

COWLES COMMISSION
FOR RESEARCH IN ECONOMICS

REPORT FOR 1947

THE UNIVERSITY OF CHICAGO

The COWLES COMMISSION FOR RESEARCH IN ECONOMICS is a not-for-profit corporation, founded in 1932, for the purpose of conducting and encouraging investigations into economic problems. The results of research by members of the COMMISSION'S staff are published in two series: COWLES COMMISSION MONOGRAPHS in book form, and shorter papers, usually reprints of articles from journals, as COWLES COMMISSION PAPERS, NEW SERIES. The COMMISSION is affiliated with the ECONOMETRIC SOCIETY, an international society for the advancement of economic theory in its relation to statistics and mathematics. There is a close relation between the COMMISSION and the UNIVERSITY OF CHICAGO.

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ANNUAL REPORT, 1947

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I. ECONOMETRIC RESEARCH

During the last four years or so the Cowles Commission has considered as its main object the measuring of economic relations. The annual reports for 1944 and 1945, and the five-year report for 1942-1946 discuss in some detail the need for this type of research, and its ultimate promise of a clearer, more realistic, and more useful economics. In what follows, the main contents of the work done in 1947 will be stated briefly, and details will be indicated by the titles of the subjects studied and discussed by the staff. Most of these items have been circulated, as summaries or full draft papers, in advance of staff discussion, and have been also communicated to a few experts for comments and criticisms. The main headings of econometric research have been again (1) Construction of Economic Models, (2) Revision of Economic Fundamentals, (3) Revision of Statistical Tools.

I. 1. CONSTRUCTION OF ECONOMIC MODELS.

The second draft of Klein's "Economic Fluctuations, U.S. 1921-1941" was completed and it is planned to publish it as a Cowles Commission Monograph. In this book, discussion of the general principles of model building is followed by an attempt to use a theory of rational behavior of firms to derive, in first approximation, some of the relevant economic relationships. For example, the possible determinants of the aggregate capital outlay, and of the changes in aggregate inventories and other assets are specified on the basis of plausible behavior of individual firms. A simple three-relations model is studied as an illustration of the method and is followed by the study of a larger and more detailed model. The numerical characteristics of each model have been estimated by new methods. Critical analysis of the data used concludes the volume. The Monograph does not claim to have given final answers. Its results will have to be revised in the light of more and better data, better statistical methods and in the light of further theoretical study, especially the study of cost and price formation. The limited data will never permit the empirical testing of very detailed models involving numerous variables and equations. But there is a variety of ways in which, for example, "total production" can be split into a few distinct components. In particular, two-section models (urban vs. rural; or two countries trading with each other) were the subject of staff work during 1947. Under the joint guidance of the Cowles

Commission and the Agricultural Economics Research group of the University of Chicago (Professors T. W. Schultz and Gale Johnson), Cooper continued the work of Haavelmo on the agricultural sector. For the time being, it is not attempted to estimate demand or supply functions for single food items, but rather to show the interrelations between the whole urban and the whole rural sector, hoping to discover, in particular, what determines the demand and supply of labor and its movements between the sectors. In the course of these studies, the importance of measuring the relation between weather and crop yields was recognized; on this subject preliminary models were constructed and data collected by Arrow and Rubin.

The general methodology of empirical economics has been discussed by Hurwicz and by Marschak and in Koopmans' review article, "Measurement without Theory."

The following list of staff papers is a chronological one and may thus illustrate the process of cross-fertilization and maturation of ideas within a cooperative group.¹

Relations between Consumption Functions Obtained from Budget Data and Those Derived from Time Series: *Haavelmo*

(P) Economic Structure, Path, Prediction and Policy: *Marschak*

Some Obstacles for Studies of Single Commodity Markets: *Cooper*

(V) Forecasting a Multilateral Balance of Payments: *Ragnar Frisch*, University of Oslo

A Closed Model for International Trade: *Sonia Klein*

(V) A Two-Country International Trade Model: *J. Hartog*, Netherlands Economic Institute, Rotterdam; a Rockefeller Fellow

