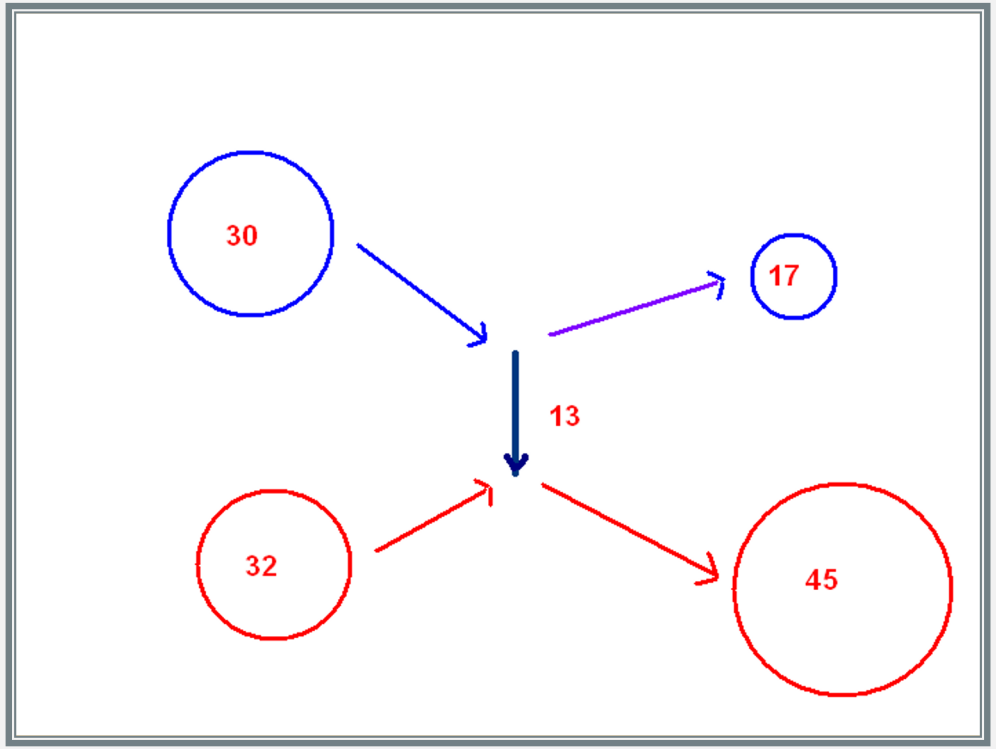
Statistical Mechanics of “Money”

- Agents are molecules of an ideal gas, that exchange money as molecules exchange energy.

$$w_i(t+\Delta t) = w_i(t) - \Delta w$$

$$w_j(t+\Delta t) = w_j(t) + \Delta w$$

- This simple model (D-Y) delivers a Boltzmann – Gibbs (exponential) distribution
- Many authors (including ourselves) introduced a kind of <u>multiplicative noise</u>



Wealth concentration in systems with unbiased binary exchanges

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FAIR OR EFFICIENT MARKET MODELS

BINARY EXCHANGE MODELS

$$x_i^* = x_i + \Delta_i \quad \text{and} \quad x_j^* = x_j + \Delta_j$$

BIASED OR UNFAIR MODEL

$$\Delta_i = \epsilon\lambda x_j - (1-\epsilon)\lambda x_i, \quad \epsilon \in \{0,1\}, \quad \mathbb{E}[\epsilon] = \frac{1}{2}$$

FAIR OR YARD-SALE MODEL

$$\Delta_i = \eta\lambda \min(x_i, x_j), \quad \eta \in \{-1,1\}, \quad \mathbb{E}[\eta] = 0,$$

$$\Delta_i = \eta\frac{x_i x_j}{x_i + x_j}, \quad \eta \in \{-1,1\}, \quad \mathbb{E}[\eta] = 0.$$

YARD SALE MODEL

CONDENSATION IS THE DOOM OF TRADE. LIQUIDITY GOES TO ZERO

Proposition 1: *A system of unbiased binary exchanges has* $x = 0$ *as an absorbing state.*

Proposition 2: *In a system of unbiased binary exchanges, the Gini index is monotonically increasing:*

$$\frac{dG(t)}{dt} \geq 0. \tag{17}$$

NO LIQUIDITY, NO TRADE

(ii) The stationary inequality, so, is the highest one

$$\lim_{t\to\infty} G(t) = 1 \tag{19}$$

(iii) The stationary liquidity is the lowest one

$$\lim_{t\to\infty} L(t) = 0 \tag{20}$$

$$L(t) = \frac{1}{2\langle x\rangle}\int_0^\infty dx\, l(x,t) f(x,t),$$

IT'S LIKE A INESCAPABLE CASINO

Liquidity is the amount of wealth exchanged per unit time,
And varies between 0 and 1.

CONTINUOUS CASINO I

Bruce Boghosian (Sci Am October 2019) propose the following "gedankenexperiment":

- You have $ 100,00 and the casino proposes to pay 20% if you win and to take 17% if you lose. The casino is "fair", odds are 50%

- In principle it is a good deal, the expected result is 0.5x120 + 0.5x83 = 101.50, profit 1.50. But:

- Like in "Hotel California": You can check-out any time you like,
  But you can never leave!

- You are obliged to let your bet in the table and to play indefinitely.

CONTINUOUS CASINO 2

- Imagine you play 10 times, you win 5, lose 5. Your final capital is
- **1.2 x 1.2 x 1.2 x 1.2 x 1.2 x 0.83 x 0.83 x 0.83 x 0.83 x 0.83 x $100 = $98.02**
- Playing 1000 times your capital is reduced to $13.48, and so far so bad...
- This well known phenomena is called condensation.

