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Computation Outstrips Analysis

The law of demand—that people will buy less of something if its price goes up, more if its price declines—is about as secure a proposition as economics offers. Lately the methods of economics itself have been following that law, and as a result economists are fashioning a new kind of theory.

The price that has been changing is that of computation. On any given day, for the past 20 years at least, the cost of adding or multiplying two numbers has been half of what it was 18 months earlier. At Los Alamos in 1943, a calculator was a woman who did calculations for a team organized by Richard Feynman. Today systems of hundreds of equations are a job for an average PC.

This change in degree has become a change in kind. Instead of reasoning about the economy on the basis of a few highly simplified, mathematically tractable assumptions, researchers can build more realistic models of economic behavior and see how they run. This notion has been taking hold throughout the sciences: in a new book, *Darwinism Evolving: Systems Dynamics and the Genealogy of Natural Selection,* David J. Depew and Bruce H. Weber trace similar stages in evolutionary theory. From Charles Darwin's publication in 1859 until about 1900 came the prequantitative origin (so to speak), from 1900 to 1975 or so the "Boltzmannian" statistical stage, and then computer simulation.

The statistical stage is the one that most observers of science are familiar with. Ludwig Boltzmann introduced statistical methods to physics to deal with the aggregate behavior of a gas. In 1877 no one could even imagine following the individual histories of thousands of gas molecules colliding with one another, and so Boltzmann opted for following average behavior, which is what statistical theory is good at.

Economics is just finishing its Boltzmannian stage. The statistics used by economists were invented for experiments in agronomy and perfected in the 1930s. During the 1940s and 1950s, these techniques, which let economists deduce properties of individual actors from gross measures such as price levels, spread to the rest of economics.

In discussions of monetary policy, for example, the prequantitative stage contends with philosophical issues such as "Should the government interfere in financial markets?" or "It seems reasonable that raising interest rates will throttle demand and reduce growth." Boltzmann-style analysis looks instead at whether the numbers the government collects show connections between discount rate and gross national product. The Boltzmann era ends when economists have enough computing power to test directly their ideas about how molecules of economic behavior will interact in mass. Assuming researchers agree on underlying economic behavior, the answers will be unobscured by all the confounding factors that beset real data.

This story of evolutionary progress highlights the two competing intellectual traditions—with differing attitudes toward computation—that have long coexisted. In the Greek tradition, theoreticians prove things on abstract principles. The proof of the Pythagorean theorem, for instance, does not depend on the particular sizes of the right triangles in question. The Babylonian tradition, in contrast, discovers by brute force that a million different right triangles all seem to have the same relation among the squares of their sides.

In modern economics the Greek tradition succeeds in the work of Nobel laureates Paul A. Samuelson and Kenneth J. Arrow, who applied mathematical reasoning to a minimum of data. The Babylonian tradition is more checkered: in Isaac Newton's time, it allowed calculation of hypothetical costs to show that the Somerset Levels wetlands should be drained at public expense. In 1973 Wassily Leontief won a Nobel for input-output analysis—yet his work had little practical application.

Since then, however, the law of demand, combined with the ever decreasing cost of computation, has put Greek science under a sentence of death. Elegant analysis still costs as much time and effort as it ever did, but number crunching becomes ever cheaper. The kinds of questions that the new Babylonian economists are asking are more amenable to answers, and so they will be asked more often. That's the way the marketplace of ideas works.

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