TAXES, INEQUALITY AND EQUAL OPPORTUNITIES

- **José Roberto Iglesias**
- Instituto de Física – UFRGS – Porto Alegre – Brasil
- Instituto Nacional de Ciência e Tecnologia de Sistemas Complexos – Rio de Janeiro – Brasil

- **TSALLIS'80 CBPF 8/11/2023**

Instituto Balseiro,
Centro Atómico Bariloche,
S.C. de Bariloche

Licenciatura en Física, años 60

Université Paris-Sud, Orsay, France

DOCTORAT D’ÉTAT

And in many meetings

And now, some years after…

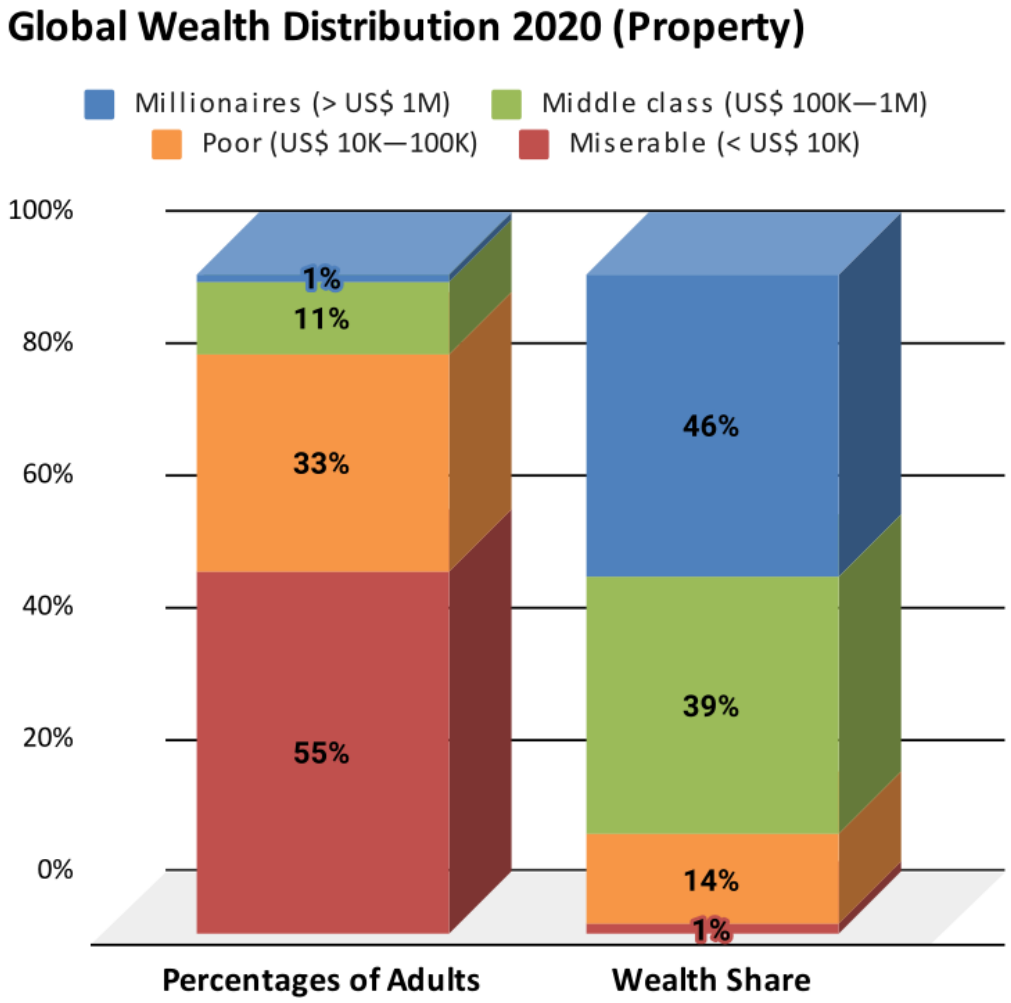
TAXES ET AL AUTHORS

- **Sebastián Gonçalves**
- Prof., Instituto de Física – UFRGS – Porto Alegre – RS - Brasil
- **Ben-Hur Francisco Cardoso**
- Ph D student. Departamento de Economia e Relações Internacionais – UFSC – Florianópolis – SC – Brasil
- **Thiago Dias**
- Prof., Universidade Federal Técnica do Paraná.

INEQUALITY

Inequality is exploding all around the world. It decreased in the XX Century but worsened in the XXI Century

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. They succeeded to 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 crush of the Soviet Union by the end of the eighties 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 coming back to the XIX century. Even in "communist" countries like China. End of protection and benefits to workers has been re-baptized as "entrepreneurism".

