

Distribution & Evolution of Social Wealth

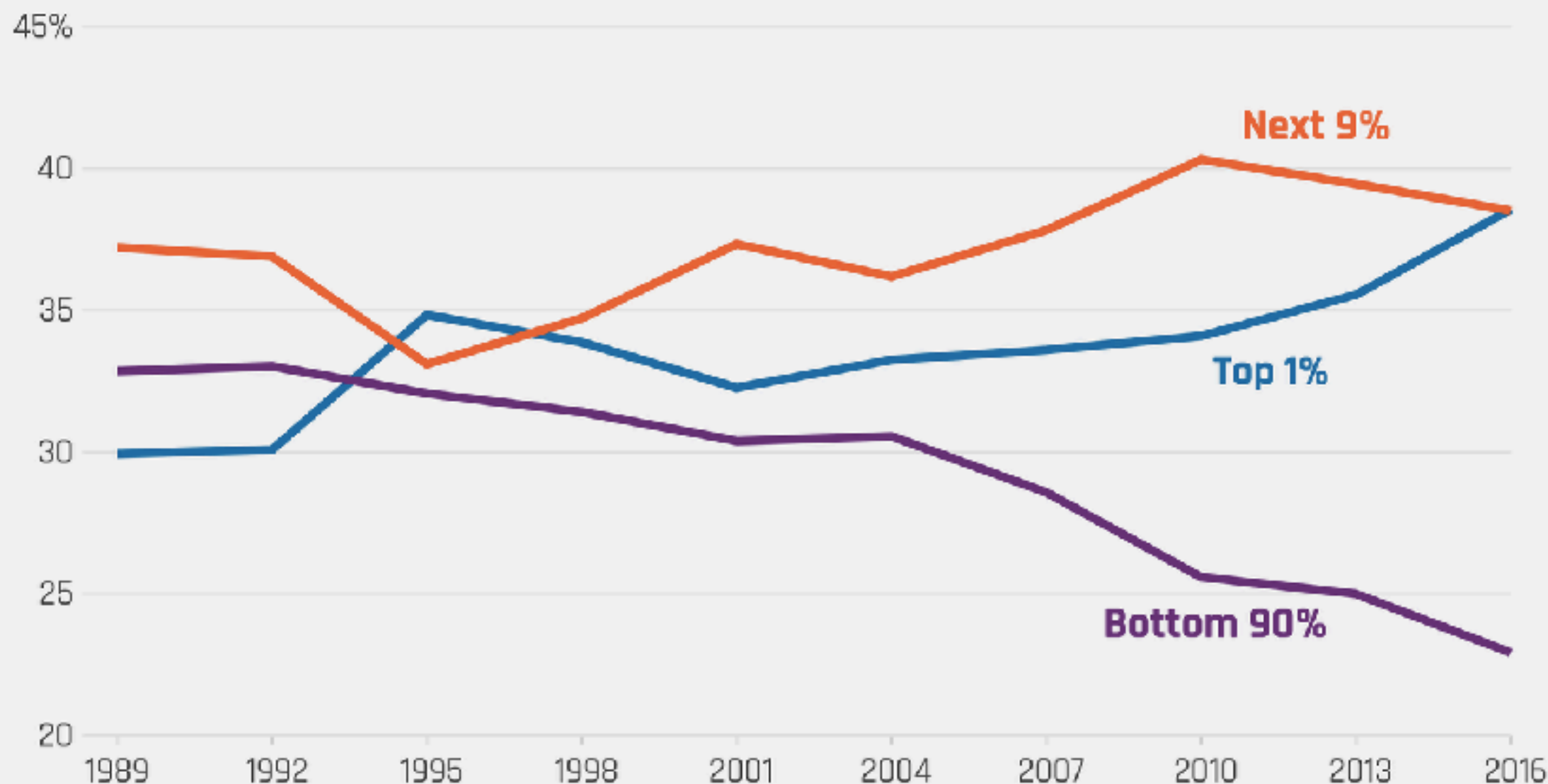
Monte Carlo Simulations

By Xiaohan Wang

Wealth Inequality is Intense

The wealthiest Americans own an increasing share of wealth

Shares of wealth in the United States by wealth percentiles, 1989-2016

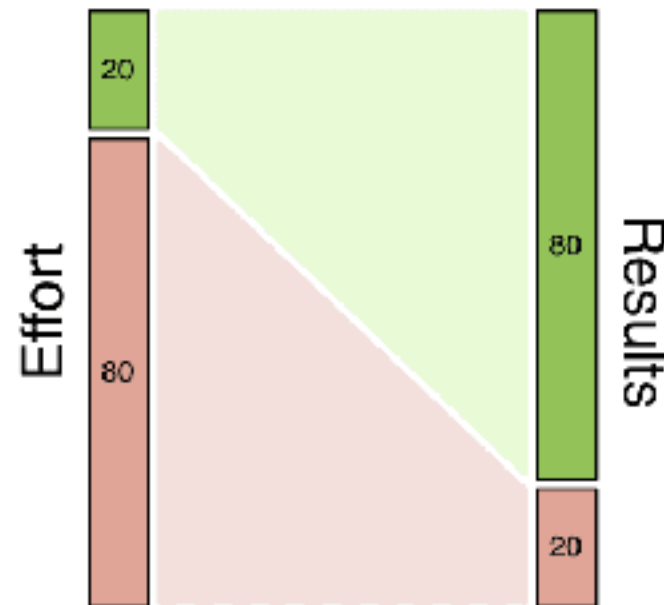


Source: Authors' calculations using Federal Reserve Board, "Survey of Consumer Finances" [2017]

Pareto Principle (80/20 Rule)

The 80-20 Rule

"For many events, roughly 80% of the effects come from 20% of the causes." - Pareto



Therefore 20% of the effort produces 80% of the results but the last 20% of the results consumes 80% of the effort.

