

A Minute with Kenneth J. Arrow

In each issue, *Algorithmic Finance* features a brief interview with one member of our advisory or editorial boards or another leading academic or practitioner. These brief conversations are intended to provide a glimpse of their current thinking. In this issue, we talk with Kenneth J. Arrow.

Kenneth J. Arrow is the Joan Kenney Professor of Economics and Professor of Operations Research, emeritus; a CHP/PCOR fellow; and an FSI senior fellow by courtesy. He is a Nobel Prize-winning economist whose work has been primarily in economic theory and operations research, focusing on areas including social choice theory, risk bearing, medical economics, general equilibrium analysis, inventory theory, and the economics of information and innovation. He was one of the first economists to note the existence of a learning curve, and he also showed that under certain conditions an economy reaches a general equilibrium. In 1972, together with Sir John Hicks, he won the Nobel Prize in economics for his pioneering contributions to general equilibrium theory and welfare theory. To date, he is still the youngest person ever to receive that award.

Arrow has served on the economics faculties of the University of Chicago, Harvard and Stanford. Prior to that, he served as a weather officer in the U.S. Air Corps (1942–1946), and a research associate at the Cowles Commission for Research in Economics (1947–1949). In addition to the Nobel Prize, he has received the American Economic Association's John Bates Clark Medal and was a recipient of the 2004 National Medal of Science, presented by President George W. Bush for his contributions to research on the problem of making decisions using imperfect information and his research on bearing risk. He is a member of the National Academy of Sciences and the Institute of Medicine. He received a BS from City College,

an MA and PhD from Columbia University, and holds approximately 20 honorary degrees.

What has been your research path?

I was born in New York City in 1921 and raised there. I graduated from C.C.N.Y. (College of the City of New York) in 1940 with a major in mathematics. Having found a strong interest in mathematical statistics, I went to Columbia University, virtually the only place in the United States where it was taught by two great leaders. Harold Hotelling and Abraham Wald. However, since Statistics was not a recognized department, I enrolled first in Mathematics, in which I received a Master's degree in 1941, and then in Economics, the department in which Hotelling had his appointment. During the academic year 1941–1942, Pearl Harbor took place. I enlisted in a program to become a weather officer and served from 1942 to the end of 1945. I was put in a research unit and wrote my first published paper, on choosing the minimum-time flight path, making use of the winds.

After returning to Columbia to start a dissertation, I joined the Cowles Commission for Research in Economics, then in Chicago, to continue my research. I also spent a number of very stimulating summers at the RAND Corporation. In the first summer, 1948, I was asked a question about the meaning of the payoff function in games when the players are not real individuals but collective entities, such as governments. This led to my developing an impossibility theorem for rational social choice, which became my dissertation topic.

My research time for the next few years was split between microeconomic theory and operations research. The latter included especially a formulation and study of dynamic inventory theory, which

stimulated a large literature. In microeconomics, Gerard Debreu and I developed a proof of the consistency of general equilibrium theory. I also showed how general equilibrium theory could be extended to take account of uncertainty. A paper particularly interesting to me was an analysis of the economics of medical practice and medical insurance which emphasized the importance of differences in information among transacting individuals.

My academic career, after one year at the University of Chicago, was entirely spent at Stanford and Harvard Universities. I retired under the then-prevailing rules in 1991 but have maintained a research career.

What are your research interests right now?

I have two ongoing sets of research interests. One is the treatment of health improvements in measurements of welfare (like national income and wealth). It is clear that individuals are willing to give up current income to reduce the probability of death. While there has been a literature on this subject in the last forty years, the models have been too simple. In particular, they do not identify the changes as age changes. The aim is to construct a model to use the existing empirical data to determine the value of extending life, to be compared with the costs as a basis for policy.

My other chief research interest, continuing from earlier work, is the determination of the rate of return appropriate for evaluating public investments with long futures. The immediate spur for this work is to provide a foundation for climate change policy (I had first heard of anthropogenic climate change in my military weather training). There are many problems arising

from uncertainty, future learning, and the aggregation of individuals with diverse time preferences.

What do you see as academically exciting?

There is no shortage of interesting issues in economics and finance. A basic problem is the formation of the expectations which determine the amount of direction of investment, whether real or financial. There are several issues here: the optimal acquisition of information, the ways in which information is disseminated or withheld, and, perhaps most difficult, the expectations about the behavior of others, which, in turn, is influenced by their expectations. Related is the issue of how decisions, including those about acquiring and using information, are in fact made. The dominant assumption of rationality is increasingly challenged by behavioral and neurological studies. At a different, more empirical level, is the long-standing question as to why the economic and financial systems seem to break down repeatedly, though not strictly periodically. The emergence of the business cycle and financial crises in the early 19th century has never been well explained; the theoretical question about the formation of expectations may be related, as asserted long ago by Keynes and by Morgenstern.

What would you work on if you had lots of time?

If I had enough time and ability, I would work on the fundamental nature of information as a commodity within an interacting economic and financial system.