Manufacturing in the United States, 1921-1941, a Tentative Model: *Patinkin*

(P) Theories of Effective Demand and Employment: *Klein*

(P) Measurement without Theory (Review of Mitchell and Burns' "Measurement of Business Cycles"): *Koopmans*

Mobility of Labor between Agriculture and Non-Agriculture: A Study in Dynamic Equilibrium: *Cooper*

(V) Fiscal Policy and National Income: *J. Gelting*, University of Copenhagen; a Rockefeller Fellow

Economic Fluctuations, U.S. 1921-1941. Second Draft: *L. Klein*. Mimeo-

¹ The letter (P) indicates items published, or presented in meetings or lectures during 1947. The place and date of publication or presentation of such items will be found in the section "Staff Notes and Publications" which also includes the discussion items and draft papers which were mentioned in the five-year report, 1942-1946, but reached the publication stage in 1947.

The letter (V) indicates staff discussions opened by a visitor's paper. Visitors stayed for various periods, from three days to a large part of the year. Some of those who stayed long participated fully in staff work regardless of official affiliation.

graphed, 196 pages + 12 charts. Contents: I. Model building—General Principles. II. Economic Theory. III. Statistical Models. IV. Adequacy of Available data. V. Charts.

Some Remarks on Klein's "Effective Demand and Employment": *Domar*

(P) Some Problems Arising in Estimating Economic Relationships: *Hurwicz*

Structural Equations for the Study of the Relation of Corn Yield to Weather: *Rubin*

Forecasting National Income in June, 1947: *Arrow*

(V) Price Flexibility and Inconsistent Systems: *R. Dehem*, University of Louvain (Belgium); a Rockefeller Fellow

(P) The Role of Econometric Models in Economic Research: *Cooper*

(P) Capital Accumulation and the End of Prosperity: *Domar*

(P) Family Expenditures and the Marginal Propensity to Consume: *Haavelmo*

(V) System of Trade Cycle Equations Derived from Barger's Quarterly Data U.S. 1921-39: *Colin Clark*, Queensland Bureau of Industry, Brisbane, Australia.

Price Flexibility and Unemployment: *Patinkin*

(P) Three Lectures on Forecasting National Income: *Arrow*

Eighteen Lectures on Income and Employment: *Marschak* (Mimeographed, 33 pages)

I. 2. REVISION OF ECONOMIC FUNDAMENTALS.

The logical consistency of an aggregative model (such as the Keynesian one), and its relation to the theories (such as the Walrasian theory) of the individual firm and household, have naturally occupied the minds of the staff economists for some time. This is the subject of Patinkin's Ph.D. thesis; it emphasizes that if a system of behavior and market equations is inconsistent, then some groups are forced to abandon their desired behavior pattern. This is linked to the concept of "involuntary unemployment."

The problem of connecting the theory of single individuals producing and using numerous commodities, with the theory of a few large national aggregates, has important statistical implications. If, say, the relation between total consumption, total income, price level, etc., is subject to random disturbances, these must have their origin, at least in part, in the random elements of the behavior of single individuals. On these lines, studied by Haavelmo and Arrow, one may hope to solve the problem of "best index numbers," and to combine in the best possible way the use of aggregate time series with "cross-section data" on family budgets, on firms' costs and outputs, or on their attitudes.

Because of the random features in the economic, as well as in the political and the climatic, environment, each firm acts under conditions of uncertainty. A theory of firms' behavior under such conditions has been developed by Arrow building forth on some earlier work of Hurwicz (Cowles Commission Paper, New Series No. 16: Theory of the Firm and of Investment). Marschak studied the impact of taxes upon firms' behavior under conditions of uncertainty.

Simon's contribution to the study on the economic aspects of atomic energy (see below sec. II) was based on a theoretical analysis of effects of inventions. This led him to the reconsideration of the theory of production functions, with the emphasis on the co-existence of different technical methods. This may explain the discontinuous response of output to some price changes and the "trigger effect" of some inventions. Discontinuous responses of quantities to prices (and conversely), the important practical problems arising therefrom, and the mathematical solution of such problems have also occupied Koopmans (in connection with his study of transportation: see below sec. III) and Hurwicz.