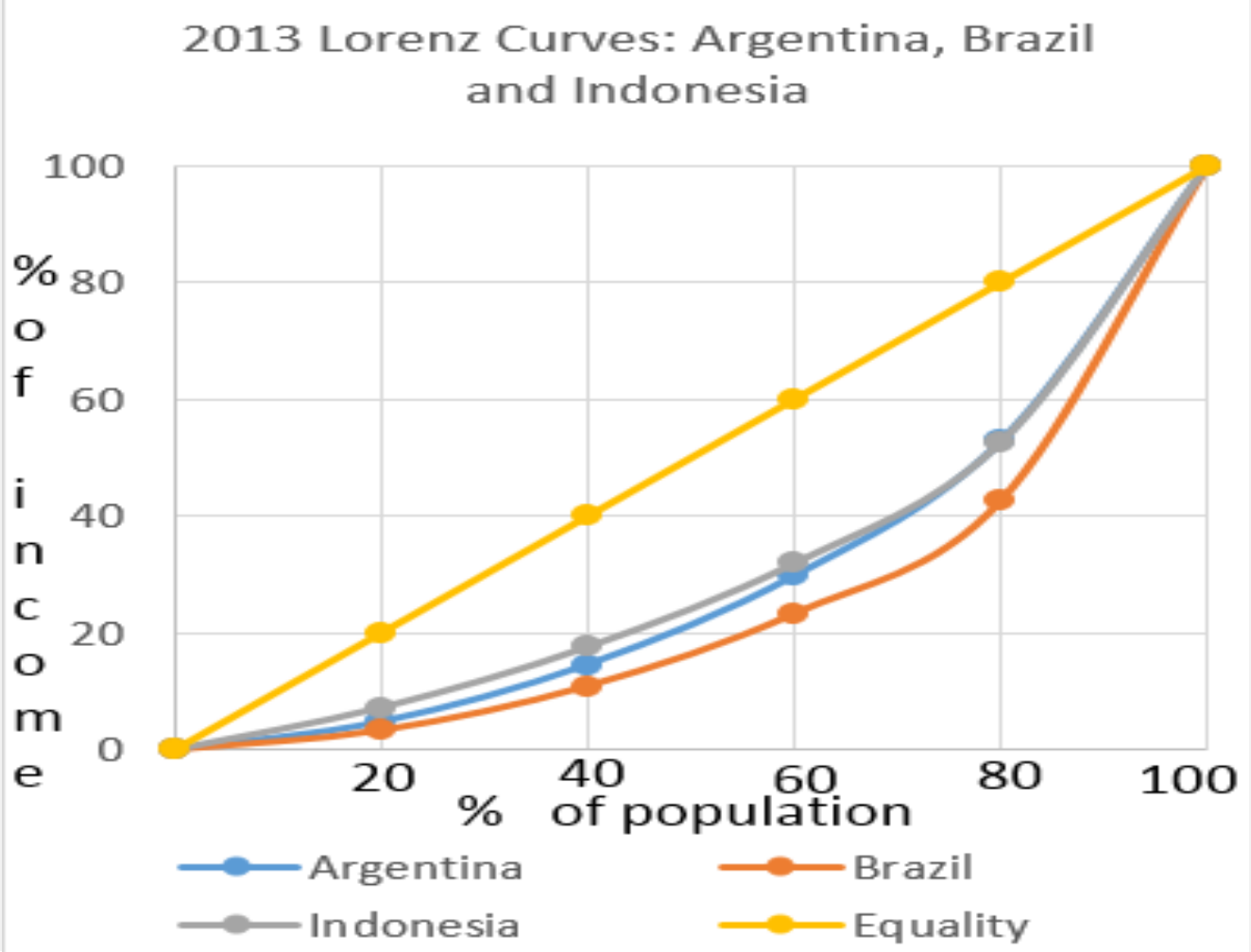
Total Wealth in the World

- *Total World Wealth:* *4.544×10^{14} USD*
- *(454 trillion dollards)*
- *Total Adults Population:* *5.319×10^{9}*
- *Wealth per capita:* *85.429×10^{3} U$S*

- *Global Wealth Report 2023 | Credit Suisse & UBS*

QUANTIFYING INEQUALITY

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.

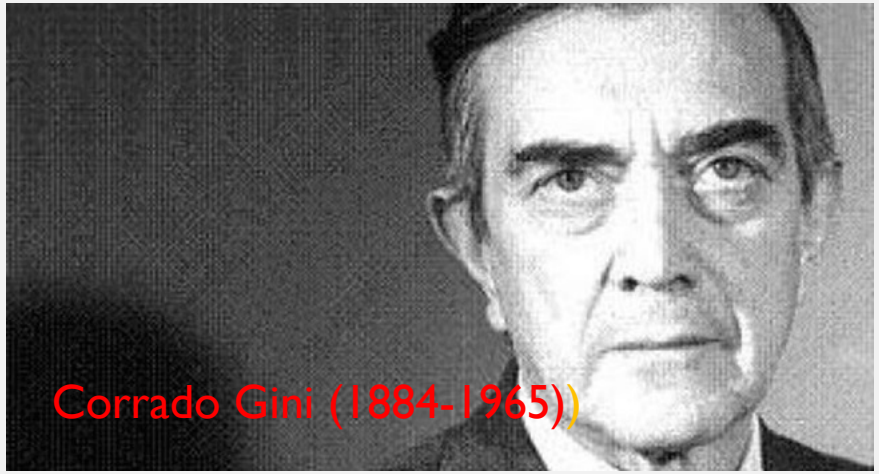
Income share held by Country	lowest 20%	second 20%	third 20%	fourth 20%	highest 20%
Argentina	4.8	9.8	15.2	23.0	47.2
Brazil	3.3	7.6	12.4	19.3	57.4
Indonesia	7.2	10.4	14.3	20.7	47.4

Database: World Development Indicators, 2013

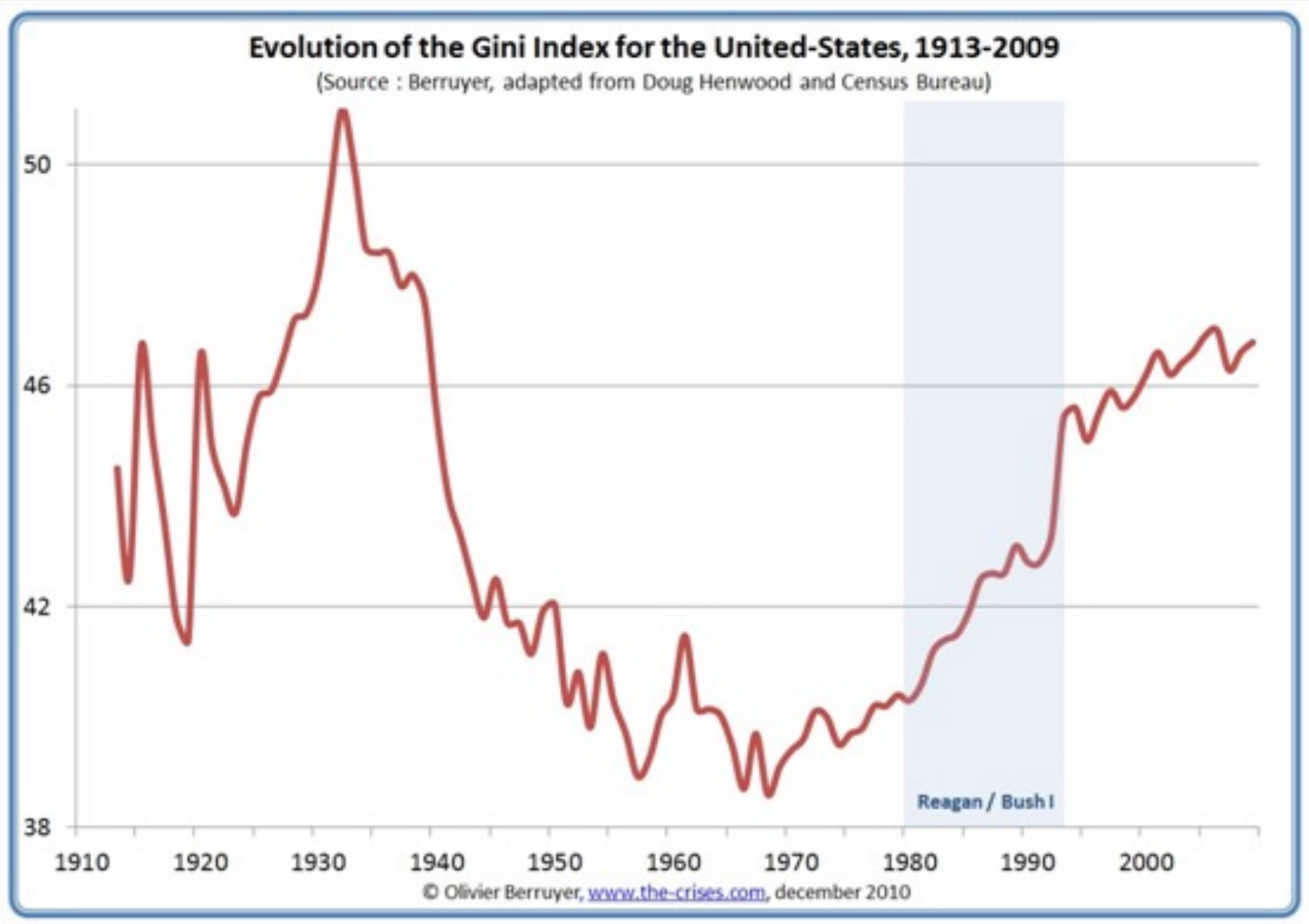
MEASURING INEQUALITY: THE GINI COEFFICIENT