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Distribution of world GDP, 1989^[9]

Quintile of population	Income
Richest 20%	82.70%
Second 20%	11.75%
Third 20%	2.30%
Fourth 20%	1.85%
Poorest 20%	1.40%

Hypothesis

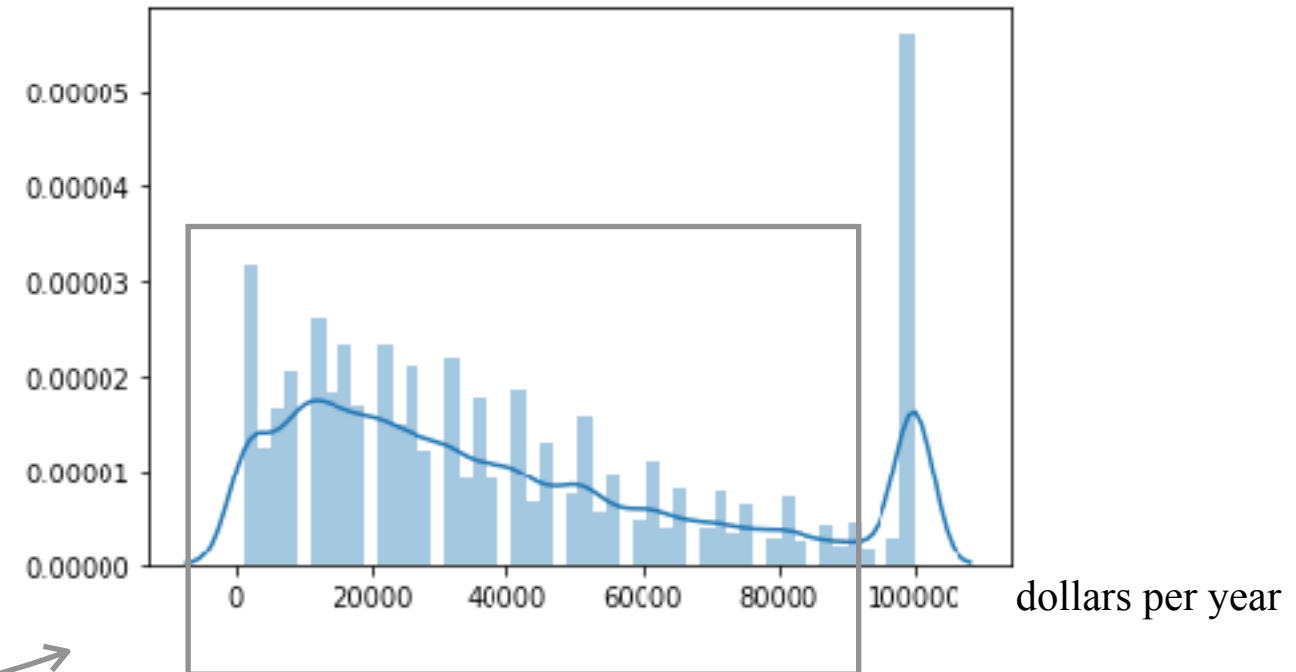
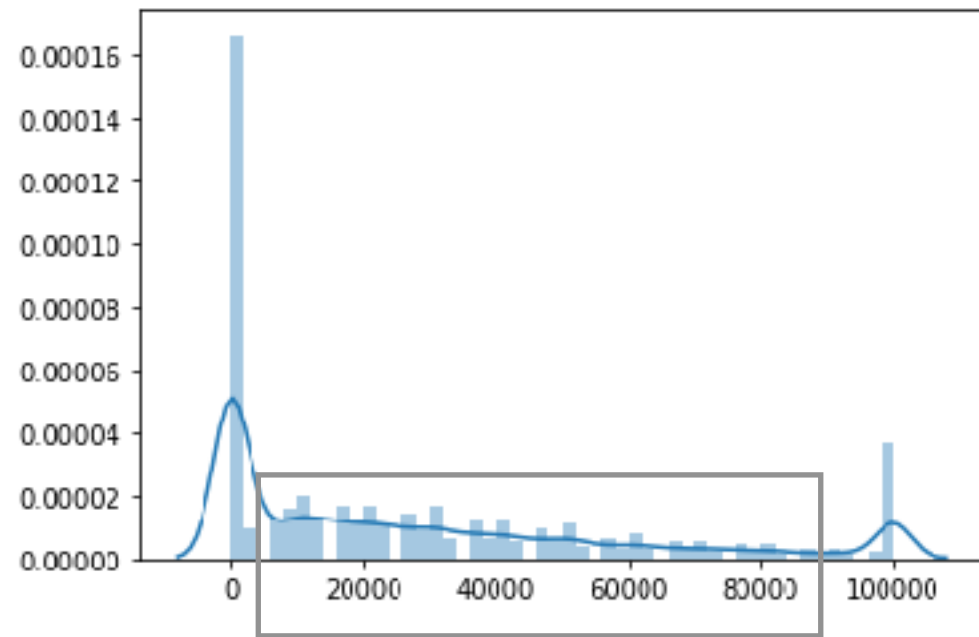
- A small portion of people would have the most of wealth within the whole society
- As time goes by, the difference between top 20% wealthy people's wealth and the rest 80% would be greater and greater.
- If the piecewise income tax rate changes to flat tax, the difference would be greater.
- Living in situations that would cause much more accidental loss, but with more chance for unstable income, the difference would be greater than the basic situation.
- People who work harder, even achieved a little more than others, they would have more wealth amounts as long as they persist year by year.