The following discussion papers can be listed (chronologically) as dealing with the revision of economic fundamentals.*

Planning under Uncertainty: *Arrow*

On the Consistency of Economic Models: A Theory of Involuntary Unemployment, Second Draft: *Patinkin*. Ph.D. Thesis, mimeographed, 147 pp.

Constant Utility Index of the Cost of Living: *Klein and Rubin*

(P) On Mathematics for Economists (on Crum-Schumpeter's book):

Marschak

Taxation and Entrepreneurs' Choice: Two Notes. *Marschak*

(P) Note on Allocation of Output: *Patinkin*

(P) Optimum Utilization of the Transportation System: *Koopmans*

(V) Economic Planning, Policy and Action under Uncertainty: Professor *Leo Tornquist*, University of Helsinki

(V) Interest Rate, Social Yield and Social Productivity, Professor *M.*

Allais, University of Paris

(P) Summarizing a Population of Behavior Patterns: *Arrow*

(P) Some Economic Effects of Technological Change: *Simon*

I. 3. REVISION OF STATISTICAL TOOLS.

The contents of the Cowles Commission Monograph No. 10, "Statistical Inference in Dynamic Economic Models" were given in the 1942-46 report. The shortage of printing facilities has held up the publication of this monograph. In the meantime, An-

* See Footnote on page 3.

derson and Rubin have prepared an extensive manuscript on the estimation of a single difference equation in a complete model. Such estimation of a part, instead of the whole, of the model leads to statistically less accurate results but seems to be less laborious and is more flexible since it requires fewer theoretical assumptions regarding the part of the model in which the investigator has little interest, e.g. for reasons of practical policy under consideration. Rubin has extended the method to the case where two or more equations, which form part of a larger model, are estimated simultaneously; and the case when non-linear relations are admitted into parts or the whole of the model. Anderson, Hurwicz and Reiersøl have studied problems arising when not only each behavior relationship is subject to a random disturbance ("shocks") but when each variable is also subject to a random disturbance ("errors"—in particular, errors of measurement).

During the last months of the year a cooperative study was made by Koopmans and two visitors: Olav Reiersøl (University Norway, Oslo; a Rockefeller Fellow) and George Rasch (State Serum Institute, University of Copenhagen, Denmark; a Fellow of the University of Chicago). They made a comparative study of problems arising from the specification of models, in particular problems of identification, in three fields: a multivariate model designed for the study of human metabolism; a model designed for the analysis of mental aptitudes; and an econometric model of the type employed by the Cowles Commission in its economic research. The similarities and differences encountered help to understand the nature of scientific induction.

Computational work at the Chicago office was directed by DeVries. Later in the summer, the Thomas Watson Laboratories at Columbia University kindly permitted the use of their computing machines, including the relay calculator. On a part-time assignment in New York, Chernoff is studying for the Cowles Commission the applicability of these machines to the computational problems arising in the estimation of economic structure according to multi-equational economic models.

In March, the third Cowles Commission Conference on Statistical Methods was held. While problems of multi-equational models were again discussed, the main conference work dealt with stochastic processes, another subject of obvious importance to the student of economic time series. The program was as follows:

Identifiability, Estimability and Multicollinearity: *Koopmans*.
Efficiency of Maximum Likelihood Estimates: *Abraham Wald*, Columbia University.

Degrees of Freedom in Simultaneous Equation Systems: *Rubin*.
Summary of *Lejbnik's* Results on Serial Correlation, Discrete and Continuous: *Koopmans*.

On Serial Correlation in a Continuous Stochastic Process: *Rubin*.
Estimating the Parameters of a Continuous Stochastic Process: *Leonard J. Savage*, Institute for Radiobiology, University of Chicago.

An Integral Equation Describing a Stochastic Process in Radioactivity: *H. B. Mann*, Ohio State University.

A Possible Continuous Stochastic Process and Some Applications: *Rubin*.

Other problems of statistical method discussed during the year are indicated (in chronological order) by the title of the following papers.*

Estimation of a Single Stochastic Difference Equation in a Complete System: *Anderson and Rubin*. Mimeographed, 62 pp.

