Wassily W. Leontief, 1906–99

Wassily Leontief and His Contributions to Economic Accounting

PROFESSOR WASSILY LEONTIEF, the founder of input-output (I-O) accounts, died last month. During his illustrious career, he contributed to many areas of economic research, including international trade theory, business cycle theory, and capital theory. But he is best known for the creation and refinement of input-output analysis, which has fundamentally influenced the evolution of economic analysis and economic accounts.[1]

The technique, which details the structure of the economy through a matrix of input-output coefficients, is so integral to both that in 1973, he was awarded the Nobel Prize in Economics for its development. In the United States, the major economic accounts produced by the Bureau of Economic Analysis (BEA) use the input-output accounts as an integrating principle or as an analytical tool. This use of I-O accounting is paralleled in the System of National Accounts (SNA)—the international guidelines for economic accounts. The SNA uses I-O accounting as a framework for coordinating and checking the conceptual and statistical consistency of the accounts and for providing a detailed basis for analyzing industries, products, and other economic relationships.

Leontief emigrated from the Soviet Union to Germany, where he received his doctorate in 1928. He came to the United States in 1931, worked briefly at the National Bureau for Economic Research, and then joined the Harvard University faculty. After staying at Harvard for 45 years, he founded the Institute for Economic Analysis at New York University.

Leontief's earliest work contained elements of input-output accounting, but he developed his first I-O tables in the United States in order to facilitate his study of the effects of technological change on the American economy. He collected detailed information—often from interviews with industry engineers—about production processes and constructed a matrix that described the transactions of more than 40 economic industry groups or sectors. The completed matrix revealed the interindustry relationships of inputs and outputs from which coefficients could be derived so that the direct and indirect effects of changes in the economy could be traced throughout the economy.

Leontief continued to apply I-O accounts to the study of practical economic questions throughout his career. One of his primary interests was in the application of the technique to defense analyses. His interest in this area began during World War II, when he worked with the Bureau of Labor Statistics (BLS) staff to construct I-O accounts for the United States that could facilitate the planning of post-war demobilization. This U.S. matrix was also used to guide the construction of hypothetical I-O accounts for Germany that were used by the Office of Strategic Services to plan wartime activities.

After the war, interest in I-O accounts grew quickly in the United States and elsewhere, as their usefulness for policy making in both centrally planned and free-market economies was recognized. As the I-O accounts were developed, their usefulness as an integrating tool for, and a check on the accuracy of, other economic accounts also became increasingly apparent. In fact, by 1957, input-output tables were being regularly constructed in the United Kingdom, Norway, Denmark, the Netherlands, Italy, Canada, and Japan.[2] The first U.S. I-O accounts were produced by BLS in 1952. BEA's first I-O table, for 1958, was released in 1964. Since then, BEA has published I-O accounts for all the years covered by the economic censuses (the primary source of data for the accounts).[3]

Given the impact of the I-O technique on economic accounting, it is interesting to note that Leontief's initial motivation had little to do with improving economic accounts. In a recent interview, he explained that national income analyses were "not very disaggregated. Everything gives you one figure, while I thought that to understand the operation of the system, one figure is not enough. . . . I was not interested in improving the system; I was just concentrating on understanding how it works."[4] But Leontief's creation of input-output accounts was not driven solely by the practical requirements of his own research. On the contrary, Leontief considered himself a theorist, but he felt strongly that the purpose of theory was to provide

1. For a comprehensive discussion of Leontief's career, see Anne P. Carter and Peter A. Petri, "Leontief's Contributions to Economics," *Journal of Policy Modeling* 11 (Spring 1989): 7–30.

2. U.S. Congress, Joint Economic Committee, Subcommittee on Economic Statistics, "The National Economic Accounts of the United States: Review, Appraisal, and Recommendations," in *The National Economic Accounts of the United States*, report by the National Accounts Review Committee, National Bureau of Science Research, 85th Congress, October 1957, 244.

3. See W. Duane Evans and Marvin Hoffenberg, "The Interindustry Relations Study for 1947," *Review of Economics and Statistics* (May 1952), and "The Interindustry Structure of the United States: A Report on the 1958 Input-Output Study," SURVEY OF CURRENT BUSINESS 44 (November 1964): 10–17.

