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Title: "Global distribution and inequality in energy consumption compared with the money, wealth, and income distributions and inequality: insights from statistical physics"

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Abstract:

About 10 years ago, we proposed a mathematical analogy between the probability distribution of money among economic agents and the probability distribution of energy among molecules in a gas in statistical physics [1]. The analogy is based on treatment of both money and energy as a limited resource partitioned and redistributed among the participants using the principle of maximal entropy. The subsequent quantitative studies of the probability distributions of wealth and income for different countries indeed found that these distributions are often given by the exponential function for the majority of population at the lower end of the distribution: see the recent review [2]. The exponential distribution is consistent with the Boltzmann-Gibbs distribution, which described probability distribution of energy in statistical physics.

Money and wealth are somewhat artificial concepts compared with physical standards of living. In the new study presented here, we investigated the global distribution of energy consumption per capita for different countries around world using the data from the Word Resources Institute [3]. We found that this distribution is also approximately described by the exponential function. We argue that the global energy production is another limited resource, so the same partitioning principle can be applied, as described above. Comparing the data for 1990 and 2005, we find that the latter distribution is closer to exponential, and the boundary between developed and developing countries in terms of energy consumption is less pronounced. We attribute this change to the effect of globalization, which, however, does not lead to the energy consumption equality, but rather to the exponential distribution with a high degree of inequality. Given the experience from statistical physics, we argue that this highly unequal distribution is very robust and difficult to change, because it maximizes entropy.

These considerations have important consequences for strategies aimed at reduction of fossil fuel consumption and CO2 production because of the inherent and very stable global inequality in energy consumption. It is not likely that the same strategies would be effective for both high and low ends of the distribution. It would be necessary to tailor these strategies for the different ends and quantitatively evaluate their

effectiveness in terms of total savings of fossil fuel given the exponential shape of the probability distribution curve.

[1] A. Dragulescu and V. M. Yakovenko, "Statistical mechanics of money", The European Physical Journal B 17 (2000) 723.

[2] V. M. Yakovenko and J. B. Rosser, Jr., "Colloquium: Statistical Mechanics of Money, Wealth, and Income", accepted to Reviews of Modern Physics (2009).

[3] World Resource Institute data, http://earthtrends.wri.org.

The papers are available on the author's Web page
http://www2.physics.umd.edu/~yakovenk/econophysics/