Situation	Stable Income	Unstable Income	Social Welfare	Income Tax	Accidental Loss
Basic	±5%	1/1000,\$1000	\$2400	piecewise	1/50,-\$5000
A	±5%	1/1000,\$1000	\$2400	flat(35%)	1/50,-\$5000
B	±5%	1/50,\$1000	\$2400	piecewise	1/5, -\$5000
C	+15% -5%	1/1000,\$1000	\$2400	piecewise	1/50, -\$5000

Project Design

Plot the distribution of personal income amounts

percentage



```
41 def stable_income_sample(size):
42     ''' Combine 3 distributions in piecewise fashion to generate random sample with income values
43     :param size: the number of a group of people
44     :return: sample: a ndarray of personal income values
45     '''
46     # the following three percentage numbers are averaged from three real datasets(2016-2018 CPS)
47     sample_left = np.zeros(math.ceil(0.287 * size)).astype('Int32')
48     sample_middle = np.random.triangular(0, 1250, 100000, math.ceil(0.645 * size)).astype('Int32')
49     sample_right = np.random.choice([100000, 1000000], math.floor(0.068 * size)).astype('Int32')
50     sample = np.concatenate([sample_left, sample_middle, sample_right], axis=0)
51     np.random.shuffle(sample)
52     return sample
```

Factors



Gains



Stable Income



Unstable Income



Social Welfare



Loss



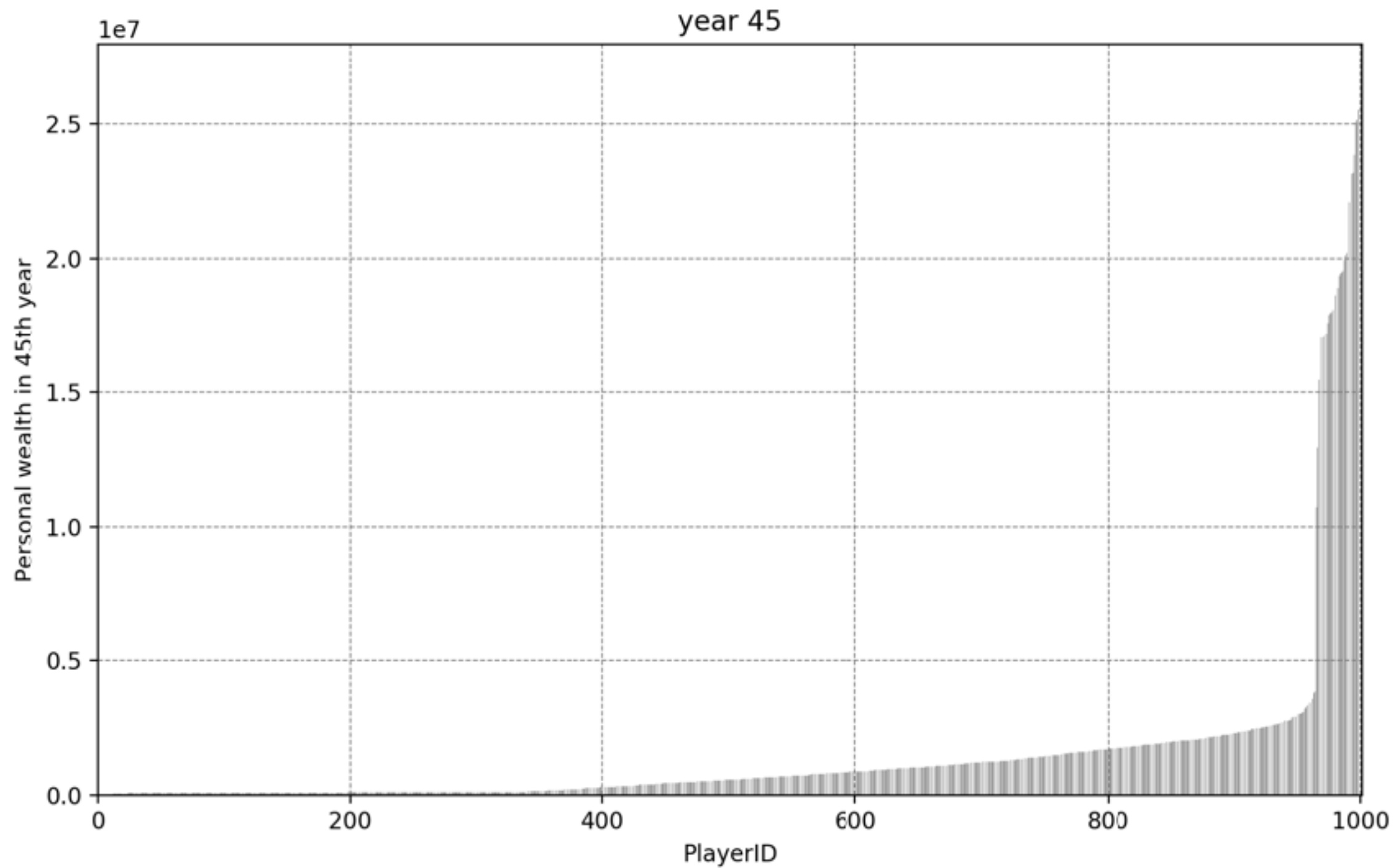
Income Tax



Accidental Loss

$$\text{Net wealth} = \text{Stable Income} + \text{Unstable Income} + \text{Social Welfare} - \text{Income Tax} - \text{Accidental Loss}$$