4. See Duncan K. Foley, "An Interview with Wassily Leontief," *Macroeconomic Dynamics* 2 (1998): 118.

NOTE.—This tribute was prepared by J. Steven Landefeld and Stephanie H. McCulla.

a simplified picture of real systems, so he opposed the growing tendency among economists to formulate theories without a firm foundation in observable reality. Indeed, in his 1970 presidential address to the American Economic Association, Leontief warned of the "palpable *inadequacy* of the scientific means" with which economists try to analyze economic problems.[5]

His emphasis on the need for detailed data to support theory is similar to the scientific method that underlies the physical sciences, but Leontief noted one important difference: "In contrast to most physical sciences, we study a system that is not only exceedingly complex but is also in a state of constant flux.... Without a constant inflow of new data the existing stock of factual information becomes obsolete very soon.... What a contrast with physics, biology, or even psychology, where the magnitude of most parameters is practically constant and where critical experiments and measurements don't have to be repeated every year!"[6] While this emphasis may have been unusual during a time when abstract or speculative economic theory was gaining widespread acceptance, Leontief's perspective actually led him to share many of the criticisms of the economic profession held by other economists.

Leontief devoted considerable attention to economic statistics and, in his presidential address, discussed many of the issues–such as budgets, decentraliztion, and classification–that economic accountants are still struggling with today. He recognized that shifting from abstract theory and "casual empiricism" to the "systematic large-scale factual analysis" that he envisioned would not be easy and would require a sizable increase in resources for economic statistics in order to keep pace with the growing complexity of the economy. He supported the decentralized Federal statistical system because he felt that it worked well and that it had the advantage of having specialized information collected by those most closely associated with it. However, he insisted on the need for uniform classification systems among all agencies, which is particularly relevant today as the new North American Industry Classification System is implemented and as a new product classification system is created.

Leontief also had specific ideas about the full potential of I-O accounts, and it is a testament to his vision that so much of the evolution of the accounts at BEA has corresponded to his ideas. In fact, many of the improvements implemented by BEA in the last three decades were suggested by Leontief in the comments he contributed to BEA's 50th anniversary issue of the SURVEY OF CURRENT BUSINESS.[7] For instance, based on his experience, he suggested that the increased computational capacity of computers would allow greater industrial detail in, and faster compilation of, the accounts. He was correct, and BEA has continuously expanded the detail of the I-O accounts and worked to speed up their release.[8] Leontief also characterized BEA's documentation of the I-O accounts as "all too brief and general." Like detail and timeliness, the provision of transparent documentation has always been an important objective at BEA. With the 1979 release of tables for 1972, BEA provided extensive documentation of the underlying detail and adjustments, and additional documentation was provided with the 1992 tables.

Leontief's comments also included suggestions for improving the methodology used to prepare the accounts. For instance, he was troubled by BEA's use, in its early tables, of "fictitious transfers" that moved secondary products from the industry that produces them to the industry in which they are a primary product. Beginning with the I-O table for 1972, BEA included secondary products and their associated inputs in the primary industry. Additionally, while Leontief was satisfied with the industry-to-industry format of the accounts, he recognized that some analysts need a product-to-product framework. In the tables for 1972, BEA separated the single transactions table into a "make" table and a "use" table that facilitate the derivation of product-to-product tables.[9]

Leontief devoted his career to expanding the applications of I-O analysis; in particular, he and his group of researchers at Harvard were among the first to apply I-O accounts to regional impact analysis.[10] BEA recognized the usefulness of this approach, and in the 1960's, it expanded its regional program to include an I-O modeling system. By the 1970's, BEA had introduced its Regional Input-Output Modeling System (RIMS), which is derived from the I-O tables.[11]

More recently, a new application of the I-O accounts has been found—the construction of satellite, or supplemental, accounts. The ability of the I-O framework to provide detail and to reveal the relationships between industries and products has made it the framework of choice for satellite accounts that focus on providing more information about a partic-

5. See Wassily Leontief, "Theoretical Assumptions and Nonobserved Facts," *American Economic Review* 61 (1971): 1.

6. See Leontief, "Theoretical Assumptions," 3–4.

7. See Wassily W. Leontief and Anne P. Carter, "Goals for the Input-Output Data System in the Seventies," *The Economic Accounts of the United States: Retrospect and Prospect*, SURVEY 51, Part II (July 1971): 28–32.

8. In 1997, BEA met its goal to release the I-O tables within 5 years of the economic census year by releasing the tables for 1992.

9. For more details on the evolution of BEA's input-output accounts, see Paula Young, "The U.S. Input-Output Experience: Present Status and Future Prospects," in *Problems of Compilation of Input-Output Tables*, ed. Alfred Franz and Norbert Rainer (Vienna, Austria: Verlag Orac, 1986). See also the article on the 1982 benchmark input-output accounts in the July 1991 SURVEY, the article on the 1987 accounts in the April and May 1994 issues, and that on the 1992 accounts in the November 1997 issue.

