



Harry M. Markowitz

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1990

Autobiography



I was born in Chicago in 1927, the only child of Morris and Mildred Markowitz who owned a small grocery store. We lived in a nice apartment, always had enough to eat, and I had my own room. I never was aware of the Great Depression.

Growing up, I enjoyed baseball and tag football in the nearby empty lot or the park a few blocks away, and playing the violin in the high school orchestra. I also enjoyed reading. At first, my reading material consisted of comic books and adventure magazines, such as *The Shadow*, in addition to school assignments. In late grammar school and throughout high school I enjoyed popular accounts of physics and astronomy. In high school I also began to read original works of serious philosophers. I was particularly struck by David Hume's argument that, though

we release a ball a thousand times, and each time, it falls to the floor, we do not have a necessary proof that it will fall the thousand-and-first time. I also read *The Origin of Species* and was moved by Darwin's marshalling of facts and careful consideration of possible objections.




From high school, I entered the University of Chicago and took its two year Bachelor's program which emphasized the reading of original materials where possible. Everything in the program was interesting, but I was especially interested in the philosophers we read in a course called OII: Observation, Interpretation and Integration.

Becoming an economist was not a childhood dream of mine. When I finished the Bachelor's degree and had to choose an upper division, I considered the matter for a short while and decided on Economics. Micro and macro were all very fine, but eventually it was the "Economics of Uncertainty" which interested me--in particular, the Von Neumann and Morgenstern and the Marschak arguments concerning expected utility; the Friedman-Savage utility function; and L. J. Savage's defense of personal probability. I had the good fortune to have Friedman, Marschak and Savage among other great teachers at Chicago. Koopmans' course on activity analysis with its definition of efficiency and its analysis of efficient sets was also a crucial part of my education.



At Chicago I was invited to become one of the student members of the Cowles Commission for Research in Economics. If anyone knows the Cowles Commission only by its influence on Economic and Econometric thought, and by the number of Nobel laureates it has produced, they might imagine it to be some gigantic research center. In fact it was a small but exciting group, then under the leadership of its director, T. Koopmans, and its former director, J. Marschak.

When it was time to choose a topic for my dissertation, a chance conversation suggested the possibility of applying mathematical methods to the stock market. I asked Professor Marschak what he thought. He thought it reasonable, and explained that Alfred Cowles himself had been interested in such applications. He sent me to Professor Marshall Ketchum who provided a reading list as a guide to the financial theory and practice of the day.

The basic concepts of portfolio theory came to me one afternoon in the library while reading John Burr Williams's *Theory of Investment Value*. Williams proposed that the value of a stock should equal the present value of its future dividends. Since future dividends are uncertain, I interpreted Williams's proposal to be to value a stock by its expected future dividends. But if the investor were only interested in expected values of securities, he or she would only be interested in the expected value of the portfolio; and to maximize the expected value of a portfolio one need invest only in a single security. This, I knew, was not the way investors did or should act. Investors diversify because they are concerned with risk as well as return. Variance came to mind as a measure of risk. The fact that portfolio variance depended on security covariances added to the plausibility of the approach. Since there were two criteria, risk and return, it was natural to assume that investors selected from the set of Pareto optimal risk-return combinations.

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I left the University of Chicago and joined the RAND Corporation in 1952. Shortly thereafter, George Dantzig joined RAND. While I did not work on portfolio theory at RAND, the optimization techniques I learned from George (beyond his basic simplex algorithm which I had read on my own) are clearly reflected in my subsequent work on the fast computation of mean-variance frontiers (Markowitz (1956) and Appendix A of Markowitz (1959)). My 1959 book was principally written at the Cowles Foundation at Yale during the academic year 1955-56, on leave from the RAND Corporation, at the invitation of [James Tobin](#). It is not clear that Markowitz (1959) would ever have been written if it were not for Tobin's invitation.

My article on "Portfolio Selection" appeared in 1952. In the 38 years since then, I have worked with many people on many topics. The focus has always been on the application of mathematical or computer techniques to practical problems, particularly problems of business decisions under uncertainty. Sometimes we applied existing techniques; other times we developed new techniques. Some of these techniques have been more "successful" than others, success being measured here by acceptance in practice.

In 1989, I was awarded the Von Neumann Prize in Operations Research Theory by the Operations Research Society of America and The Institute of Management Sciences. They cited my works in the areas of portfolio theory, sparse matrix techniques and the SIMSCRIPT programming language. I have written above about portfolio theory. My work on sparse matrix techniques was an outgrowth of work I did in collaboration with Alan S. Manne, Tibor Fabian, Thomas Marschak, Alan J. Rowe and others at the RAND Corporation in the 1950s on industry-wide and multi-industry activity analysis models of industrial capabilities. Our models strained the computer capabilities of the day. I observed that most of the coefficients in our matrices were zero; *i.e.*, the nonzeros were "sparse" in the matrix, and that typically the triangular matrices associated with the forward and back solution provided by Gaussian elimination would remain sparse if pivot elements were chosen with care. William Orchard-Hayes programmed the first sparse matrix code. Since then considerable work has been done on sparse matrix techniques, for example, on methods of selecting pivots and of storing the nonzero elements. Sparse matrix techniques are now standard in large linear programming codes.

During the 1950s I decided, as did many others, that many practical problems were beyond analytic solution, and that simulation techniques were required. At RAND I participated in the building of large logistics simulation models; at General Electric I helped build models of manufacturing plants. One problem with the use of simulation was the length of time required to program a detailed simulator. In the early 1960s, I returned to RAND for the purpose of developing a programming language, later called SIMSCRIPT, which reduced programming time by allowing the programmer to describe (in a certain stylized manner) the system to be simulated rather than describing the actions which the computer must take to accomplish this simulation. The original SIMSCRIPT compiler was written by B. Hausner; its manual by H. Karr who later co-founded a computer software company, CACI, with me. Currently SIMSCRIPT II.5 is supported by CACI and still has a fair number of users.

I am sorry I cannot acknowledge all the people I have worked with over the last 38 years and describe what it was we accomplished. As each of these people know, I often considered work to be play, and derived great joy from our collaboration.

From [Les Prix Nobel](#). *The Nobel Prizes 1990*, Editor Tore Frängsmyr, [Nobel Foundation], Stockholm, 1991

This autobiography/biography was written at the time of the award and later published in the book series [Les Prix Nobel/Nobel Lectures](#). The information is sometimes updated with an addendum submitted by the Laureate. To cite this document, always state the source as shown above.

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