Basic Simulations & Analysis



Basic Simulations & Analysis

1.3% of people have 20% of all the wealth

10% of people have **58%** of all the wealth

20% of people have **73%** of all the wealth

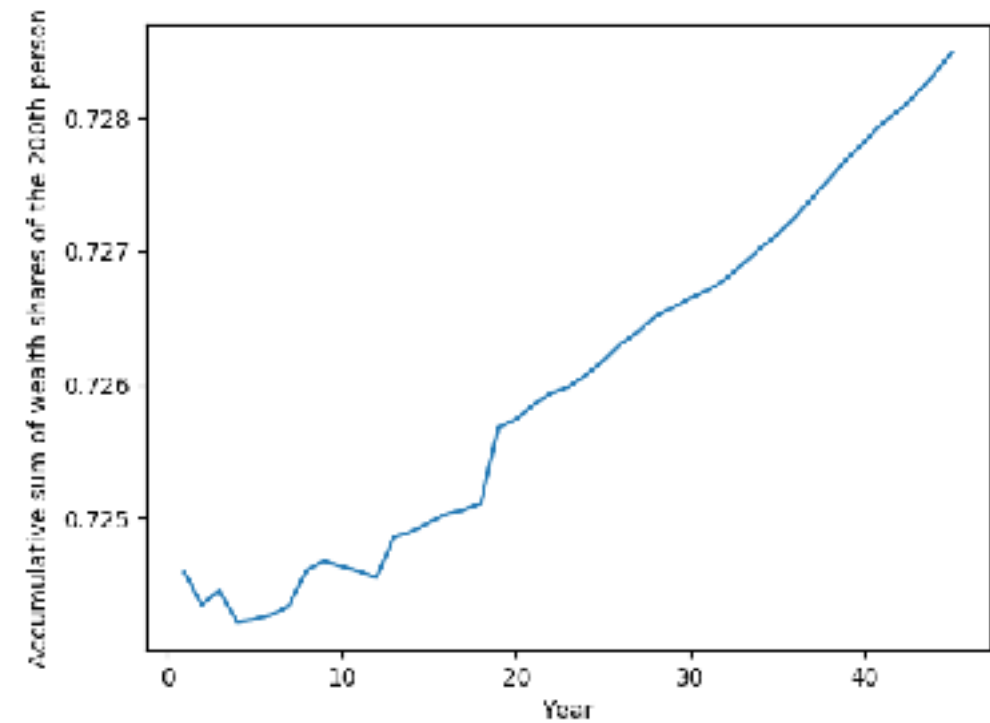
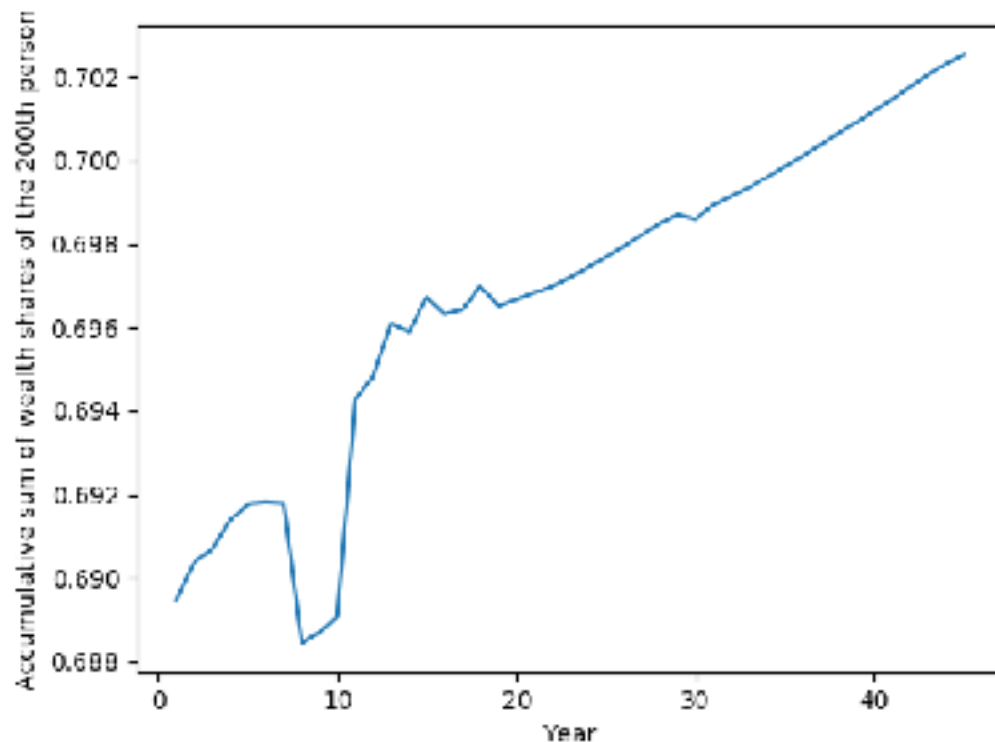
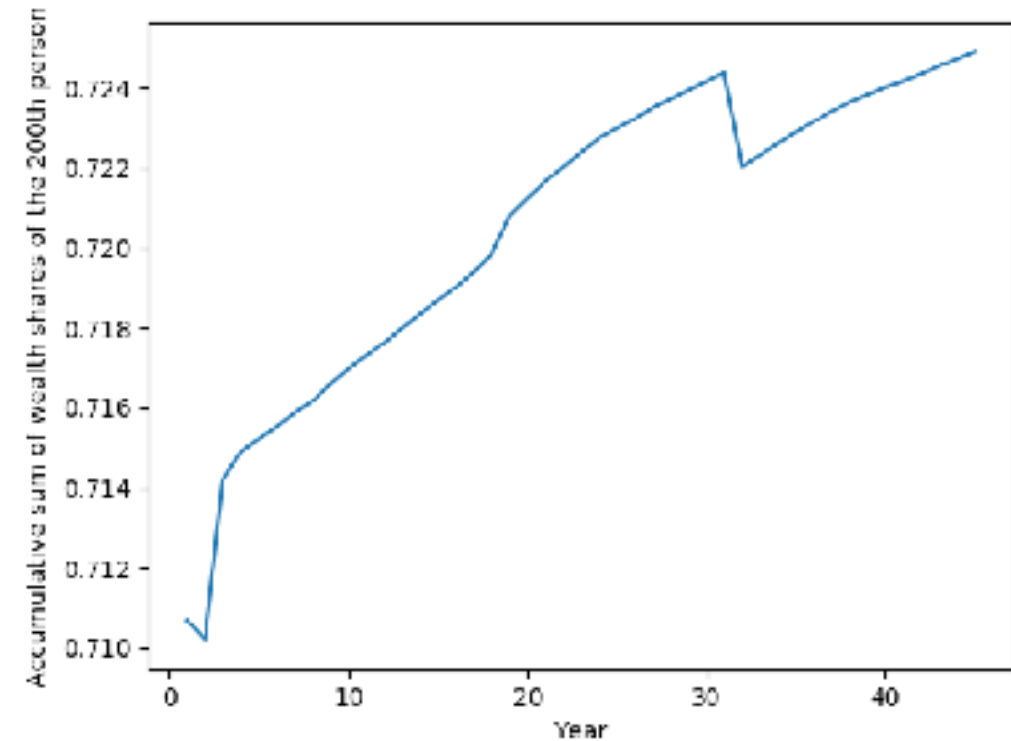
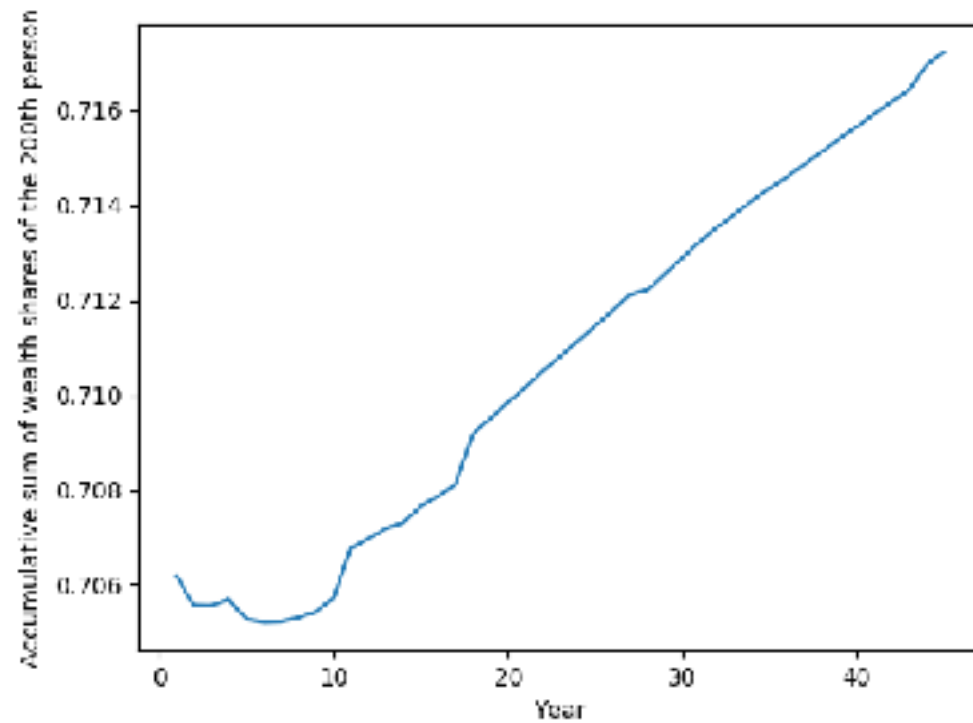
H1: A small portion of people would have the most of wealth within the whole society