10. See Wassily W. Leontief, "Interregional Theory," and Walter Isard, "Some Empirical Results and Problems of Regional Input-Output Analysis," in *Studies in the Structure of the American Economy* (New York: Oxford University Press, 1953).

11. RIMS traces the effects of a change in economic conditions (for example, the closing of a manufacturing plant or a defense base) on a local area. The RIMS multipliers have been used in numerous studies by government agencies—such as the U.S. Nuclear Regulatory Commission, the Department of Defense, and the Department of Housing and Urban Development—and by private groups to evaluate the effects of various development policies or other activities, such as tourism, offshore drilling, or new business development.

ular sector or activity. BEA used an I-O framework in its construction of its integrated economic and environmental satellite accounts, its transportation satellite accounts, and its travel and tourism satellite account.[12]

The I-O accounts are also essential to other BEA programs. They are the primary source of data for the national income and product accounts (NIPA's): During each comprehensive NIPA revision, the results of the most recent benchmark I-O accounts are incorporated into the NIPA's for that reference year, and other years are revised as required. In addition to this "benchmarking" role, the I-O accounts provide a method for checking the accuracy of the NIPA's and the balance of payments accounts. Leontief commended this increased accuracy as a great advantage of integrating I-O accounts with the other national accounts.

Leontief also had a more direct connection to BEA. He actively supported BEA's Foreign Training Program, which offers economic accounting classes to employees of foreign statistical agencies. In fact, the students regularly visited Leontief, and he always shared his experiences enthusiastically.

These visits, his recent interviews, and his dedication to his work until the time of his death illustrate how much Professor Leontief enjoyed economics—both theoretical and empirical. Indeed, it is to the benefit of the entire field that he did.

Selected Bibliography of Wassily W. Leontief

"Economic Statistics and Postwar Policies." In *Postwar Economic Problems*, edited by S. Harris, 159–168. New York: McGraw-Hill, 1943.

"Environmental Repercussions and the Economic Structure—An Input-Output Approach." *Review of Economics and Statistics* 52 (1970): 262–271.

Input-Output Economics. New York: Oxford University Press, 1966.

Input-Output Economics. 2nd ed. New York: Oxford University Press, 1986.

"Quantitative Input and Output Relations in the Economic System of the United States." *Review of Economics and Statistics* 18 (1936): 105–125.

"Some Basic Problems of Empirical Input-Output Analysis." In *Input-Output Analysis: An Appraisal.* Princeton: Princeton University Press, 1955.

"Structural Matrices of National Economies." *Econometrica* 17 (1947): 273–282.

The Structure of the American Economy, 1919–1939: An Empirical Application of Equilibrium Analysis. New York: Oxford University Press, 1951.

"Theoretical Assumptions and Nonobserved Facts." Presidential address to the American Economic Association, Detroit, Michigan (December 29, 1970). *American Economic Review* 61 (1971): 1–7.

With Anne P. Carter. "Goals for the Input-Output Data System in the Seventies." In *The Economic Accounts of the United States: Retrospect and Prospect.* SURVEY OF CURRENT BUSINESS 51, Part II, 50th anniversary issue (July 1971): 28–32.

With Hollis B. Chenery, Paul G. Clark, James S. Duesenberry, Allen R. Ferguson, Anne P. Grosse, Robert N. Grosse, Mathilda Holzman, Walter Isard, and Helen Kisten. *Studies in the Structure of the American Economy*. New York: Oxford University Press, 1953.

With Faye Duchin. *Military Spending: Facts and Figures, Worldwide Implications and Future Outlook.* New York: Oxford University Press, 1983.

With M. Hoffenberg. "The Economic Effects of Disarmament." *Scientific American* 204 (April 1961): 47–55.

For a more complete bibliography of Professor Leontief's work, see Duncan Foley, "An Interview with Wassily Leontief," *Macroeconomic Dynamics* 2 (1998): 116–140.

12. See "Integrated Economic and Environmental Satellite Accounts," SURVEY 74 (April 1994): 33–49; "Accounting for Mineral Resources: Issues and BEA's Initial Estimates," SURVEY 74 (April 1994): 50–72; "U.S. Transportation Satellite Accounts for 1992," SURVEY 78 (April 1998): 16–27; and "U.S. Travel and Tourism Satellite Accounts for 1992," SURVEY 78 (July 1998): 8–22.