Comparison of Three Methods of Estimation in a Simple Model: *DeVries*.

Effect of a Certain Lagged Term in the Inventory Adjustment Equation on the Iterative Maximum Likelihood Computation: *DeVries*.

Comparison of Three Methods of Estimation in a Simple Model: *De Haavelmo*.

(P) Reply to Prof. Fréchet's Question on Limits of Application of Probabilities to Economics: *Marschak*.

(P) Stochastic Processes in Economics: *Koopmans*.

Statistical Problems of Importance to Cowles Commission: *Koopmans*.

Systems of Linear Stochastic Equations: *Rubin*, Thesis, mimeographed, 42 pp.

Alternative Derivation of the Variance Ratio Principle: *Koopmans*.

(P) Errors and Shocks in Economic Relationships: *Anderson and Hurwicz*.

(P) Statistical Inference from Non-Experimental Observations: an Example from the Field of Economic Policy: *Marschak*.

The Identification of Structural Characteristics: *Koopmans*

(V) A Biometric Multidimensional Model: *G. Rasch*, State Serum Institute, Copenhagen; a Fellow of the University of Chicago.

(V) Remarks on Estimation: *Rasch*.

(V) On the Identification Problem in Factor Analysis: *O. Reiersøl*, University of Norway, Oslo; a Rockefeller Fellow.

(V) Confluence Analysis When the Model Contains Both Shocks and Errors: *Reiersøl*.

(P) The Identification of Economic Relationships: *Koopmans*.

Lectures on Statistical Methods of Measuring Economic Relations: *Koopmans*. Mimeographed, 126 pp.

* See Footnote on page 3.

II. STUDY OF THE ECONOMIC ASPECTS OF ATOMIC ENERGY

This study, sponsored by the Social Science Research Council (Committee on Social Aspects of Atomic Energy; W. Riefler, Chairman) and the Rockefeller Foundation, started in October 1946; the technological chapters, completed in first draft during 1947, are now being circulated to experts. The outline of the study is as follows:

PART I. ECONOMIC COMPARISONS OF ATOMIC AND CONVENTIONAL POWER: 1. Economic Characteristics of Atomic Power; 2. Atomic Energy in the Fuel and Power Economy of Various Regions of the World.

PART II. ATOMIC POWER IN SELECTED INDUSTRIES: 3. Electrochemical and Electrometallurgical Industries; 4. Copper, Lead and Zinc; 5. Cement, Brick and Glass; 6. Iron and Steel; 7. Railroads; 8. Water Transportation; 9. Agriculture.

PART III. ATOMIC POWER AND ECONOMIC DEVELOPMENT: 10. Atomic Power and the Industrialization of Backward Areas; 11. Atomic Power in Advanced Economies.

World maps of electricity cost and of the distribution of solid fuels and water power will be attached to Chapter 2.

The main work in directing and editing the study has been done by Schurr. Boorstein worked mainly on the subject of Chapter 2 (atomic energy in the fuel and power economy of various regions of the world) and prepared a preliminary draft of this chapter. Perazich gave general engineering advice and worked in particular on the subject of various energy-consuming industries, treated in Chapters 3-5 and 7-9; he prepared preliminary drafts of these chapters. Drafts of other chapters were prepared by Schurr (Chapter 1) and by part-time consultants, Harold Wein (Chapter 6) and Herbert Simon (Chapters 10-11). Cartographic help was provided by Robert Carmin of the Department of Geography and Geology, Michigan State College. Valuable aid has been derived from consultation with various technical experts, in particular Mr. A. B. Kinzel, Union Carbide and Carbon Corporation, and Mr. Philip Sporn, American Gas and Electric Service Corporation.

Two Cowles Commission Special Papers issued in 1947 contained some preliminary results of the study. One paper is that of John Menke of the Clinton Laboratories at Oak Ridge; it was prepared for the Cowles Commission in 1946, but its publication was delayed. The other paper includes a report presented by Schurr at the meeting of the American Economic Association,

with criticisms by Philip Sporn; and an earlier article by Marschak.