	ID	Fortune	Percent	Cumulative_sum	Initial_fortune	Increased_by
0	892.00000	31463384.20000	0.01707	0.01707	29817.65000	1054.19329
1	656.00000	31128799.35000	0.01689	0.03396	6042.60000	5150.55717
2	781.00000	30624828.55000	0.01661	0.05057	45436.50000	673.01381
3	96.00000	30537849.45000	0.01657	0.06714	82079.50000	371.05209
4	456.00000	28818687.30000	0.01563	0.08277	2400.00000	12006.78637
5	914.00000	28562750.45000	0.01550	0.09827	560555.75000	49.95434
6	924.00000	27868713.20000	0.01512	0.11338	60751.50000	457.73292
7	935.00000	27849017.80000	0.01511	0.12849	9156.70000	3040.38148
8	897.00000	27307338.10000	0.01481	0.14331	2400.00000	11377.05754
9	536.00000	27203005.20000	0.01476	0.15806	2400.00000	11333.58550
10	514.00000	26904926.05000	0.01460	0.17266	44663.25000	601.39517
11	655.00000	26457790.75000	0.01435	0.18701	33054.45000	799.43052
12	553.00000	25302972.45000	0.01373	0.20074	66429.75000	379.89620

	ID	Fortune	Percent	Cumulative_sum	Initial_fortune	Increased_by
87	903.00000	2877391.80000	0.00156	0.56370	56628.75000	49.81150
88	532.00000	2841942.45000	0.00154	0.56524	560555.75000	4.06987
89	786.00000	2815935.30000	0.00153	0.56677	15611.60000	179.37455
90	812.00000	2807731.70000	0.00152	0.56829	44027.25000	62.77259
91	557.00000	2776003.20000	0.00151	0.56980	58421.25000	46.51701
92	454.00000	2772062.00000	0.00150	0.57130	22679.35000	121.22846
93	599.00000	2767260.80000	0.00150	0.57280	10440.20000	264.05822
94	464.00000	2763988.35000	0.00150	0.57430	2400.00000	1150.66181
95	506.00000	2749319.55000	0.00149	0.57579	2400.00000	1144.54981
96	674.00000	2738998.60000	0.00149	0.57728	27495.45000	98.61643
97	905.00000	2736581.95000	0.00148	0.57876	7654.50000	356.51283
98	759.00000	2735435.50000	0.00148	0.58025	2400.00000	1138.76479
99	149.00000	2722972.50000	0.00148	0.58172	37780.50000	71.07349
100	580.00000	2713637.45000	0.00147	0.58320	49081.50000	54.28840
101	616.00000	2710210.70000	0.00147	0.58467	2400.00000	1128.25446
102	663.00000	2708358.10000	0.00147	0.58614	38602.50000	69.16017
103	378.00000	2682245.40000	0.00146	0.58759	2400.00000	1116.60225