HOW TO AVOID CONDENSATION

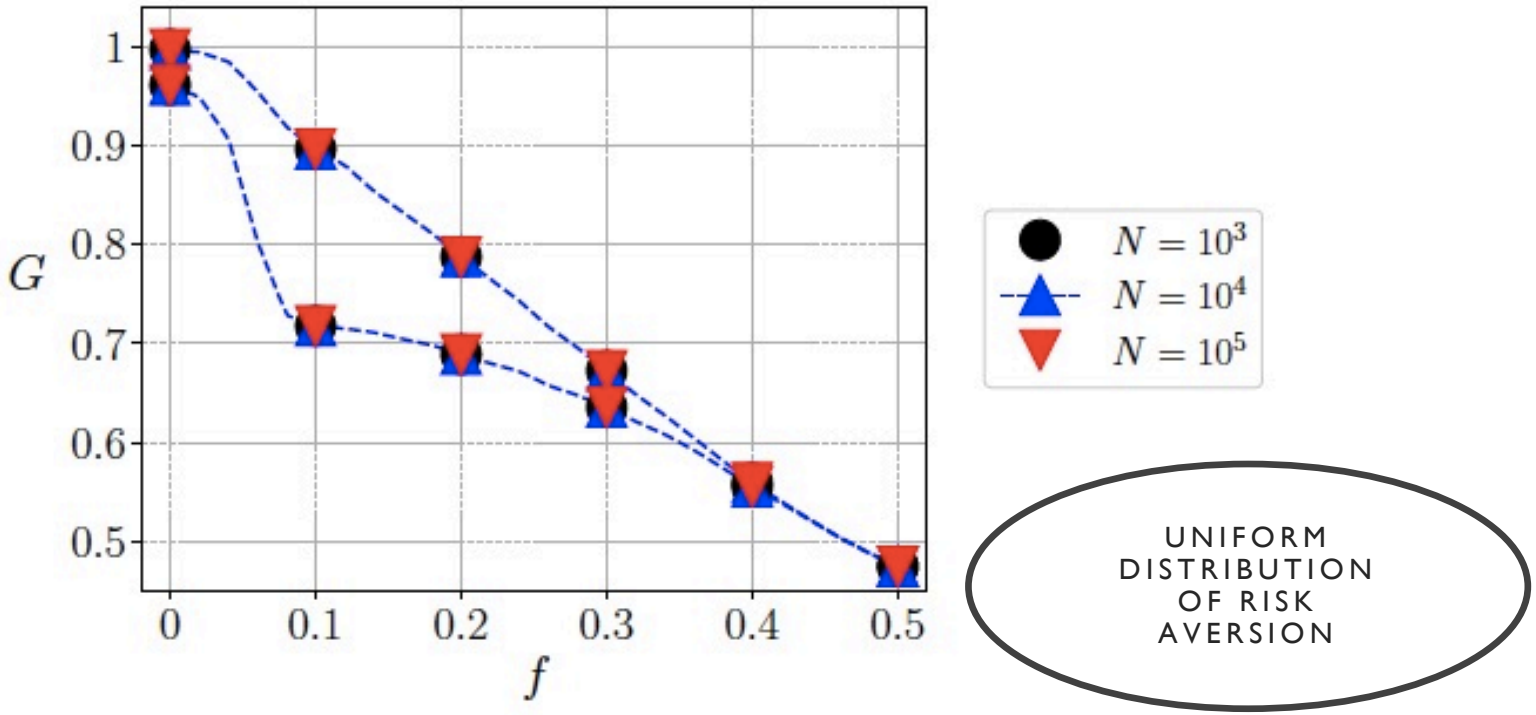
- First: A random (constant or not, equal for all or no) fraction, β, of the agent´s wealth is set aside. Ir is the saving propensity or risk-aversion.
- Then, the exchanged amount within the Yard-sale model is:
- $\Delta w = \min[(1-\beta_1)w_1;(1-\beta_2)w_2]$
- This is not enough to avoid condensation. Just introduces a delay.

- **To avoid condensation** one introduces a proctetion factor *f*
- The probability that the poorer Agent wins in the transaction is

$$p = \frac{1}{2} + f \times \frac{w_2 - w_1}{w_2 + w_1}$$

- being $f: 0 \leq f \leq 0.5$
- Ref: N. Scafetta, S. Picozzi and B. West, cond-mat/0209373v1 (2002)

GINI COEFFICIENT (YARD-SALE MODEL)



