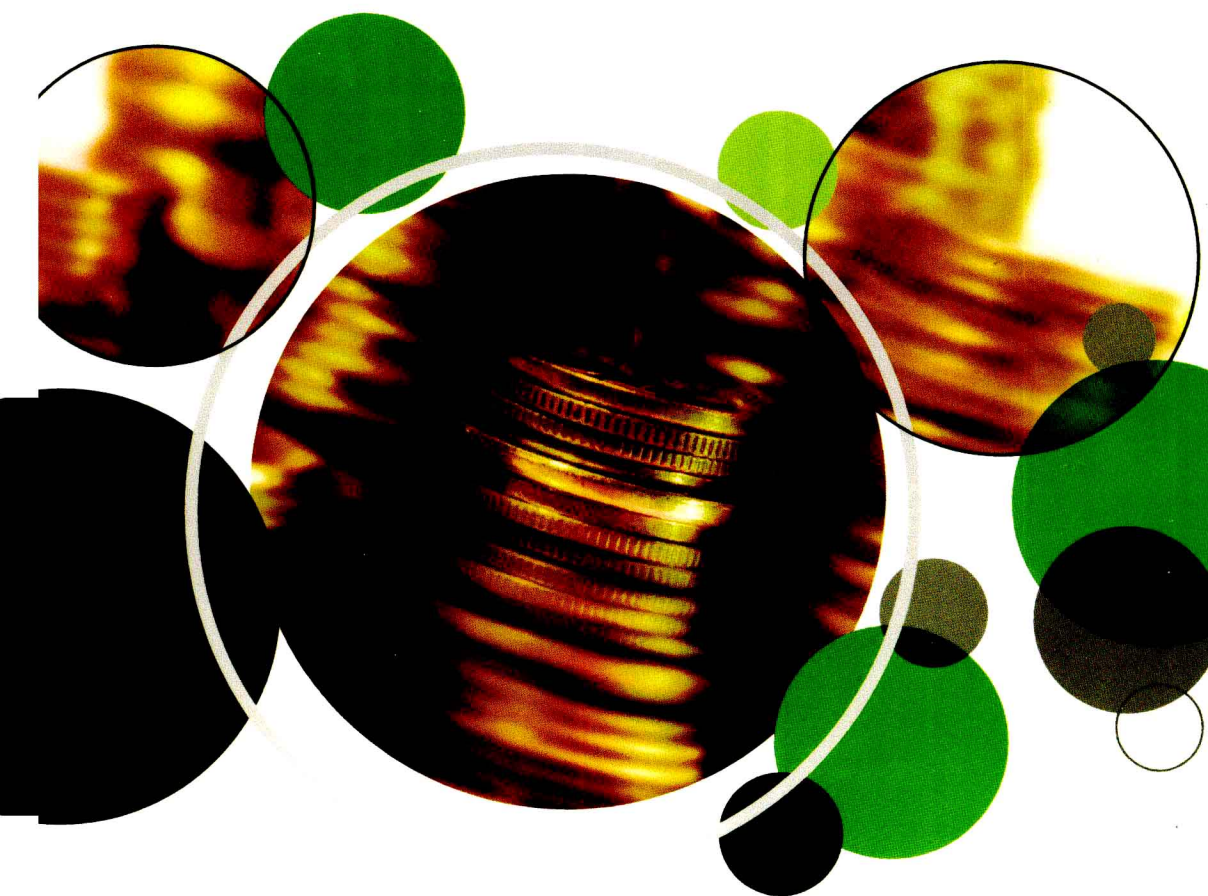


Volume 4



**Wassily W. Leontief,
Leonid V. Kantorovich,
Tjalling C. Koopmans
and J. Richard N. Stone**



Edited by
Howard R. Vane and **Chris Mulhearn**

PIONEERING PAPERS OF THE NOBEL MEMORIAL LAUREATES IN ECONOMICS

Wassily W. Leontief, Leonid V. Kantorovich, Tjalling C. Koopmans and J. Richard N. Stone

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General Introduction

Howard R. Vane and Chris Mulhearn

The ‘Sveriges Riksbank (Bank of Sweden) Prize in Economic Sciences in Memory of Alfred Nobel’, popularly known as the Nobel Prize in Economics, was first awarded in 1969. At the time of writing (July 2008), over the 39 years since its inception, there have been some 61 Nobel Laureates in economics. The Prize, like the Nobel awards in other disciplines, recognises specific discoveries, achievements or breakthroughs in economic science, rather than outstanding economists or a person’s lifetime work.¹