Basic Simulations & Analysis

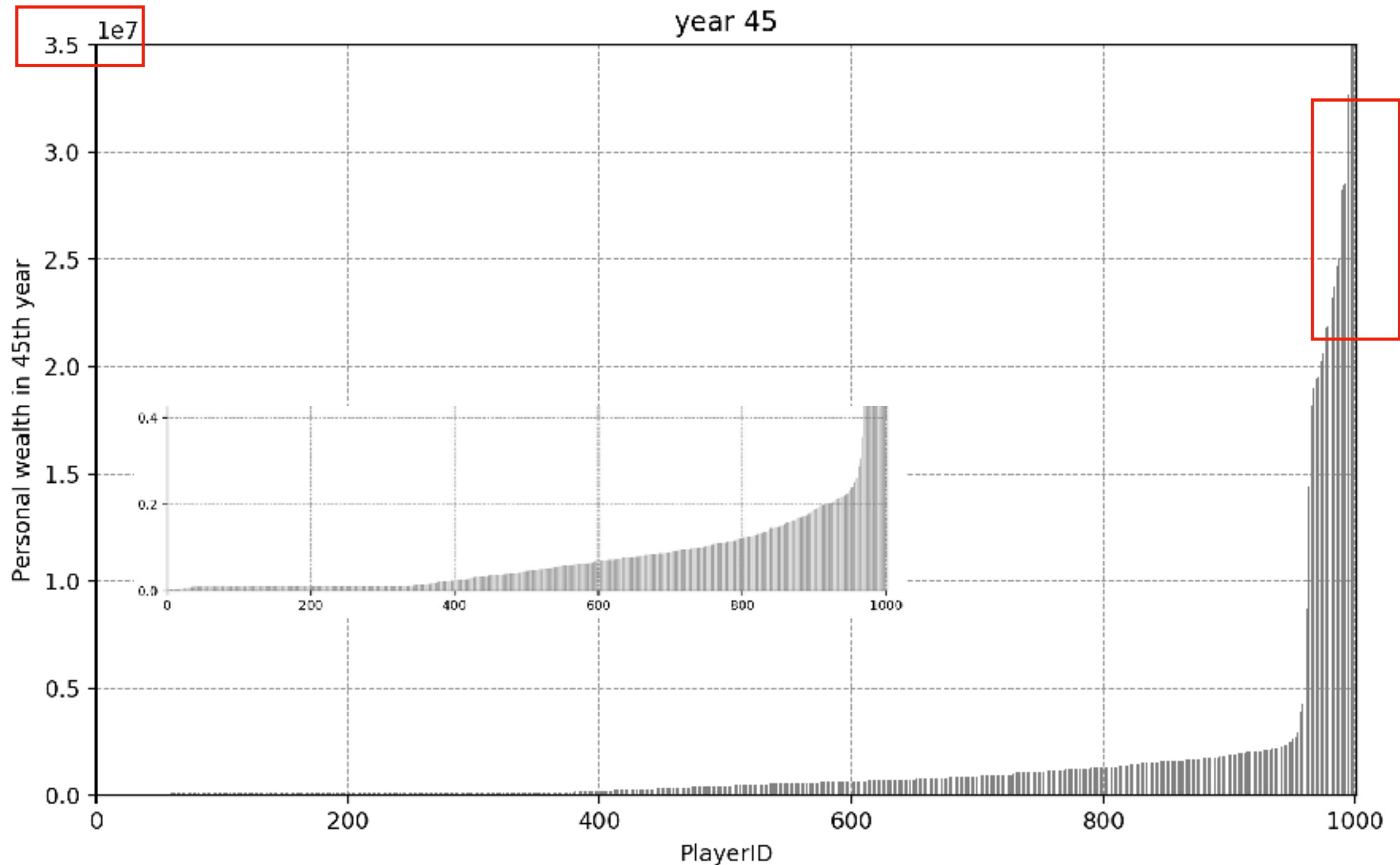
H2: As time goes by, the wealth difference between the richest 20% of people and the rest 80% would be greater.



Situation1. Flat Income tax rate

Income Range	[0, 9700)	[9700,39475)	[39475,84200)	[84200,160725)	[160725,204100)	[204100,510300)
Tax rate	10%	15%	25%	30%	35%	45%

