

## LEONID HURWICZ: AN APPRECIATION

Kenneth J. Arrow

Remarks delivered at a luncheon meeting of the American Economic Association, 3 January 2009, honoring American recipients of the Nobel Memorial Prize in Economic Science for 2007

I come to speak of that transforming figure in modern economic theory, Leonid Hurwicz. Let me first locate him in space and time. We are today accustomed to the international mobility of academics. It is hard to imagine staffing our universities, maintaining our research capabilities, even filling our graduate student ranks, without the influx of foreign scholars at all levels. Leo was also part of an international migration but under vastly different circumstances. It was not driven by voluntary decisions. It was the result of political oppression, racial discrimination, and war on a scale and with an extent that we fortunately have not approached again.

Leo and I were part of the staff of the Cowles Commission for Research in Economics during the period that it was located in Chicago. The first director, Jacob Marschak was thrice a refugee. Tjalling Koopmans was in neutral Geneva, when his native Netherlands was invaded, Trygve Haavelmo, from Norway, was caught in the United States by the outbreak of war.

Leo's family had been caught up in the plagues of the time. Polish, they had fled from the invading German armies in both world wars. Leo was therefore born in Moscow in 1917, though the family returned to Poland at the end of World War I. Leo attended Josef Pilsudski University (now the University of Warsaw) and graduated with a law degree (in "both" the laws, i.e., civil and canon law). I have not been able to determine just how he received any kind of education in either mathematics or

economics. Evidently, he was interested enough in economics to attend the London School of Economics (L.S.E.) in 1938-9. There was an outstanding group of economists there at that time, but perhaps the most intellectually influential was Friedrich von Hayek. In 1939-40, Leo attended the Postgraduate Institute of International Studies in Geneva, though already a refugee from a Poland fallen to German and Soviet invasion. Leo's parents and brother fled to the relatively more hospitable Soviet Union, where they were incarcerated in a prison labor camp. They did return to Poland in 1945 and then migrated to the United States.

Leo did manage to leave Geneva and migrated to the United States in 1940, on a ship from Lisbon. He was briefly a research assistant for Paul Samuelson and then went to Chicago, where he taught mathematics to Air Force weather trainees at the Institute of Meteorology. From 1944 on, he became associated with the Cowles Commission in Chicago. Among others, there were Marschak, Koopmans, Lawrence Klein, Haavelmo, Franco Modigliani (a visitor), and myself. From 1946 on, he had appointments at Iowa State College, the University of Illinois, and, from 1951 on, the University of Minnesota.

It is noteworthy that, despite the paucity of academic credentials, Leo's ability was quickly and widely recognized. He was, for example, selected as early as 1945 to write an article-length review of von Neumann and Morgenstern's game-theoretic challenge to standard economics for the *American Economic Review*.

There was at this point a widespread interest among economists in economic planning. A particular aspect was the "socialism controversy," kicked off by Ludwig von Mises's argument that rational calculation under socialism was impossible. Hayek put the argument in a more moderate form, that the information needed for achieving an

optimum was widely dispersed and could not be assembled in one place. Since the relevant information existed somewhere, there was an implicit assumption that the transfer of information was costly.

A counter-argument was that a capitalist system also required the transfer of information, if only through market prices, and that a socialist system could achieve the same information transfer as a privately-owned economy. The interest in market socialism was much more widespread in this period than anyone accustomed to current economic discourse might imagine. Fred Taylor's presidential address to the American Economic Association in 1928 dealt with it. My teacher, Harold Hotelling, belonged to this group. Although the study of the feasibility of market socialism had begun as early as 1906 and continued throughout the 1920s and early 1930s, it was given a most thorough and widely-noticed statement by the Polish socialist economist, Oskar Lange, in 1938. Lange indeed accepted Hayek's argument but argued that the tâtonnements which explained how competitive markets in a private economy came into equilibrium could also be employed by a socialist state. Lange was a professor at the University of Chicago at this point; he was, in particular, responsible for bringing the Cowles Commission there, I can only assume that exposure to both Hayek and Lange must have sharpened Leo's interest in the question of the exchange of information needed to run the economy.

