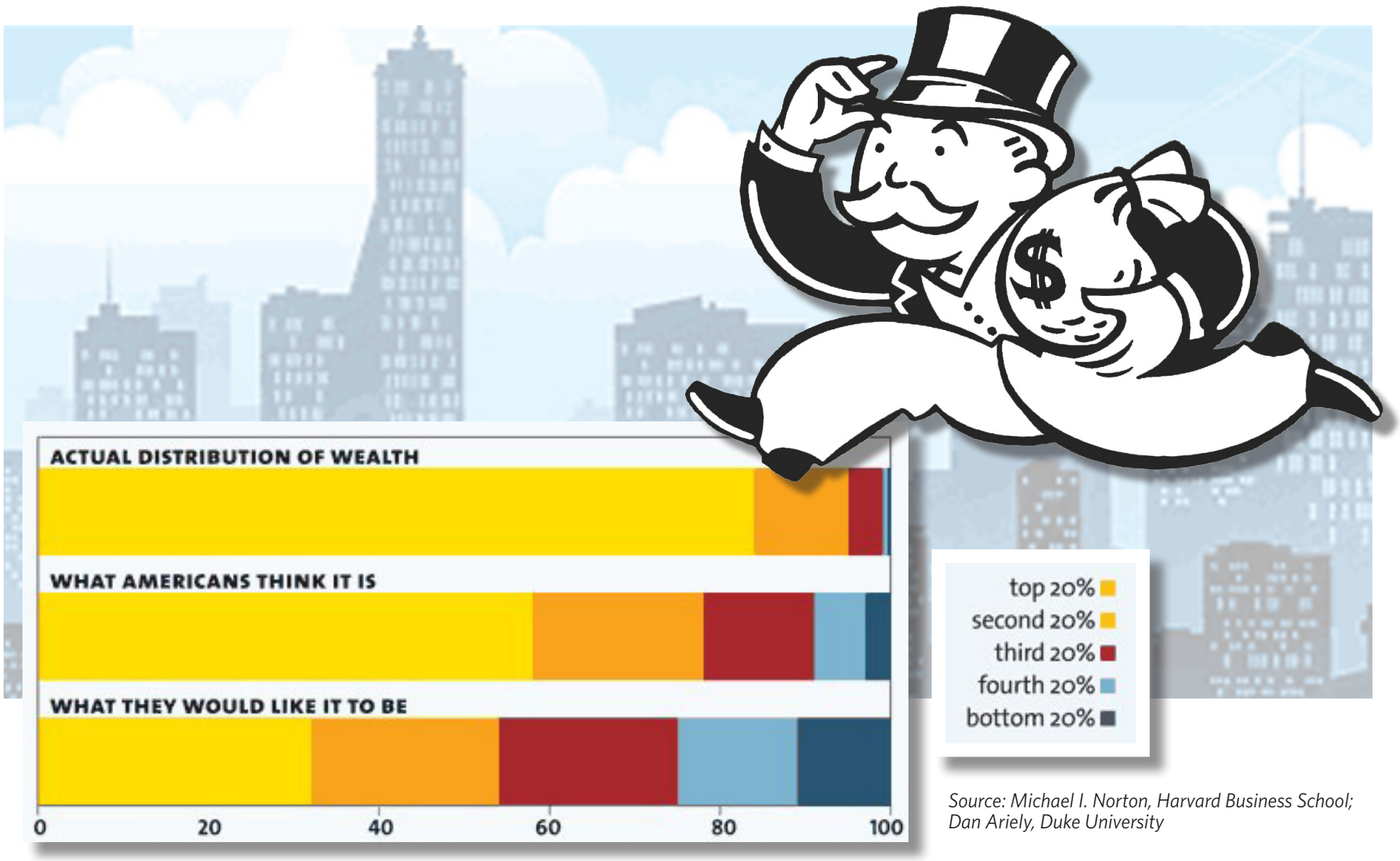
Boston University **Physics Colloquium**



Source: Michael I. Norton, Harvard Business School; Dan Ariely, Duke University

Boltzmann and Fokker-Planck Equations for Economic Modeling

The Boltzmann equation provides a continuum description of a population of particles undergoing pairwise interactions in which they can exchange momentum and energy. An economy consists of economic agents who engage in pairwise transactions in which they can exchange wealth. It has long been suggested that it ought to be possible to write a Boltzmann equation that describes an economy. This work describes how to do exactly that for a simplified microeconomic model, called the "Yard-Sale Model." We also show how, in the limit of small transactions, this Boltzmann equation reduces to a nonlinear Fokker-Planck equation for the probability distribution function of wealth.

Stability of a market economy is one of the fundamental tenets of classical and neoclassical economics, dating back at least to Adam Smith's "invisible hand" concept. In spite of that, we find that our model market economy is highly unstable, with a strong tendency toward oligarchy. Mathematically, its time-asymptotic state is a singular distribution. It can be stabilized by adding some mechanism for wealth redistribution, such as a wealth tax, in which case its steady state is shown to be similar to the the famous Pareto distribution, with a cutoff at very low values of wealth and power-law decay at very high values. Indeed, this appears to be the first detailed microeconomic explanation of Pareto's century-old law of wealth distribution, a key observation of macroeconomics.

Along the way, we will demonstrate how this approach to economic modeling is capable of describing many of the metrics that economists use to characterize wealth distribution, such as the Pareto-Lorenz exponent, the Gini coefficient, and the Gibrat coefficient. We will also examine real data and trends over the last century to emphasize why a fundamental understanding of wealth concentration is more important today than it has been in a very long time.

Bruce Boghosian Tufts University

October 21, 2014
Tuesday

3:30 - 4:30 PM
Refreshments at 3 PM

SCI 109
Metcalf Science Center

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