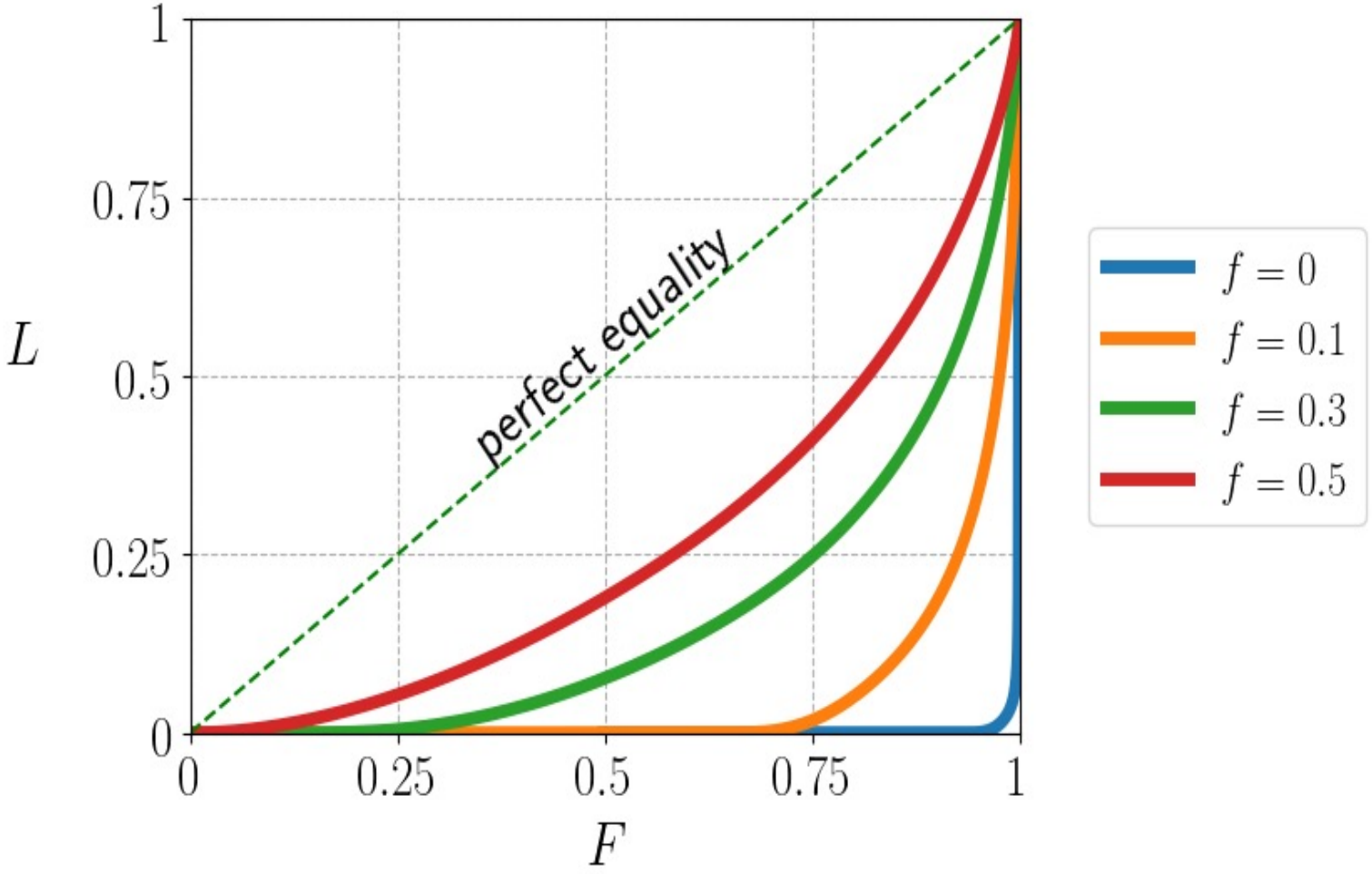
UNIFORM DISTRIBUTION OF RISK AVERSION

FIG. 4. Equilibrium Gini index, with (top curve) and without (bottom curve) zero wealth agents, as a function of the social protection factor, f. Results are independent of the system's size.

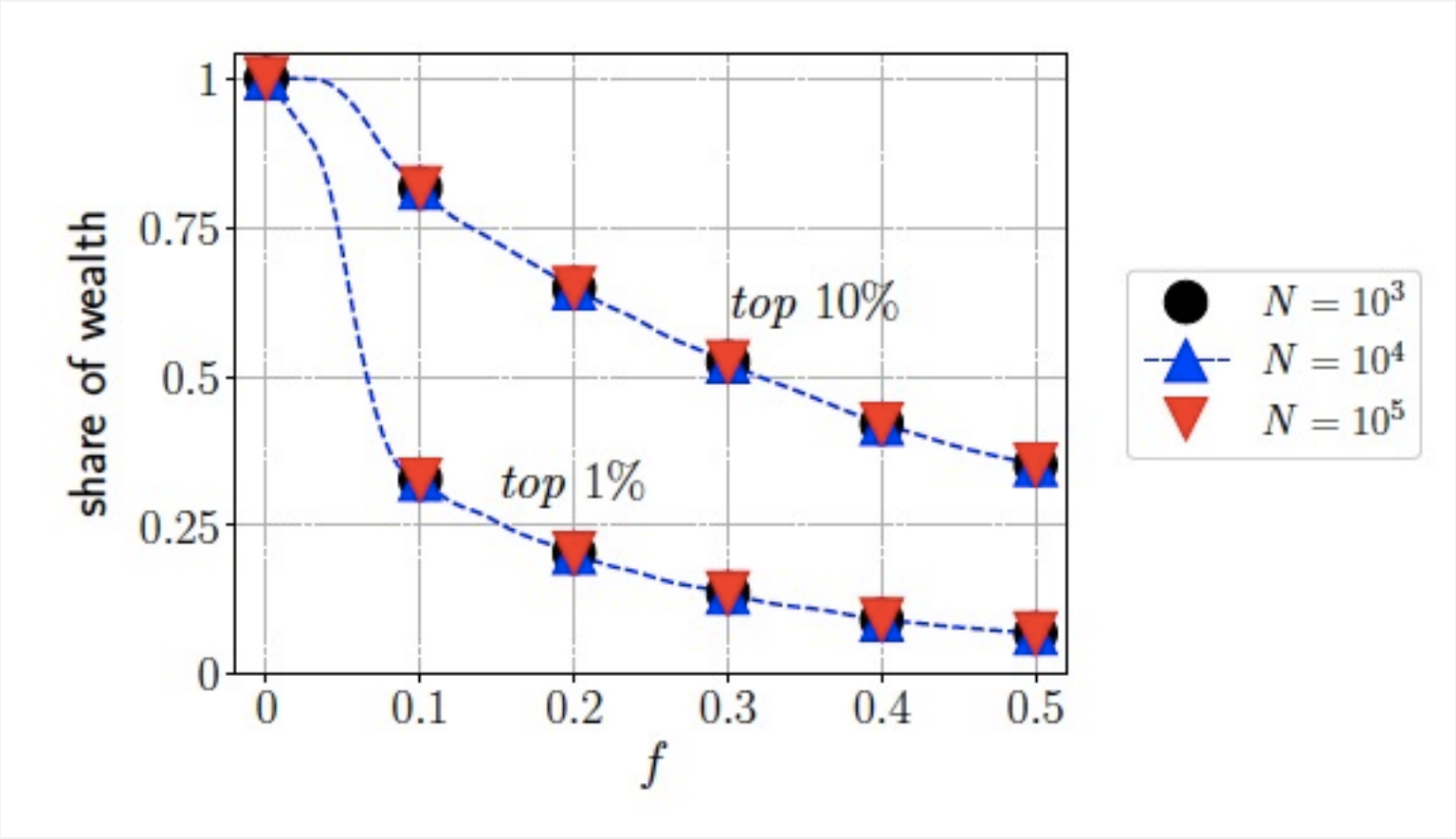
Uniform distribution of risk-aversion

LORENZ CURVES

UNIFORM DISTRIBUTION OF RISK AVERSION



TOP 1% AND 10% (YARD-SALE MODEL)