Leo brought his rigorous mind to stating the issue formally, in an unpublished paper about 1948. He laid bare what the problem was. He envisioned a number of agents (including possibly a central authority), each possessed of private information. The agents sent messages to each other, and there were conditions of equilibrium. The message space must be large enough to determine allocation. The allocation (how much

each agent gets of each commodity) has to be conveyed, of course. The question is, how much larger the message space has to be than that specifying the allocation to insure optimality (in whatever sense is desired)? Economy calls for using as small a message space as possible. Leo used the *dimensionality* of the message space as a measure of its size. He showed that (under concavity) just  $n-1$  extra variables are needed (e.g., prices).

To illustrate, consider two allocations under concavity: (1) prices, with supply and demand as responses, and equilibrium defined by equating aggregate supply to aggregate demand; (2) quantities for each agent, a response message giving all marginal rates of substitution, equilibrium when marginal rates are equal. Both methods yield Pareto-optimal allocations, but, obviously, the second requires many more dimensions in the message space.

Those who know Leo know how perfectionist he was and how difficult it was for him to feel a paper was ready for publication. Some of us at Stanford (the mathematician, Sam Karlin, the philosopher, Patrick Suppes, and myself) were interested in developing the application of mathematical methods in the social sciences. We decided to have a conference, whose proceedings were to be published. I promptly invited Leo, to insure that his paper would finally see the light of day, though only in 1960. (Arrow-Karlin-Suppes 1960)

To this point, Leo had assumed that messages were truthful. The stress was on the difficulty of communication, not on incentives, and so the emphasis is quite different than in the subsequent development of mechanism design theory. His early theory has found more resonance today among some game theorists, under the name of “algorithmic game theory.” At the time, there were alternative approaches, particularly the theory of

teams, developed by Marschak and Roy Radner. Although, in my judgment, very interestingly, the theory of teams has not been taken up too much. The treatment of information costs in team theory has been rather arbitrary and less developed than Leo's dimensionality criterion.

In 1972, Leo restated the problem of choice in decentralized systems. He now added the important condition of incentive compatibility to the criteria for a suitable allocation system with decentralized information. He emphasized the game-theoretic formulation, now as a matter of design. The importance of Leo's statement and results has been emphasized in the Nobel lectures of Maskin and Myerson.

Incentive-compatible allocation mechanisms had been studied earlier in specific fields, most notably, William Vickrey's idea of second-price auctions, where an optimal allocation is found as a Nash equilibrium (indeed, a dominant-strategy equilibrium) of a suitably designed game. But Leo was the first to give a general formulation into which all results could be fitted.

A compendium of the results in mechanism design found by Leo and his collaborators is to be found in the 2006 book by Leo and his close collaborator, Stanley Reiter. For a searching and yet spare statement of the essentials of mechanism design, please do read Leo's Nobel address, with a title which points to the essential issue, "But who will guard the guardians?"

Important as Leo's work on allocation mechanisms was, it was far from exhausting his contributions to economics. Let me list briefly a few other fields of his interest.

The main research topic at the Cowles Commission during the days of Leo's participation was the development of statistical estimation of simultaneous equation systems. Hurwicz contributed several papers to aspects of this subject, several, notably a very general formulation of the concept of identification. Another area was a detailed study of the foundations of consumer demand theory, most notably in connection with the much-mooted question of integrability. The results appeared in 1971 as a volume of papers, edited by John Chipman, Leo, Ket Richter, and Hugo Sonnenschein.

I had the great pleasure of working with Leo for a number of years on two topics closely related to his basic interest in decentralized allocation methods: gradient methods in concave programming, and the question of conditions under which tâtonnements converge under the usual Walrasian conditions.

Leo's breadth and strength of interests and feelings were felt not only in the world of economics. He had broad cultural interests, and, above all, his political insights were deep and penetrating. He was my dear friend and intellectual companion for over sixty years. We will all miss him.