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

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


Corrado Gini (1884-1965))

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



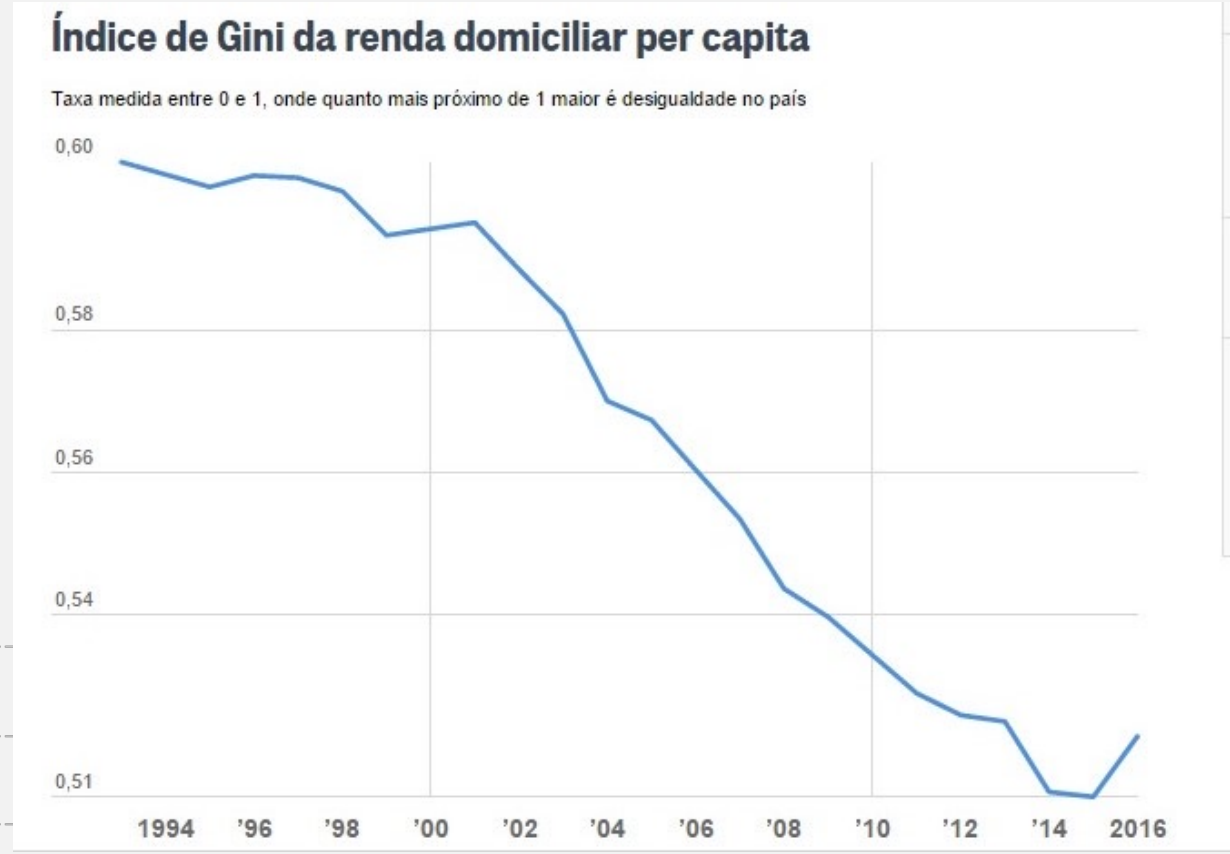
GINI USA
(PIKKETY)