REGULATIONS (TAXES)

III. TAXES

We will describe here a simple mechanism where taxes are collected from all agents and distributed among them according to different criteria. The tax collection mechanism works as follows: at each Monte Carlo Step, all agents pay the fraction λ of its wealth as taxes. This kind of taxation is simple to simulate and correspond to a kind of tax on the possessions, different from the more usual tax on the revenues that retains a percentage of the earnings. After this taxation process, the amount collected is redistributed. Here, we study two types of redistribution: universal and directed.

INEQUALITY, A SCOURGE OF THE XXI CENTURY

Inequality, a scourge of the XXI century

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GINI VS. PERCENTAGE OF TAXES: UNIVERSAL ASSIGNATION

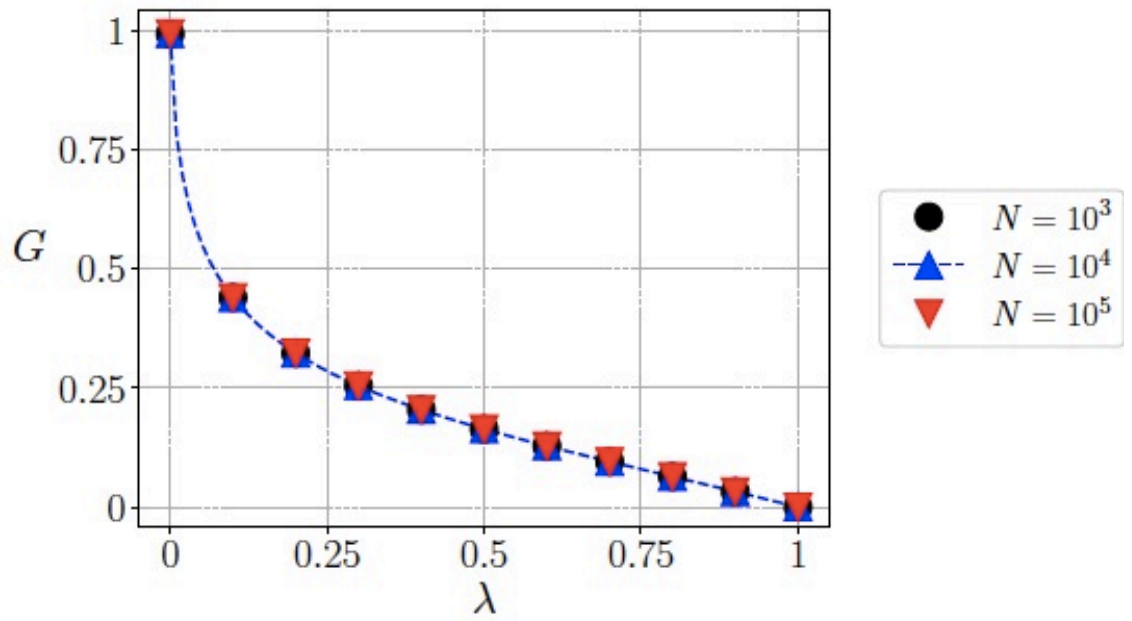
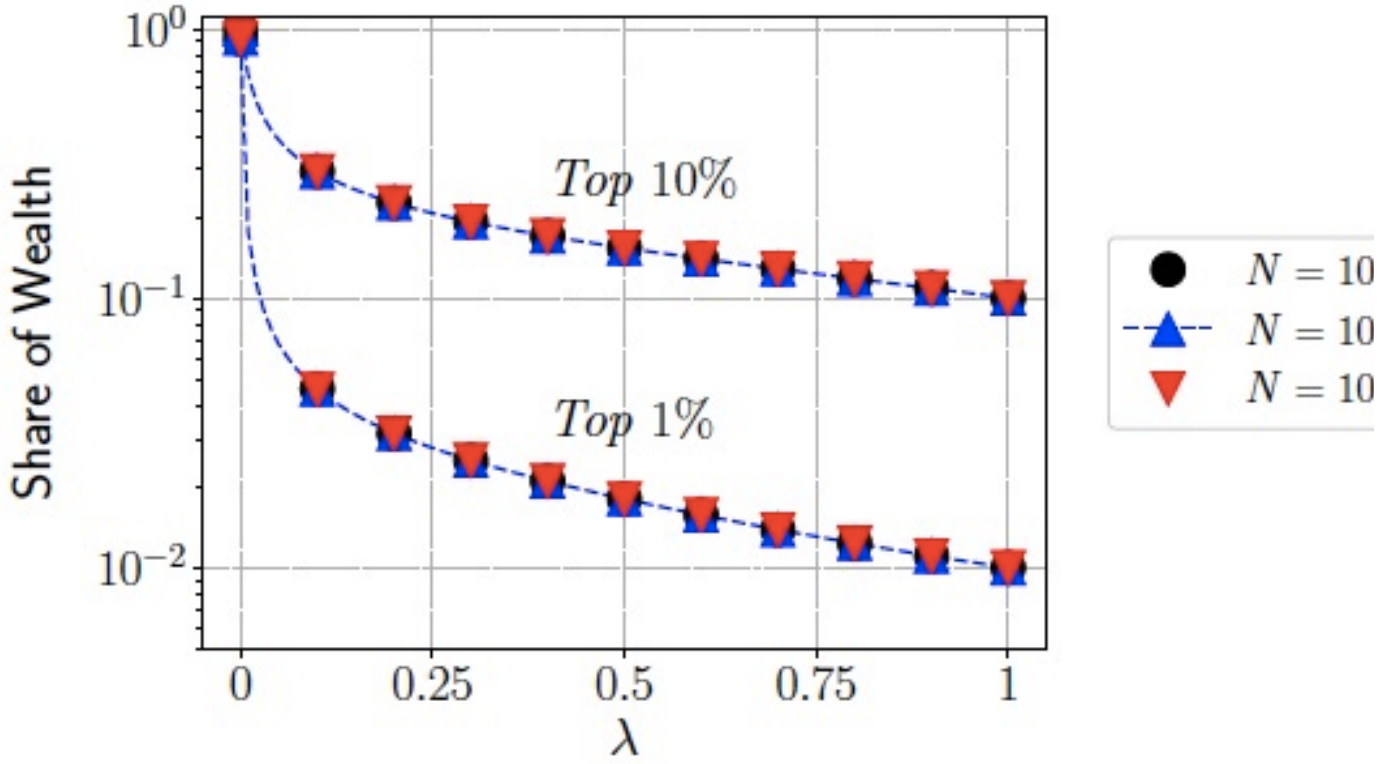