The aim of this series is to bring together, in a number of volumes, *some* of the pioneering papers of the Nobel Memorial Laureates that have helped shape the development of modern economic thought. Because the work of the Prize winners spans a wide range of fields it is possible to categorise the awards in a number of ways. However, as Lindbeck (1985; 2001) acknowledges, any chosen classification is going to be ‘rather arbitrary’ because of the ‘overlapping’ and, in some cases, ‘multidimensional nature’ of the Laureates’ contributions (see also Chapter 1 of Vane and Mulhearn, 2005). Wherever possible, we have sought to include in each volume Laureates working in the same *broad* area of study. In some cases deciding which Laureate’s papers should be grouped together was relatively straightforward because the sub-disciplines were readily identifiable, for example, in the case of the pioneering game theory papers of Harsanyi, Nash, Selten, Aumann and Schelling. For other volumes we have sought to identify a common link underlying the Laureates’ work. For example, in the case of the volume containing work by Friedman, Lucas and Phelps an initial unifying theme is their research in macroeconomics and, more specifically, their analyses of tradeoffs, most notably between inflation and unemployment. In some of the volumes where it is less clear that there is a single common thread we have grouped together the papers of Laureates working in two or more fields.

In this general introduction to the series we would like to highlight six main points.

- First, in order to keep the length and cost (given copyright permission fees) of each volume to manageable proportions we have imposed an arbitrary limit of not more than six papers under each Laureate’s name per volume (with one exception, Paul Samuelson whose influence on economics has been so profound and wide-ranging).
- Second, to avoid duplication across the series, no paper appears in more than one volume. For example, the joint papers by Franco Modigliani and Merton Miller in the field of financial economics only appear under Merton’s name and not in the volume containing papers by Modigliani.
- Third, the pioneering contributions of certain Laureates appear in book form rather than in papers. For example, some of Milton Friedman’s most influential work appears in his book *A Monetary History of the United States, 1867–1960*, co-authored with Anna J. Schwartz. In cases such as this we have sought to include some representative paper (for

example, Friedman and Schwartz's 1963 *Review of Economics and Statistics* paper on 'Money and Business Cycles'; paper 4, Volume 1), or the Laureate's Nobel Lecture (paper 6, Volume 1).

- Fourth, the impact of a Laureate's work is not necessarily just confined to one field of study or, within one field, a particular topic or theme. For example, in the case of Robert E. Lucas, Jr. his classic 1988 *Journal of Monetary Economics* paper 'On the Mechanics of Economic Development' (paper 12, Volume 1), in which he highlighted the importance of human capital accumulation and learning by doing, has (together with the work of Paul Romer) led to a resurgence of interest in the analysis of economic growth and, most notably, the development of endogenous growth theory. This important contribution might not be apparent to someone looking at the Prize citation for Lucas, which is 'for having developed and applied the hypothesis of rational expectations, and thereby transformed macroeconomic analysis and deepened our understanding of economic policy' (Nobel Foundation, 2008).
- Fifth, while the pioneering papers of some Laureates are easily identifiable, for others who have made numerous breakthroughs – such as Paul Samuelson who has contributed fundamental insights into nearly every major area of economic theory – we need to stress that, at the margin, the selection of papers involves a degree of personal judgement. No doubt other economists would have preferences different to our own. In choosing the papers for each volume we have been guided, in part, by the Laureates' statements of their principal contributions to economics as *they* perceive them (see Blaug, 1999; Blaug and Vane, 2003), and in certain cases by Laureates who, in correspondence, have indicated which papers they wanted included under their name.
- Finally it is important to stress that the rationale behind this series is *not* to produce either the *Collected Works* of individual Nobel Laureates or the *Collected Writings* of one or more Laureates on a particular topic. Instead our intention is to bring together in a series of volumes some of the pioneering papers of the Nobel Memorial Laureates that have shaped the development of modern economic thought and to set in context the selection of papers chosen for each volume by an editorial introduction to the Laureates' careers and main published works.

Note

1. The five original Nobel Prizes – in Physics, Chemistry, Physiology or Medicine, Literature and Peace – have been awarded annually since 1901.