→ **35%**



Situation1. Flat Income tax rate

Maximum of personal wealth become greater 

1.1% of people have **20%** of all the fortune 

10% of people have **66%** of all the fortune 

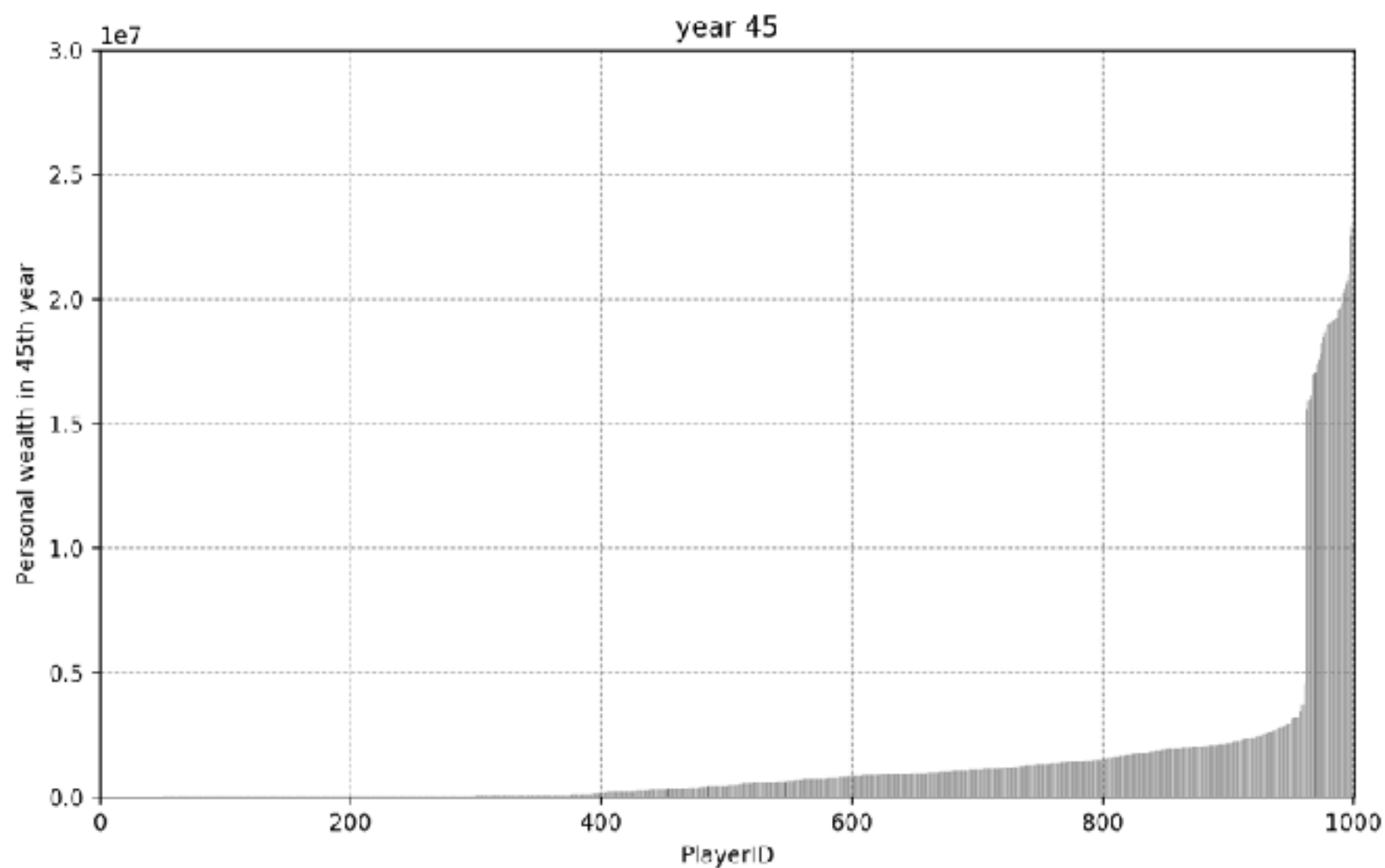
20% of people have **76%** of all the fortune 

	ID	Fortune	Percent	Cumulative_sum	Initial_fortune	Increased_by
0	199.00000	34589070.55000	0.02587	0.02587	5081.70000	6805.59436
1	707.00000	30875588.90000	0.02309	0.04896	15581.80000	1980.51619
2	925.00000	29381535.10000	0.02197	0.07093	15467.40000	1898.57815
3	795.00000	28940132.90000	0.02164	0.09257	11907.35000	2429.44279
4	432.00000	25719705.05000	0.01923	0.11181	2400.00000	10715.54377
5	118.00000	24997572.40000	0.01869	0.13050	39986.70000	624.14717
6	821.00000	24295532.40000	0.01817	0.14867	39242.45000	618.11355
7	783.00000	23106705.05000	0.01728	0.16595	9361.30000	2467.32225
8	690.00000	22899216.60000	0.01712	0.18307	2400.00000	9540.34025
9	475.00000	22859875.35000	0.01710	0.20017	19401.85000	1177.23173

	ID	Fortune	Percent	Cumulative_sum	Initial_fortune	Increased_by
191	445.00000	1320416.30000	0.00092	0.76152	2400.00000	549.17346
192	114.00000	1314623.50000	0.00091	0.76244	68250.00000	18.26188
193	434.00000	1313189.60000	0.00091	0.76335	49219.30000	25.68038
194	583.00000	1309928.75000	0.00091	0.76426	34056.75000	37.46312
195	150.00000	1294534.15000	0.00090	0.76517	3706.95000	348.21813
196	589.00000	1285352.75000	0.00089	0.76606	4332.25000	295.69404
197	891.00000	1279718.05000	0.00089	0.76695	9356.10000	135.77901
198	810.00000	1272767.60000	0.00089	0.76784	16500.25000	76.13626
199	626.00000	1266809.70000	0.00088	0.76872	1318.20000	960.01479
200	953.00000	1265480.05000	0.00088	0.76960	617500.00000	1.04936
201	742.00000	1265083.95000	0.00088	0.77048	2791.10000	452.25640
202	925.00000	1258549.50000	0.00088	0.77135	33869.55000	36.15873
203	510.00000	1255304.50000	0.00087	0.77223	10277.80000	121.13747
204	784.00000	1253888.85000	0.00087	0.77310	16196.70000	76.41632
205	214.00000	1253862.35000	0.00087	0.77397	16069.95000	77.02528
206	2 00000	1249321 90000	0 00087	0 77484	41956 20000	28 77681

Situation2. GreaterAccidental Loss

Situation	Stable Income	Unstable Income	Social Welfare	Income Tax	Accidental Loss
Basic	±5%	1/1000,\$1000	\$2400	piecewise	1/50,-\$5000
A	±5%	1/1000,\$1000	\$2400	flat(35%)	1/50,-\$5000
B	±5%	1/50,\$1000	\$2400	piecewise	1/5, -\$5000
C	+15% -5%	1/1000,\$1000	\$2400	piecewise	1/50, -\$5000