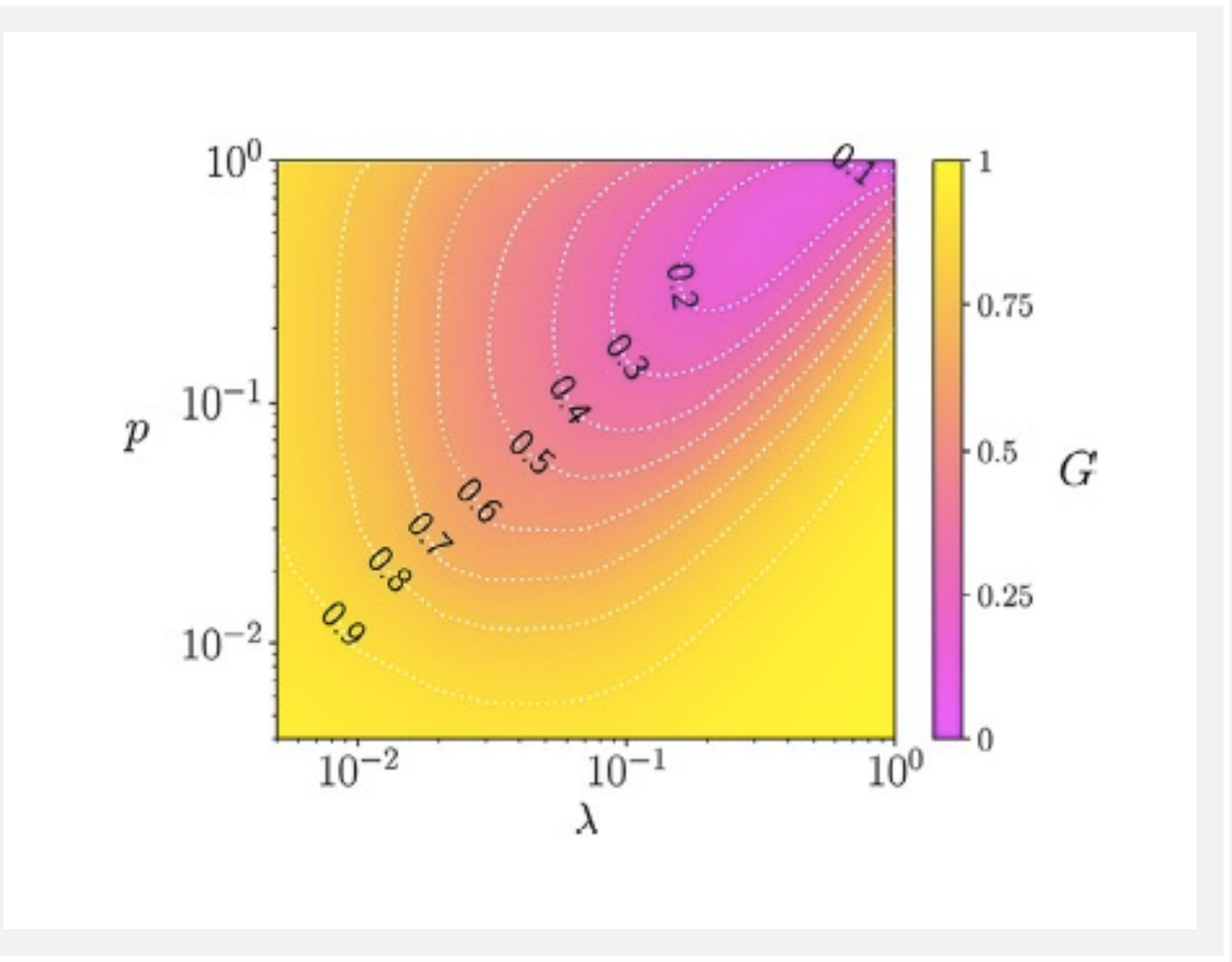
FIG. 7. Equilibrium Gini index as a function of λ, the percentage tax on fortu
independent of the system's size.