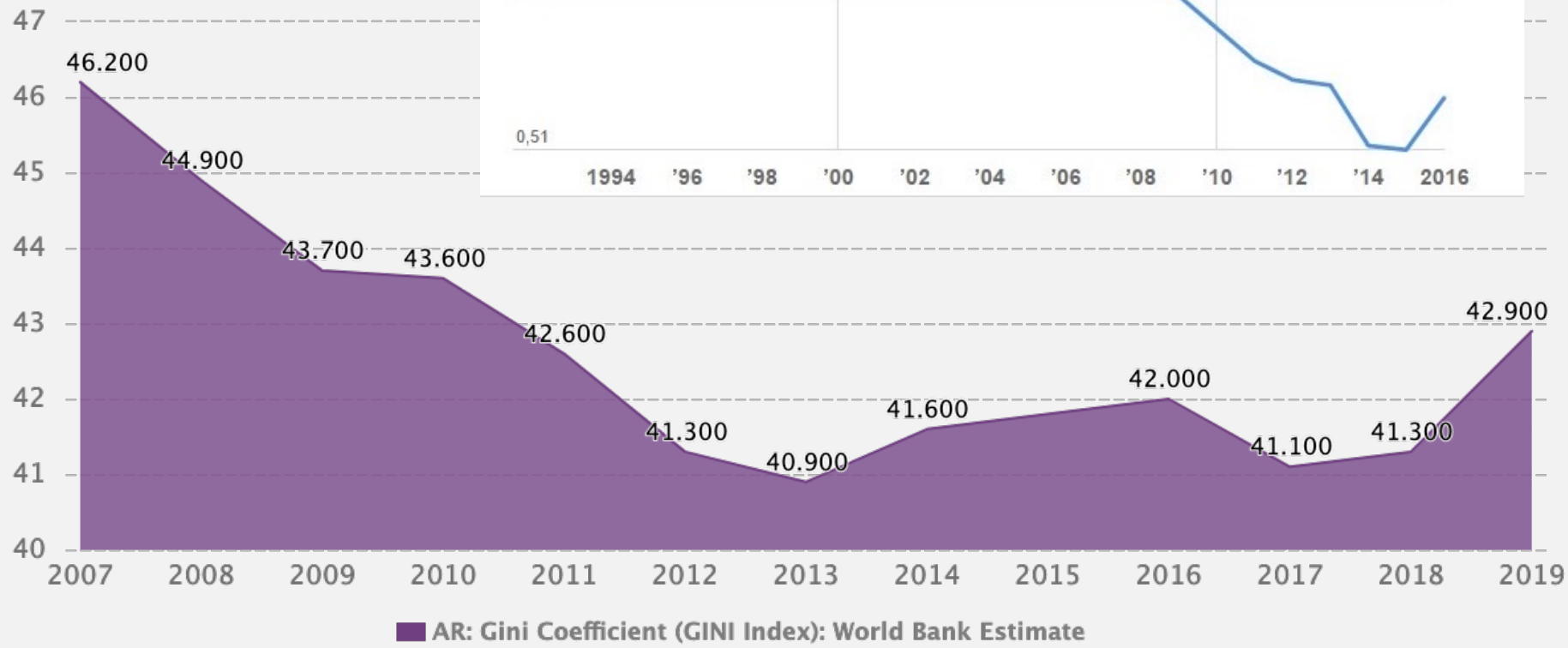
GINI 2021:
0.48

GINI BRAZIL AND ARGENTINA

GINI BRAZIL 2021
0.67
(Historical record)

GINI ARGENTINA 2021
0.45



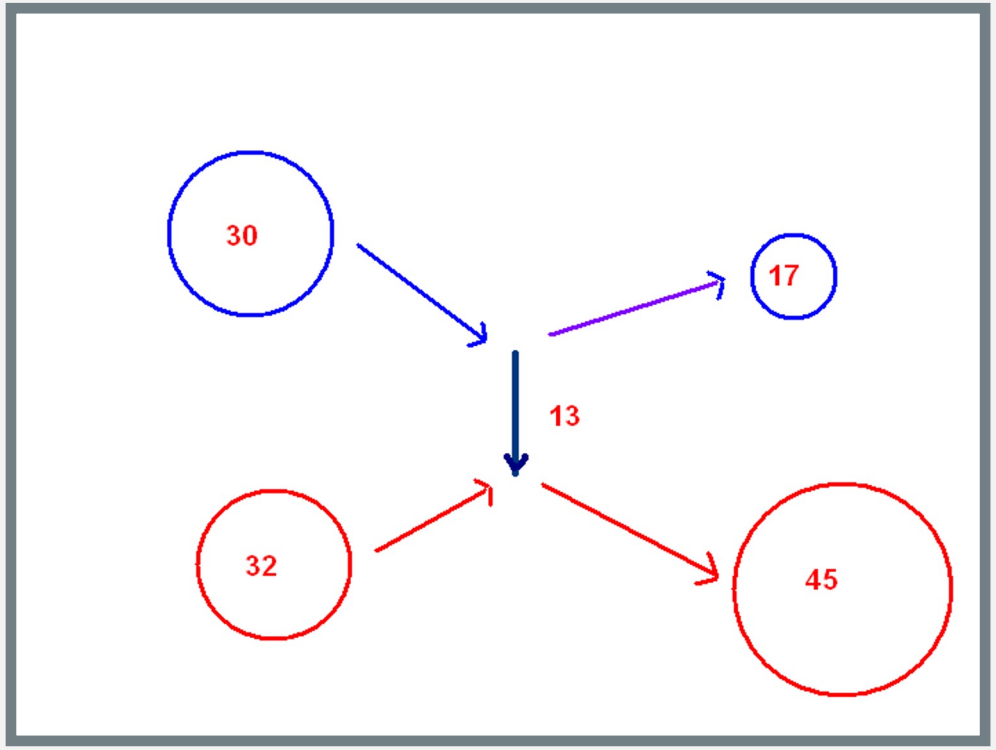


SOURCE: WWW.CEICDATA.COM | World Bank

THEORETICAL MODELS FOR THE EVOLUTION OF THE WEALTH DISTRIBUTION (AND REDISTRIBUTION). BINARY EXCHANGE MODELS

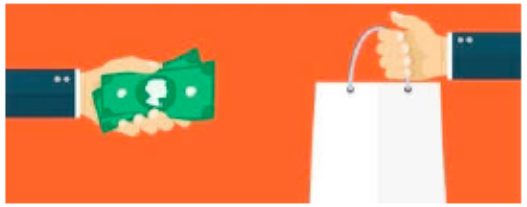
Statistical Mechanics of “Money”

- 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 (risk aversion)</u>
- Also, it’s not “fair” a random Δw



N agents with

- Wealth, $w_i(t) \geq 0$
- Risk Aversion, $0 \leq \beta_i \leq 1$



so agent i puts $(1 - \beta_i)w_i(t)$ at stake

Economical agents

Fair Exchange Rules

When agents i and j make an exchange, if i wins,

$$w_i(t+1) = w_i(t) + \Delta w$$

$$w_j(t+1) = w_j(t) - \Delta w$$

- Minimum rule: $\Delta w = \min[(1-\beta_i)w_i(t), (1-\beta_j)w_j(t)]$

Total wealth is conserved

The problem is…

Every system with fair exchanges is doomed to “condensation”
All the wealth concentrates in one (or a zero measure set) agent.

Wealth concentration in systems with unbiased binary exchanges

Ben-Hur Francisco Cardoso [a,*], José Roberto Iglesias [a,b], Sebastián Gonçalves [a]

[a] Instituto de Física, Universidade Federal do Rio Grande do Sul, 91501-970 Porto Alegre RS, Brazil
[b] Instituto Nacional de Ciência e Tecnologia de Sistemas Complexos, CBPF, Rio de Janeiro, Brazil

Physica A 579 (2021) 126123

The second law of thermodynamics predicts the thermal death of the universe. We have presented the proof that any model of binary wealth exchange based on *a priori* unbiased rule will end up in the "thermal death of the market" at the maximum unequal state.