III. OTHER STUDIES

III. 1. THEORY OF TRANSPORTATION.

The study of the economics of transportation conducted by Koopmans, and described in the five-year report 1942-1946, is being continued. He is broadening the theoretical basis of this study by a mathematical analysis of productive systems characterized by linear production functions.

III. 2. POLITICAL STATISTICS.

This work of H. T. Davis is based in part on extensive studies carried on during the past five years on price and wage patterns in antiquity. This book (320 pages) has been issued in a limited mimeographed edition and includes the following chapters:

1. Political Science as a Statistical Science. 2. Enumeration and Frequency Distributions. 3. The Central Tendency of Data. 4. Elements of the Theory of Probability. 5. The Theory of Correlation. 6. Some Problems in Political Science. 7. The Statistics of Time Series. 8. Political Science and the Distribution of Incomes. 9. Political Science and Economics. 10. The Problem of Conflict. Appendix. Mathematical Tables. Index.

III. 3. BIBLIOGRAPHY OF MATHEMATICAL TABLES by H. T. Davis (with the assistance of Vera Fisher). This inclusive bibliography when finally produced will have an approximate length of 200 pages of which 91 pages have already been prepared in mimeographed form.

III. 4. THE EQUATIONS OF MATHEMATICAL PHYSICS AND METHODS FOR THEIR SOLUTION by H. T. Davis. Approximately 150 pages have been completed in mimeographed form and an additional 150 pages are projected. The table of contents includes the following chapters:

1. Some Introductory Problems. 2. Fourier Series. 3. Fourier Integrals. 4. Orthogonal Functions. 5. The Convergence of Fourier Series and Integrals. 6. Elements of Vector Analysis. 7. The Equations of Mathematical Physics. 8. Problems in the Flow of Heat. 9. Problems in Vibration Phenomena. 10. Spherical Harmonics. 11. Cylindrical Harmonics. 12. The Sturm-Liouville Theory. 13. Elements of Integral Equations. 14. The Laplace Transform. 15. The Theory of Operators.

IV. COWLES COMMISSION SEMINARS

During 1947 the following Cowles Commission Seminars were held:

January 16. SAM H. SCHURR, "Economic Aspects of Atomic Energy as a Source of Power."

February 14. RAGNAR FRISCH, Professor of Economics, University of Norway, Oslo, "Some Basic Formulae in Demand Analysis."

February 20. SEWALL WRIGHT, Professor of Zoology, University of Chicago, "The Method of Path Coefficients."

March 6. ABBA P. LERNER, Professor of Economics, New School for Social Research, New York, "Wages, Inflation and Deflation."

April 3. HARALD CRÁMER, Professor of Mathematics, University of Stockholm, Sweden, "Stationary Stochastic Processes."

April 10. ABBA P. LERNER, Professor of Economics, New School for Social Research, New York, "Economic Planning in a Free Market."

May 8. MARTIN BRONFENBRENNER, Federal Reserve Bank of Chicago, and Department of Economics, Roosevelt College, "Comparison of Full-Employment Forecasts."

May 22. RENSIS LIKERT, Director, Survey Research Center, University of Michigan, "Sample Survey as a Tool for Economic Research."

August 7. HAROLD HOTELLING, Professor, University of North Carolina, "Statistical Problems of Welfare Economics."

October 9. COLIN CLARK, Director, Bureau of Industry, and Financial Adviser to the State Treasury of Queensland, Australia, "Social Implications of Economic Growth."

October 23. MILTON FRIEDMAN, Associate Professor of Economics, University of Chicago, "Utility Analysis of Gambling and Insurance."

November 6. HERBERT A. SIMON, Professor of Political Science, Illinois Institute of Technology, "Some Economic Effects of Technological Progress."

November 20. DR. GEORGE RASCH, State Serum Institute, Copenhagen, Denmark, "Statistical Analysis of Growth Curves."

Beginning in October some of the Cowles Commission Seminars have been held jointly with the Statistical Techniques Group of the Chicago Chapter of the American Statistical Association (Kenneth J. Arrow, Group Chairman). In particular, the papers by Milton Friedman and George Rasch were presented in a joint meeting of the two groups. This arrangement will continue in 1948, whenever the subject of the paper seems appropriate.