Every agent receives a share, same for everyone

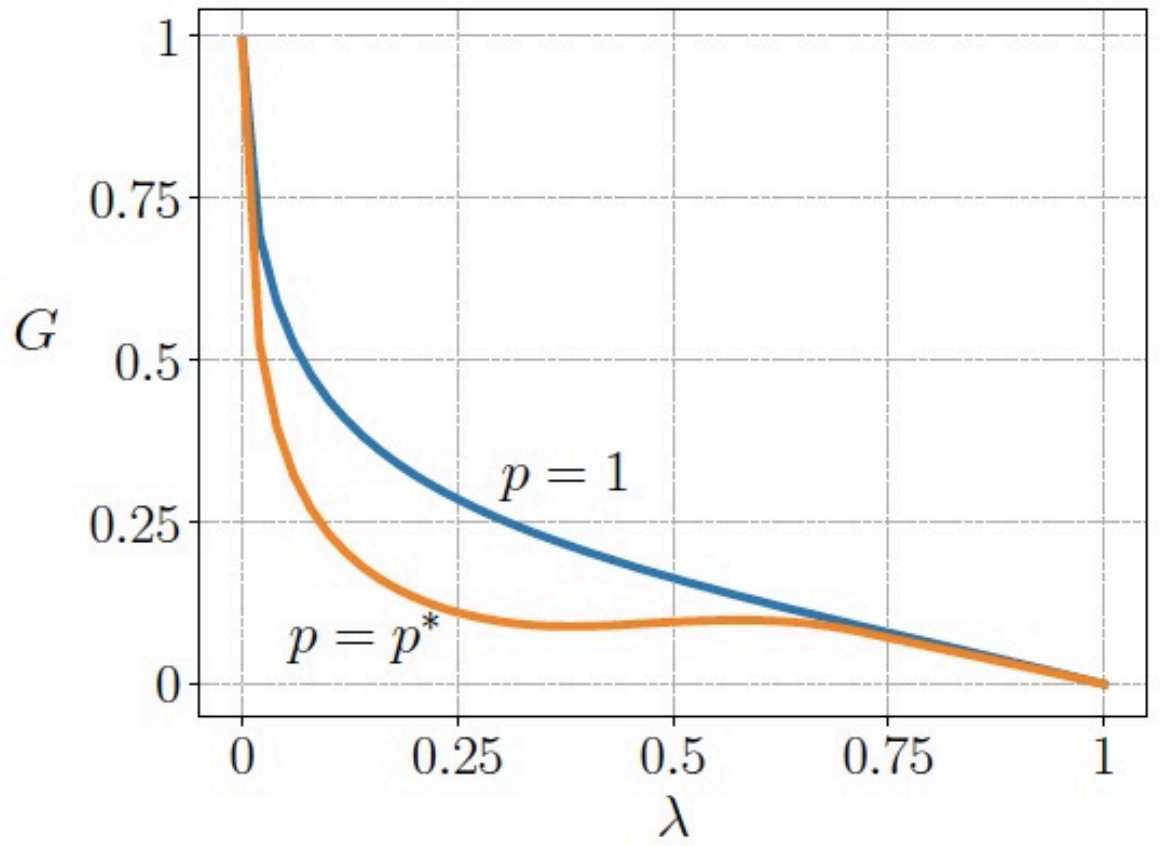
TOP 1% AND TOP 10% WITH TAXES AND REDISTRIBUTION



REDISTRIBUTION JUST FOR THE P POOREST ONES



OPTIMAL SOLUTION



For λ = 0.38, the optimum p is 0.28

WHAT ABOUT COMMERCE? DOES EQUALITY FAVORS EXCHANGES?

THE ANSWER IS **YES**.

- Defining **liquidity** as the wealth exchanged per unit time.
- The higher the Gini coefficient the lower the **liquidity**.
- Inequality acts against trade.

TAXES ON REVENUES

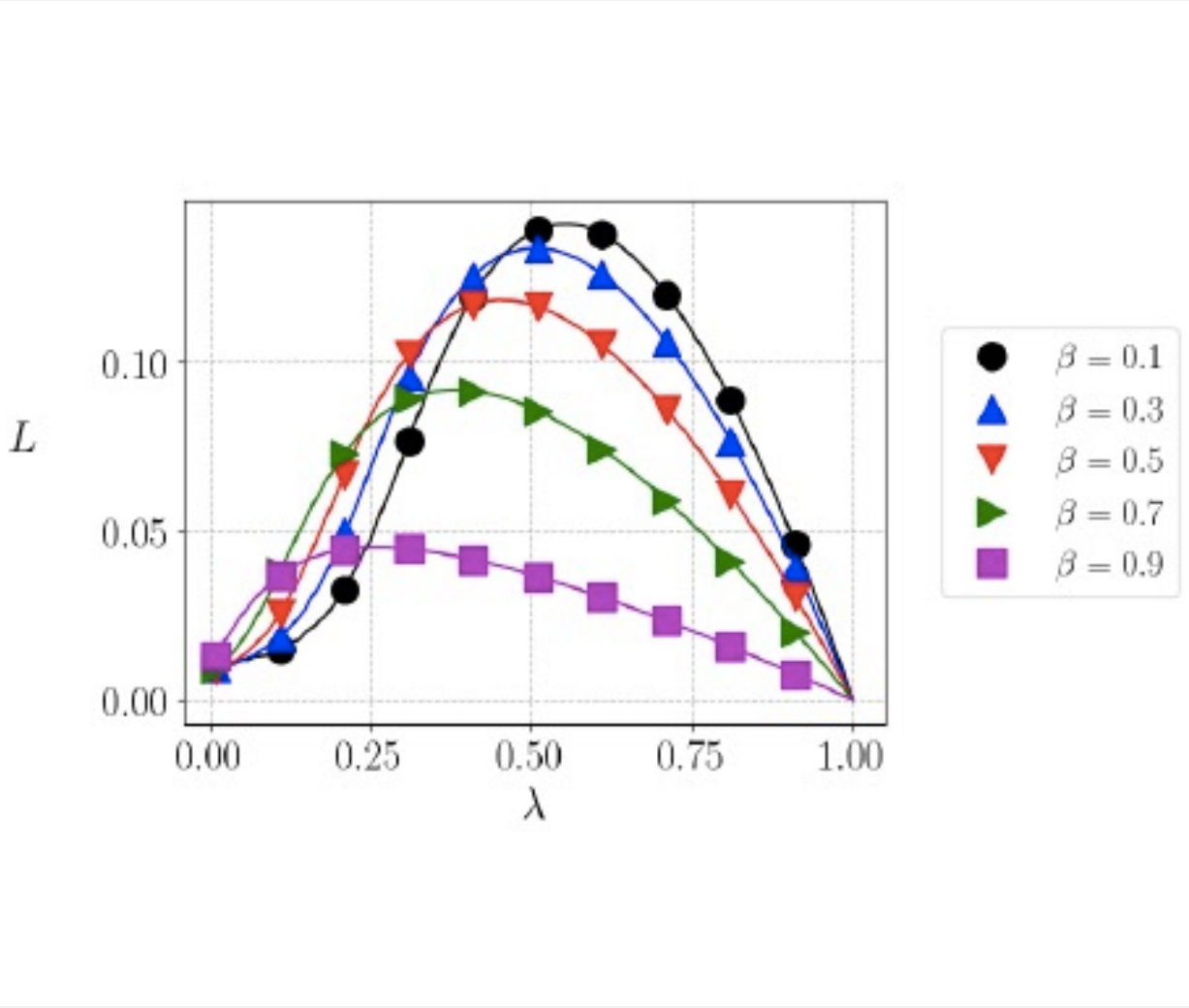
Here, for simplicity, we have considered an uniform value of β_i