FAIR OR EFFICIENT MARKET MODELS: ALWAYS END IN "CONDENSATION"

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 AN INESCAPABLE CASINO

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

CONTINUOUS CASINO 1

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-in 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

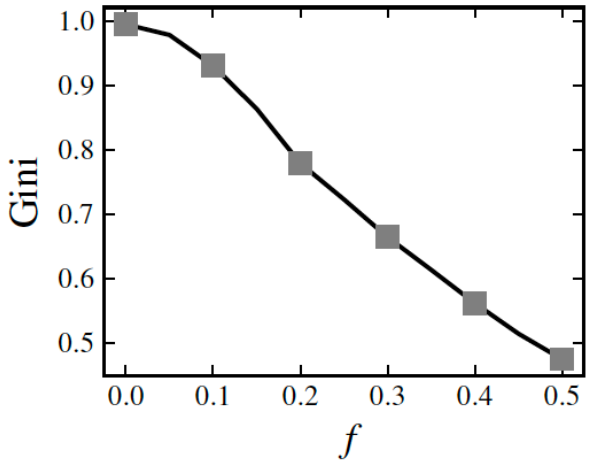
- First: A random (constant or not, equal for all or no) fraction, β, of the agent´s wealth is set aside. Ir is the saving propensity or risk-aversion.
- Then, the exchanged amount within the Yard-sale model is:
- $\Delta w = \min[(1-\beta_1)w_1;(1-\beta_2)w_2]$
- This is not enough to avoid condensation.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

- **To avoid condensation** one introduces a protection 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)

Social protection factor



Wealth distribution models with regulations: Dynamics and equilibria, BHF Cardoso, S Gonçalves, JR Iglesias, Physica A 551, 124201 (2020)

If $w_i(t) < w_j(t)$, then the probability p of i-agent to win at time t is:

$$p = \frac{1}{2} + f \times \frac{w_j(t) - w_i(t)}{w_j(t) + w_i(t)}\ , \quad 0 \leq f \leq 0.5$$

Pareto's law: a model of human sharing and creativity, Scafetta et al. (2002)

However,
the *protection factor* f,
while it can be traced to some government intervention,
may be considered artificial or
difficult to connect numerically
to a specific economic measure.

HOW TO AVOID CONDENSATION: 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

José Roberto Iglesias [a,b,*], Ben-Hur Francisco Cardoso [a], Sebastián Gonçalves [a,c]

[a] Instituto de Física, Universidade Federal do Rio Grande do Sul, 91501-970 Porto Alegre RS, Brazil
[b] Instituto Nacional de Ciência e Tecnologia de Sistemas Complexos, CBPF, 22290-180 Rio de Janeiro, RJ, Brazil
[c] URPP Social Networks, University of Zürich, Andreasstrasse 15, CH-8050 Zürich, Switzerland

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GINI VS. PERCENTAGE OF TAXES: UNIVERSAL ASSIGNATION

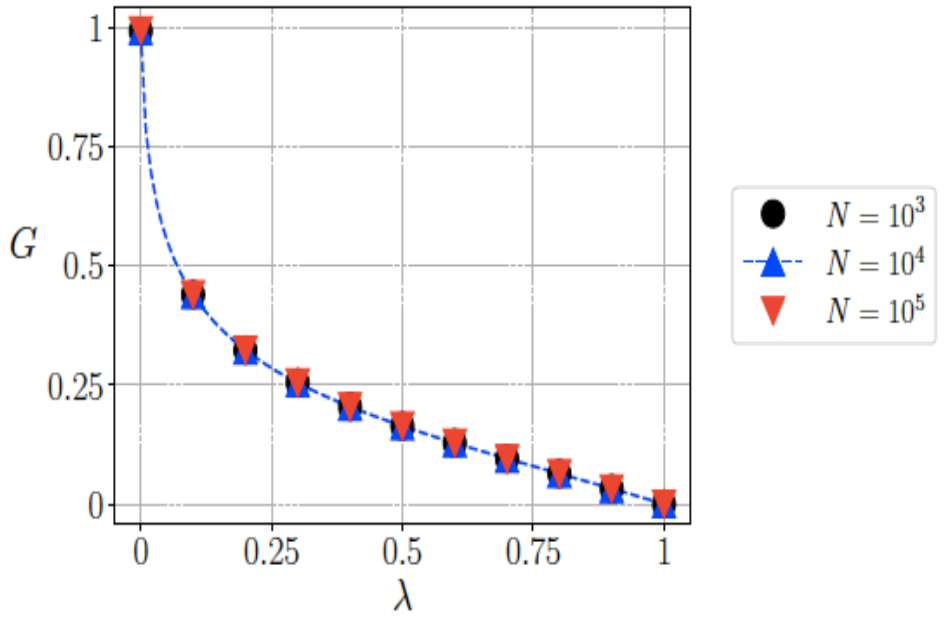
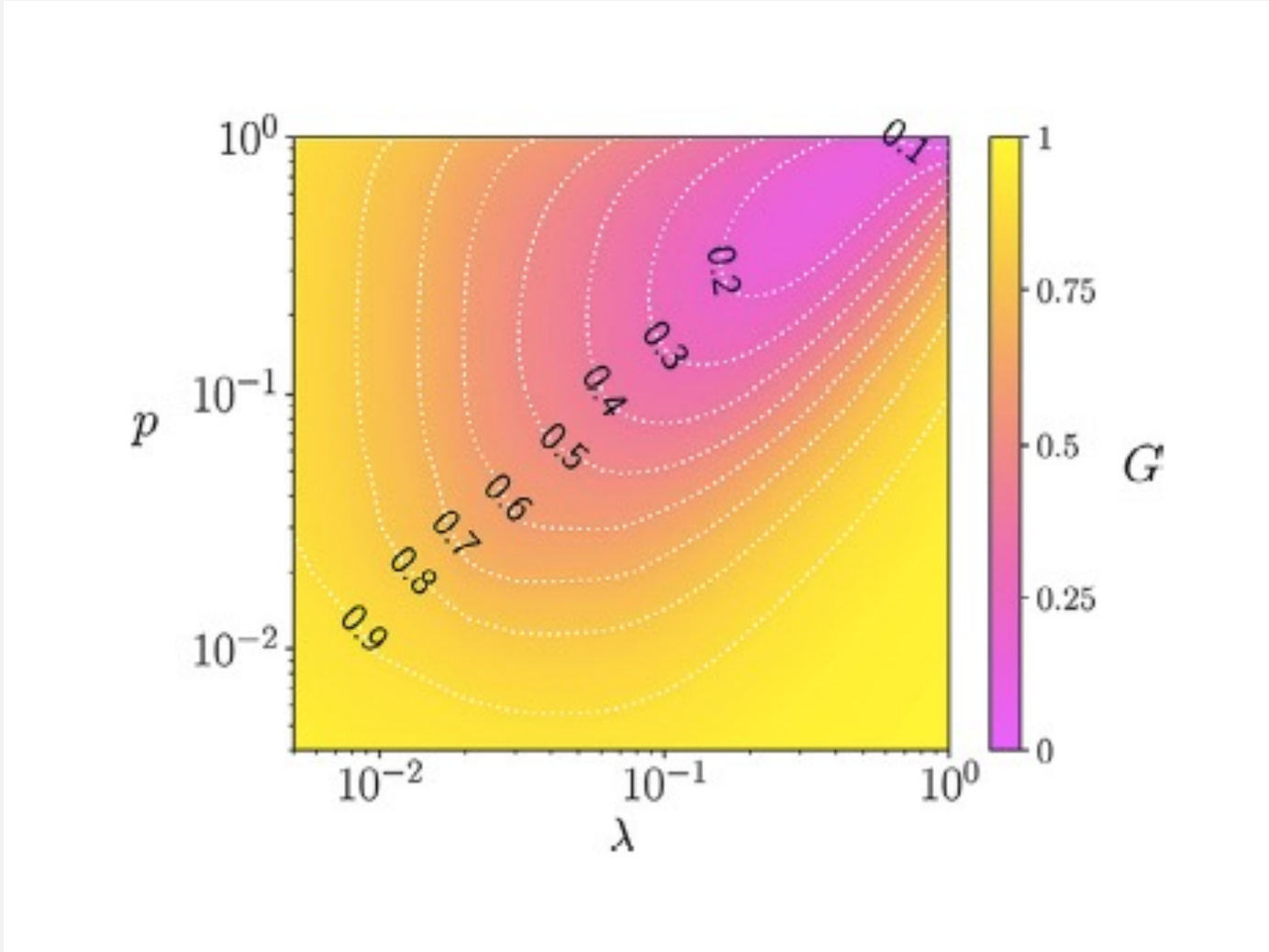