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Part I
Wassily W. Leontief

Introduction to Part I:

Wassily W. Leontief (1906–99)

Wassily Leontief was born in St Petersburg, Russia in 1906. At the age of 15 he entered the University of St Petersburg (renamed Leningrad in 1924) where he studied philosophy, sociology and economics and from where he obtained his MA in social science as a ‘learned economist’ in 1925. Leaving Russia, Leontief went to Germany where he worked at the Institute for World Economics at the University of Kiel. In 1928 he obtained a PhD from the University of Berlin. After a year spent in China, as an economic adviser to the Chinese government on the railway network, he went to the United States in 1931 (later becoming a US citizen) where he worked for a brief period as a research associate at the National Bureau of Economic Research. In 1932 Leontief joined the faculty at Harvard University where over a period of four decades he was promoted from instructor (1932–33) to assistant professor (1933–39), associate professor (1939–46) and Professor of Economics (1946–53), before finally holding the Henry Lee Chair of Political Economy from 1953 to 1975. While at Harvard he founded the Harvard Economic Research Project, devoted to input–output analysis, and served as its director from 1948 to 1973. In 1975 he left Harvard to join New York University, where he founded the Institute of Economic Analysis.

Leontief’s many offices and honours included the presidencies of the Econometric Society in 1954 and the American Economic Association in 1970. In 1973 he was awarded the Nobel Memorial Prize in Economics ‘for the development of the input–output method and for its application to important economic problems’ (Nobel Foundation, 2008).

Over the course of a long and distinguished career, the main focus of Leontief’s research was directed to the development and practical applications of input–output analysis. Input–output analysis describes the interrelationships between the sectors or industries in an economy in terms of the inputs required per unit of each sector’s output. In doing so it gives a crucial insight into the overall structure and operation of the economy. The approach allows analysts to calculate (via the derivation of technical coefficients from the input–output table) how a change in production in any one sector or industry will affect other sectors and industries in the economy. In consequence, input–output analysis has proved to be particularly useful to policy makers for forecasting and planning (for example, avoiding bottlenecks in key sectors of the economy following a planned change in final demand for consumption, investment, government expenditure and exports) in both developed and developing countries.

Leontief’s first article on input–output analysis, entitled ‘Quantitative Input and Output Relations in the Economic System of the United States’ (paper I) was published in the *Review of Economics and Statistics* in 1936. Five years later the numerical results of two ten-sector tables (consolidated from a matrix of relations between 44 sectors), which were calculated for the United States for 1919 and 1929, were published in his first book, *The Structure of the American Economy* (Leontief, 1941). Over the years he refined and extended his first basic

model to produce increasingly sophisticated and complex models (for example, by increasing the numbers of sectors covered, a task aided by the development of computers) and applied the approach to study a wide variety of important economic problems. His 1941 monograph was followed by the publication of a number of other important books based on input–output analysis (see, for example, Leontief, 1951 – the second edition of his 1941 book; 1966b; Leontief et al., 1953a; 1977b) and numerous articles in which he explored the practical applications of the approach. In the former, in one notable contribution (Leontief et al., 1953a, Chapter 3 – paper 3) he presented a dynamic version of his basic model, which subsequently led to research being undertaken by others into both the theoretical and practical problems that arise with dynamic input–output analysis.

Four examples will suffice to illustrate the practical applications of the analysis Leontief developed in his published work. First, in an early article entitled ‘Wages, Profit and Prices’ (Leontief, 1946 – paper 2), he showed how inflationary pressures, which originate in different sectors, are diffused throughout the economy. Second, he applied input–output analysis to the study of US foreign trade (Leontief, 1953b – paper 4; 1956 – paper 5) and surprisingly found that US exports were less capital intensive and more labour intensive than US imports. Leontief’s findings seemingly contradicted the Heckscher–Ohlin approach which explains the composition of international trade in terms of the relative factor endowments of different countries. According to Heckscher and Ohlin (the 1977 Nobel Memorial Laureate), given its relative abundance of capital, the United States should export capital-intensive goods and import labour-intensive goods. Leontief’s result – now known as the ‘Leontief paradox’ – has provided fertile ground for much subsequent research in the field of international trade. Third, he used input–output analysis to study the environmental repercussions of increasing economic activity (see, for example, Leontief, 1970 – paper 6). Fourth, in his Nobel Memorial Lecture (Leontief, 1974) he outlined a multi-regional input–output model for the world economy, which he subsequently presented in Leontief et al., 1977b.

While Leontief will be remembered first and foremost for the development of input–output analysis and its practical applications, he also undertook work in other areas of economics including demand and supply curve analysis, composite commodities and the problem of index numbers, the theory of international trade and the significance of Marxian economics for current economic theory. Some of his classic contributions to economics have been gathered together in two collections of essays (Leontief, 1966a; 1977a). Underlying nearly all of his work is the recurrent theme that economics is an empirical and applied science which above all else should be directed to analysing real-world problems rather than developing formal mathematical models at the expense of their practical relevance (see, for example, Leontief, 1971 – his presidential address to the American Economic Association).

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