In the system, the tax collection works as follows: two random agents, say i and j, are randomly selected to exchange wealth in such way that

$$w_i^* = w_i + (1-\lambda)(1-\beta)\min(w_i, w_j) \text{ and } w_j^* = w_j - (1-\beta)\min(w_i, w_j), \quad (2)$$

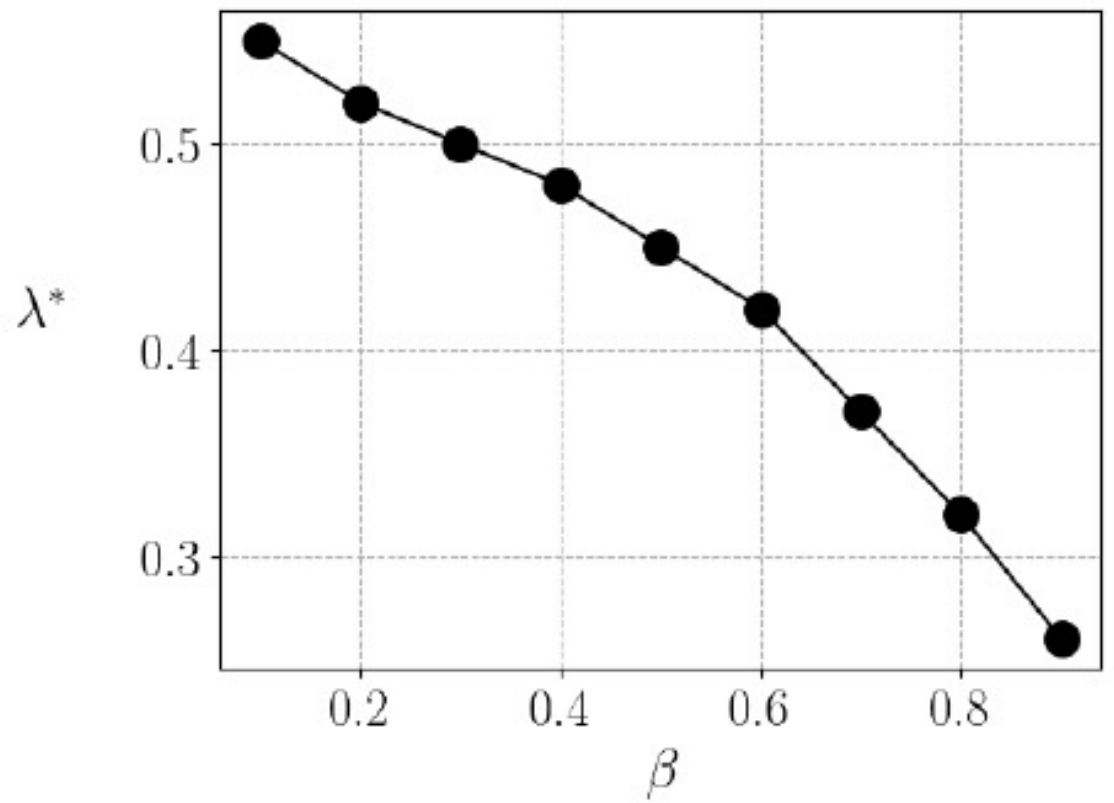
where λ is the tax rate. The collected tax $\lambda(1-\beta)\min(w_i, w_j)$ of each exchange are accumulated during one Monte Carlo Step, that is, along $N/2$ exchanges. After this period, the collected tax are equally distributed among all agents. We denote the liquidity of the system L as the total value received by the agents in exchanges, that is, the sum of values $(1-\lambda)(1-\beta)\min(w_i, w_j)$ along 1 Monte Carlo Step.