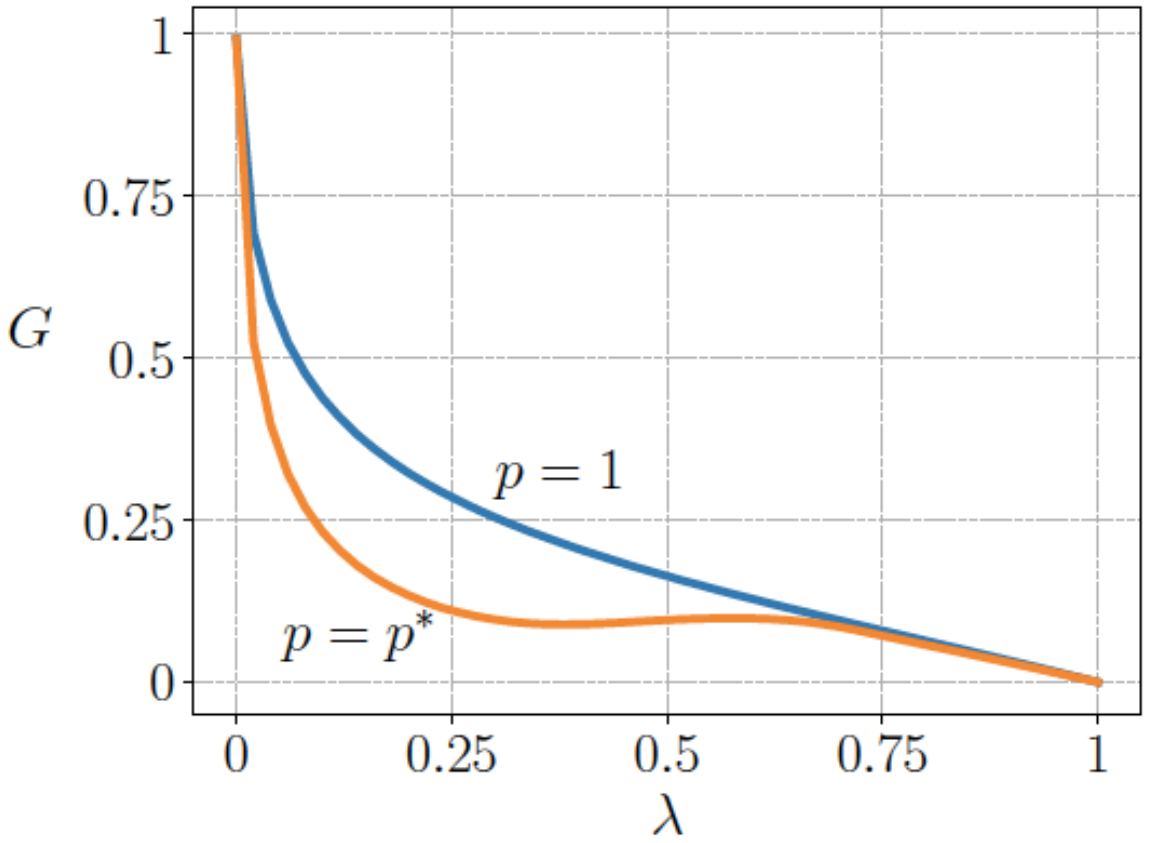
FIG. 7. Equilibrium Gini index as a function of λ, the percentage tax on fortune. Results are independent of the system's size.

Every agent receives a share, same for everyone

REDISTRIBUTION JUST FOR THE P POOREST ONES



OPTIMAL SOLUTION



For λ = 0.28, the optimum p (minimum Gini) is of the order of 0.5

TAXES ON EXCHANGES

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.