Situation2. GreaterAccidental Loss

maximum and minimum of personal wealth become smaller 

1.2% of people have **20%** of all the fortune

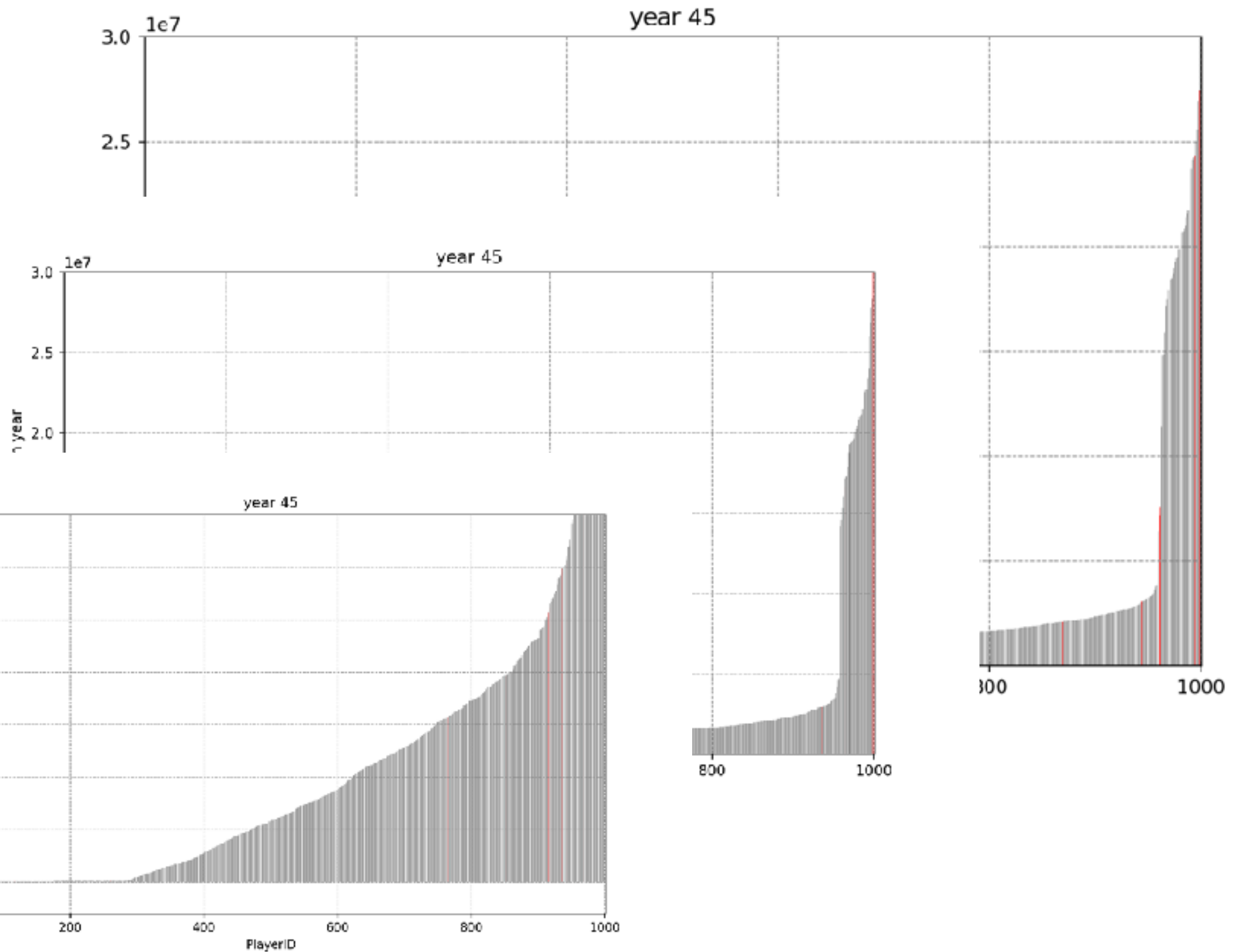
10% of people have **60%** of all the fortune

20% of people have **72%** of all the fortune

	ID	Fortune	Percent	Cumulative_sum	Initial_fortune	Increased_by
0	446.00000	32442309.75000	0.02261	0.02261	35990.25000	900.41941
1	447.00000	27957537.10000	0.01949	0.04210	39805.75000	701.34921
2	517.00000	25692754.65000	0.01791	0.06001	2400.00000	10704.31444
3	516.00000	25655747.45000	0.01788	0.07789	56410.50000	453.80447
4	515.00000	25608676.10000	0.01785	0.09574	15276.70000	1675.32251
5	514.00000	25404472.45000	0.01771	0.11345	8176.50000	3106.01063
6	948.00000	24395616.10000	0.01700	0.13046	-2600.00000	-9383.92927
7	445.00000	23666824.80000	0.01650	0.14695	15071.85000	1569.26674
8	223.00000	23435480.40000	0.01634	0.16329	-2600.00000	-9014.64631
9	471.00000	23093954.20000	0.01610	0.17939	42473.25000	542.72939
10	444.00000	22871954.25000	0.01594	0.19533	64950.00000	351.14710
11	294.00000	20232176.65000	0.01410	0.20943	75079.50000	268.47671

	ID	Fortune	Percent	Cumulative_sum	Initial_fortune	Increased_by
191	940.00000	1710895.95000	0.00110	0.71148	27923.85000	60.27006
192	810.00000	1698471.85000	0.00109	0.71257	2400.00000	706.69660
193	283.00000	1695785.65000	0.00109	0.71365	23544.65000	71.02425
194	611.00000	1690784.75000	0.00108	0.71474	12060.30000	139.19425
195	163.00000	1690764.95000	0.00108	0.71582	6436.80000	261.67166
196	123.00000	1688511.90000	0.00108	0.71690	-2600.00000	-650.42765
197	653.00000	1684433.30000	0.00108	0.71798	20288.30000	82.02486
198	164.00000	1683989.90000	0.00108	0.71906	560555.75000	2.00414
199	309.00000	1679647.50000	0.00108	0.72013	26890.25000	61.46307
200	308.00000	1673302.00000	0.00107	0.72120	2400.00000	696.20917
201	116.00000	1669947.00000	0.00107	0.72227	2400.00000	694.81125
202	838.00000	1657321.00000	0.00106	0.72333	5128.20000	322.17792
203	81.00000	1652065.55000	0.00106	0.72439	2400.00000	687.36065
204	462.00000	1651353.35000	0.00106	0.72545	5489.10000	299.84228

Situation3. What if worker harder?



THANKS

Xiaohan Wang