LIQUIDITY VS. RISK AVERSION

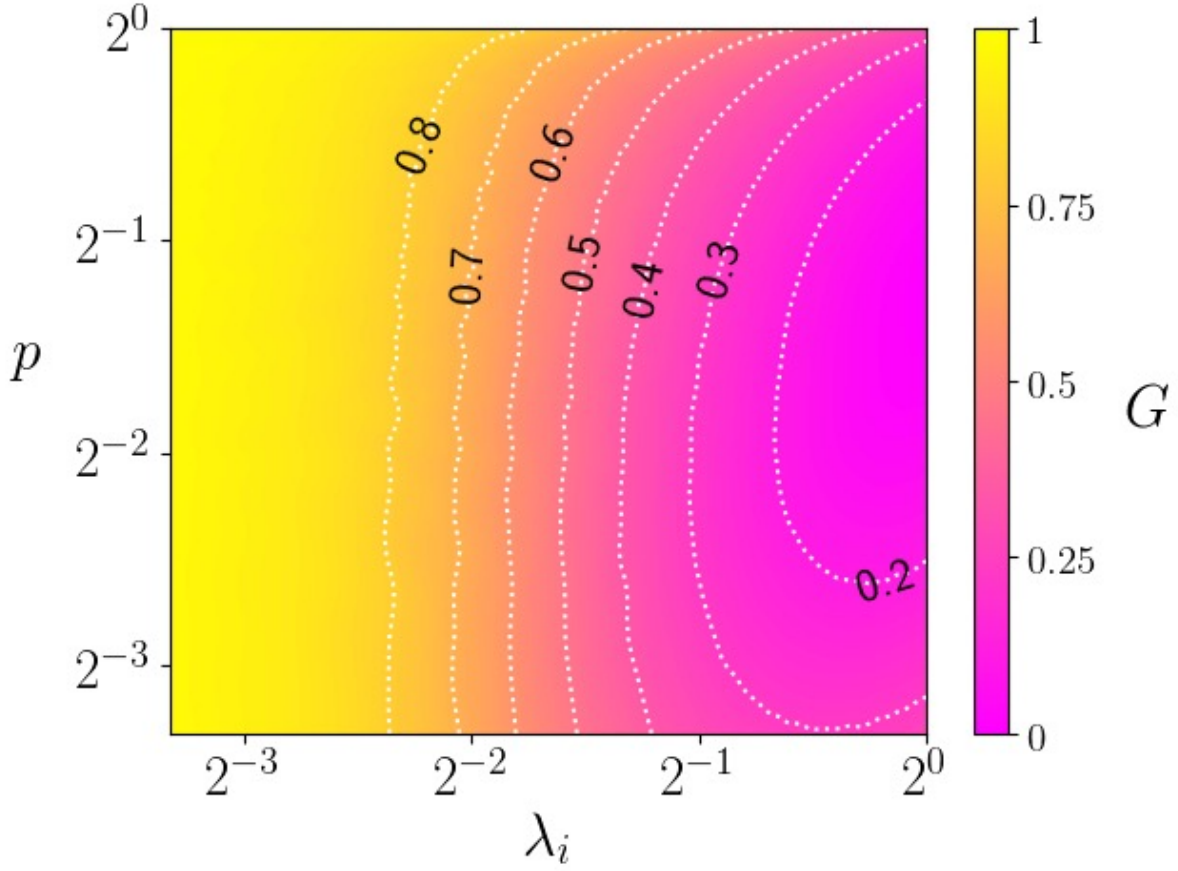


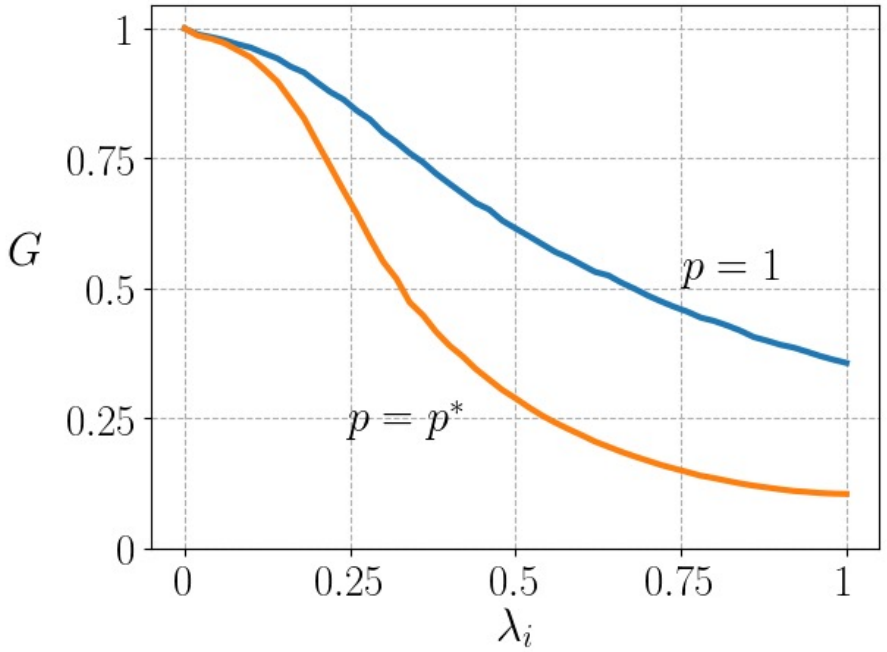
First we consider a constant risk-aversion

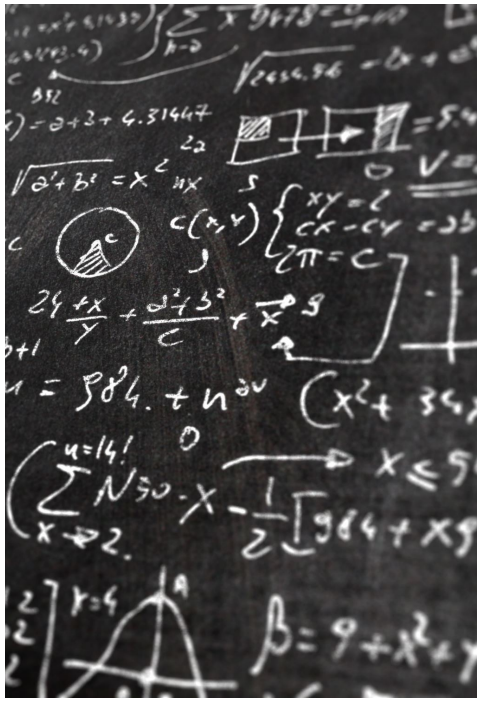
OPTIMUM VALUE OF TAXES VS. RISK AVERSION



RANDOM RISK AVERSION







P=1, UNIVERSAL ASSIGNATION; P* IS THE OPTIMUM FRACTION OF PEOPLE TO BE ASSISTED TO MINIMIZE INEQUALITY

CONCLUSIONS

Tax on wealth is more effective to reduce inequality than tax on income.

It seems evident that very high inequality is an obstacle to economic growth because greatly reduces liquidity

In the extreme case of condensation liquidity goes to zero.

Unfortunateely, this is the present tendency in worlds economies: higher concentration of wealth, increase of poverty

"El bienestar de nuestras clases dominantes … es la maldición de nuestras multitudes condenadas a una vida de bestias de carga."

EDUARDO GALEANO: Las Venas abiertas de América Latina