Taxes on trade

entropy

MDPI

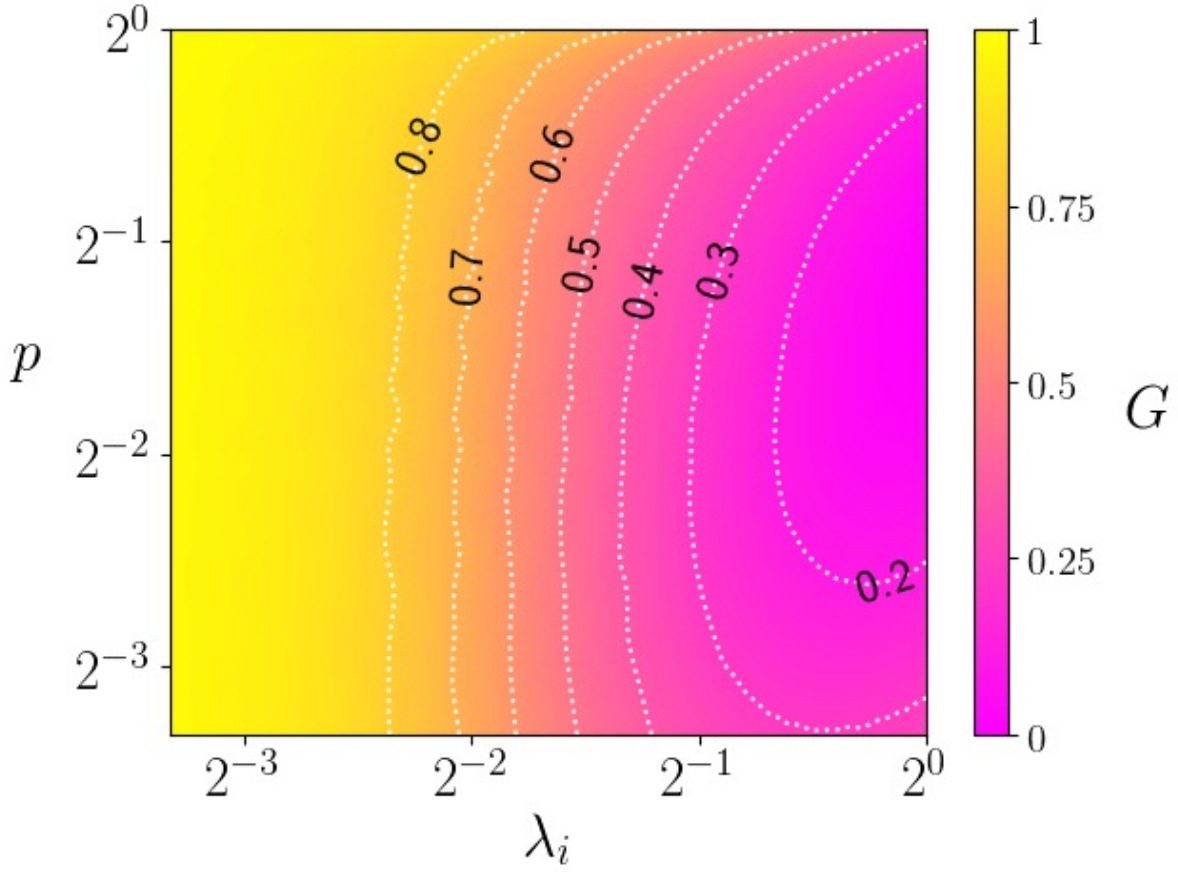
Article

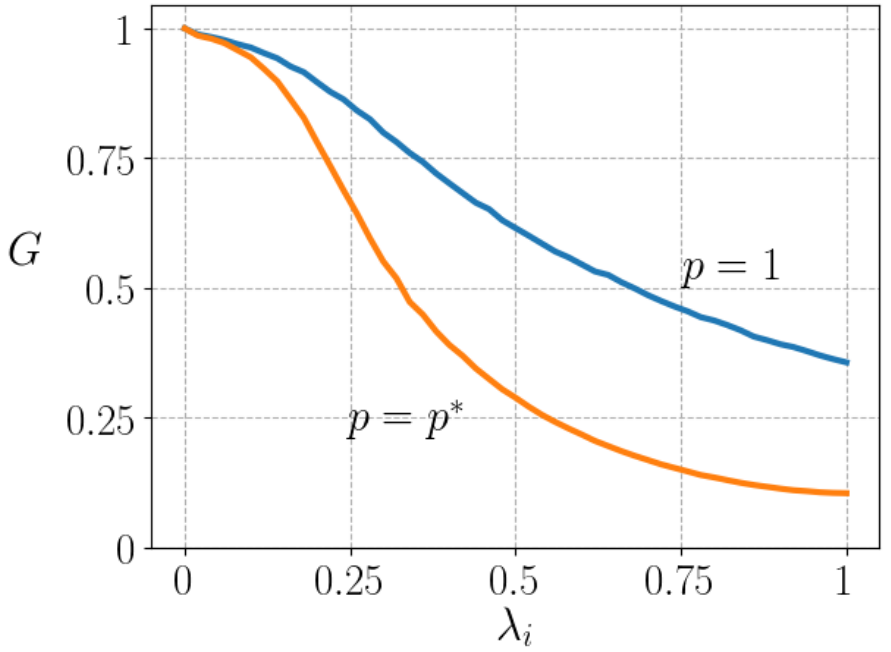
Taxes, Inequality, and Equal Opportunities

José Roberto Iglesias [1,2,3,*,†], Ben-Hur Francisco Cardoso [4,†] and Sebastián Gonçalves [1,†]

1 Instituto de Física, Universidade Federal do Rio Grande do Sul, Porto Alegre 91501-970, RS, Brazil; sgonc@if.ufrgs.br
2 Instituto Nacional de Ciência e Tecnologia de Sistemas Complexos, CBPF, Rio de Janeiro 22290-180, RJ, Brazil
3 Escola de Gestão e Negócios, Programa de Pós-Graduação em Economia, UNISINOS, Porto Alegre 91330-002, RS, Brazil
4 Departamento de Economia e Relações Internacionais, Universidade Federal de Santa Catarina, Florianópolis 88015-400, SC, Brazil; benhur.phys@gmail.com
* Correspondence: joseroberto.iglesias@gmail.com
† These authors contributed equally to this work.

RANDOM RISK AVERSION





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

Combination of both taxes

Exchange tax:

$$w_i^* = w_i + (1 - \epsilon\lambda)\Delta w$$
$$w_j^* = w_j - \Delta w,$$

After the exchange, all agents pay wealth tax:

$$(1 - \epsilon)\lambda w_i^*$$

$$0 \leq \epsilon \leq 1$$

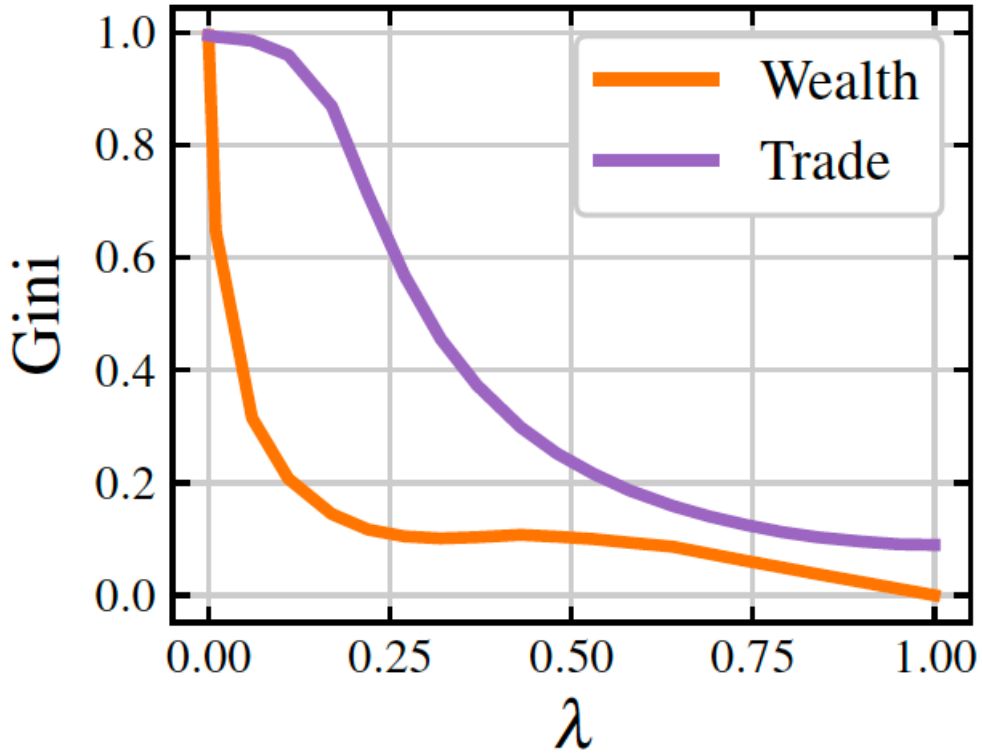
$\epsilon = 0$ (*only wealth*) $\epsilon = 1$ (*only exchange*)

