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## Some Thoughts about Distribution in Economics

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The message of this talk is a philosophical one: scientists tend to place too much focus on averages, while the world is full of singularities.

In economics the oldest and best-founded singular distribution is the Pareto Law of incomes:

$$n(I > I_0) = \frac{\text{const}}{(I_0)^\alpha}.$$

For French towns in the nineteenth century, U.S. incomes in 1916, and a number of other populations,  $\alpha \simeq 3/2$ . But as we shall see, there are many societies in which  $\alpha$  is different.

We can check that this is reasonably descriptive of the income statistics of the modern U.S. since we know minimum and maximum incomes—say \$5000 and \$10<sup>9</sup>. Their ratio is indeed  $(10^8)^{2/3}$ , where  $10^8$  is the number of households.

Let us play with other aspects of this: in particular, integrate it down from high incomes and find the total *wealth* above a given level. This turns out to be

$$n = \frac{A}{I^{3/2}}$$

$$W(> I) = 3A \left( \frac{1}{I^{1/2}} - \frac{1}{I_{\max}^{1/2}} \right)$$

$$\left( \frac{1}{2} = \alpha - 1 \right).$$

In terms of population  $N$  ( $P$  is total population)

$$W(N) = 3hP \left( \frac{N}{P} \right)^{1/3} \quad \left( 3 = \frac{\alpha}{1 - \alpha} \right).$$

So to find half the wealth you need only 1/8 the people, etc. The *rich have all the money!* Policy implication: it pays to tax the rich, not the poor! The average income is  $\alpha/\alpha - 1 \times$  minimum (a little low). (We have set  $\alpha$  a little high for today, after the Reagan revolution: its effect was to increase unfairness, lower  $\alpha$ .)

Is  $\alpha$  a fixed constant of human nature? Pareto thought it was (he also thought *increasing*  $\alpha$  made a more unfair economy, in which he was wrong).

In a truly sick society (Haiti, Zaire, etc.)  $\alpha \rightarrow 1$  and  $W(N)$  is all held by a few people. ( $\alpha < 1$  is impossible—everyone starves.)  $\alpha$  seems to be a measure of the health of the economy!

What causes Pareto? My instinct is that the economy is a system of competitive advantage, but that it contains, on the whole, positive sum, not zero-sum, games. A simple example of such a game: an elimination tournament in which, in the first round, the winning player wins 2, the loser keeps 1.

The loser is not allowed to play in the next round where the two outcomes are 2 (loser) and 4 (winner); etc. The number of players left after  $P$  plays is

$$n(p) = \frac{1}{2^p}$$

and the winnings:

$$W(p) = 2^p$$

so that we have a Pareto with  $n = \frac{1}{W}$ . In general, if the gain is  $G$  for the winner,  $W = 1/n^{\ln(1+G)}$ . An interesting sidelight for the scientists in the audience: if citations = wealth, they obey a moderately unfair Pareto. ( $I_{\max} \simeq 10^4$ ,  $I_{\min} \simeq 1$ ,  $10^5$  scientists.)

At the level of firms, however, the economy is more like Darwinian ecology than a sequence of games and, as in such an ecology extinctions, growth and decay, and competition are the rule (Dosi and Winter have suggested evolutionary models of the economy, for example).

In conclusion, I have tried to bring out one general ideas. Much of the real world is controlled as much by the “tails” of distributions as by means or averages: by the exceptional, not the mean; by the catastrophe, not the steady drip; by the very rich, not the “middle class.” We need to free ourselves from “average” thinking.