τ: the poorest fraction of the population that receives the collected taxes

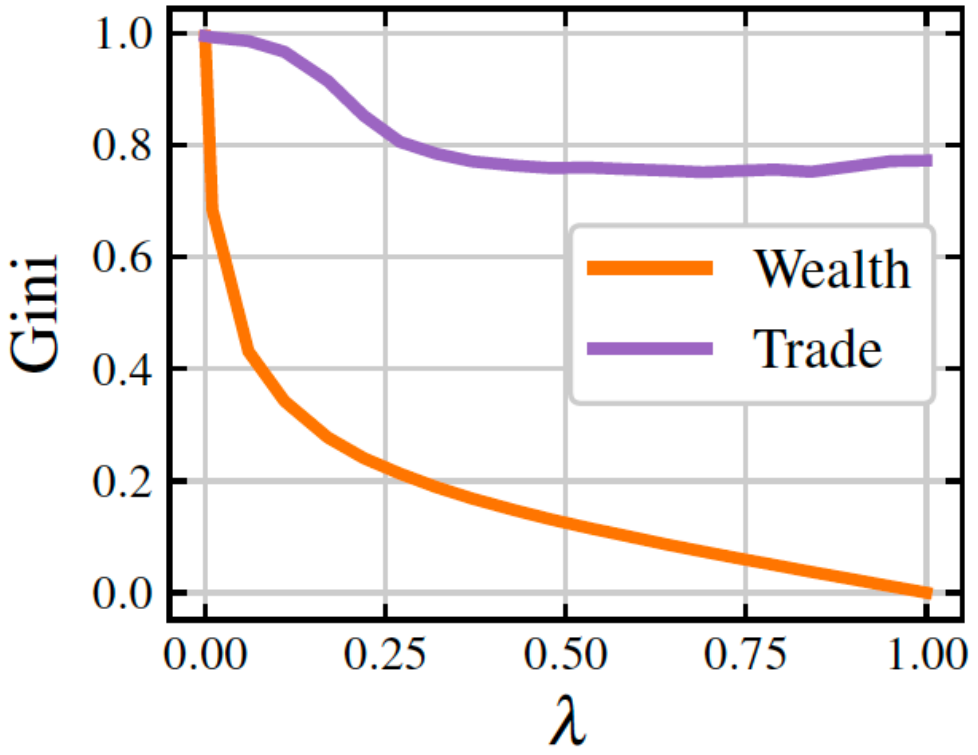
Three parameters: λ, τ, and ϵ

$\text{Gini}(\lambda, \tau, \epsilon)$

Comparison universal or targeted assignation

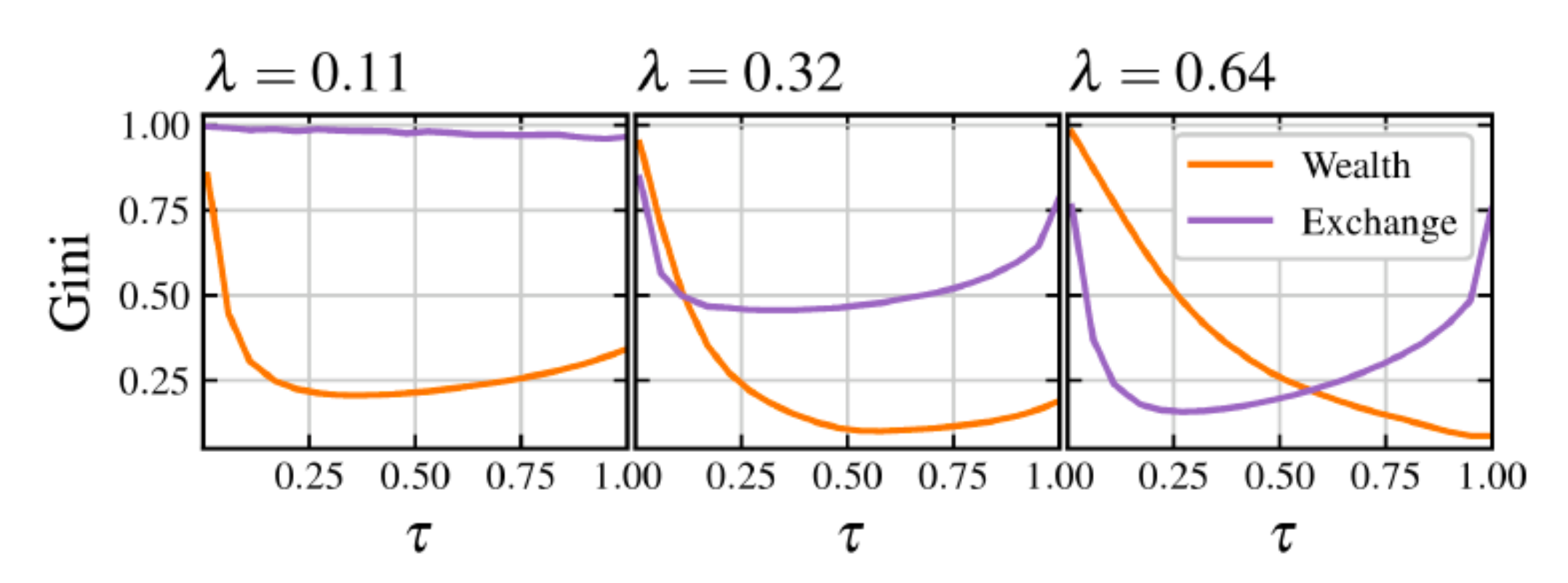


TARGETED



UNIVERSAL

What kind of taxes to reduce inequality?



CONCLUSIONS

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.

Unfortunately, this is the present tendency in the world economies: higher concentration of wealth, increase of poverty

Introduction of "rationality" in the agents (machine learning), increases inequality

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

THANK YOU

!!!FELIZ CUMPLEAÑOS CONSTANTINO!!!