V. COWLES COMMISSION PAPERS

Six Cowles Commission papers have been issued in 1947. While the New Series now includes papers devoted to econometric research, a series of Special Papers has been started to include

special studies. In 1947, these were studies on the economic aspects of atomic energy.

V. 1. NEW SERIES.

No. 19. THE PROBLEM OF AGGREGATION. KENNETH MAY, "The Aggregation Problem for a One-Industry Model," *Econometrica*, Vol. 14, October, 1946, pp. 285-298; SHOU SHAN PU, "A Note on Macroeconomics," *Econometrica*, Vol. 14, October, 1946, pp. 299-302; LAWRENCE R. KLEIN, "Remarks on the Theory of Aggregation," *Econometrica*, Vol. 14, October, 1946, pp. 303-312; KENNETH MAY, "Technological Change and Aggregation," *Econometrica*, Vol. 15, January, 1947, pp. 51-63.

No. 20. NOTES ON THE DOOLITTLE SOLUTION. NANCY BRUNER, "Note on the Doolittle Solution," *Econometrica*, Vol. 15, January, 1947, pp. 43-44; DICKSON H. LEAVENS, "Accuracy in the Doolittle Solution," *Econometrica*, Vol. 15, January, 1947, pp. 45-50.

No. 21. THREE PAPERS ON SERIAL-CORRELATION COEFFICIENTS AND OSCILLATORY TIME SERIES. R. B. LEIPNIK, "Distribution of the Serial Correlation Coefficient in a Circularly Correlated Universe," *The Annals of Mathematical Statistics*, Vol. 18, March, 1947, pp. 80-87; T. W. ANDERSON, "Review of Kendall, Contributions to the Study of Oscillatory Time Series," *Journal of the American Statistical Association*, Vol. 42, March, 1947, pp. 187-188; T. W. ANDERSON, "A Note on a Maximum Likelihood Estimate," *Econometrica*, Vol. 15, July, 1947, pp. 241-244.

No. 22. TRYGVE HAAVELMO, "Methods of Measuring the Marginal Propensity to Consume," *Journal of the American Statistical Association*, Vol. 42, March, 1947, pp. 105-122.

No. 23. LAWRENCE R. KLEIN, "The Use of Econometric Models as a Guide to Economic Policy," *Econometrica*, Vol. 15, April, 1947, pp. 111-151.

No. 24. M. A. GIRSHICK and TRYGVE HAAVELMO, "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations," *Econometrica*, Vol. 15, April, 1947, pp. 79-110.

No. 25. TWO REVIEW ARTICLES. T. C. KOOPMANS, "Measurement without Theory" (Burns and Mitchell, "Measuring Business Cycles"), *Review of Economic Statistics*, Vol. 29, August,

1947, pp. 161-172; JACOB MARSCHAK, "On Mathematics for Economists" (Crum and Schumpeter, "Rudimentary Mathematics for Economists and Statisticians"), *Review of Economic Statistics*, Vol. 29, November, 1947, pp. 269-273.

V. 2. SPECIAL PAPERS.

No. 1. JOHN R. MENKE, "Nuclear Fission as a Source of Power," *Econometrica*, Vol. 15, October, 1947, pp. 314-334.

No. 2. JACOB MARSCHAK, SAM H. SCHURR, and PHILIP SPORN, "Economic Aspects of Atomic Power," *American Economic Review*, Vol. 37, May, 1947, pp. 98-108, 111-117; *Bulletin of Atomic Scientists*, Vol. 2, September 1, 1946, pp. 8-9.

VI. STAFF NOTES AND PUBLICATIONS.

THEODORE W. ANDERSON

Anderson continued as research consultant of the Cowles Commission while teaching at Columbia University where he also did consulting work at the Bureau of Applied Social Research. On July 1, he became assistant professor at Columbia University and went on a year's leave of absence as a Guggenheim Fellow. Since September, he has been doing research work at the Institute of Mathematical Statistics, University of Stockholm, Sweden. His papers, published or presented in 1947, are the following:

"Review of Kendall, Contributions to the Study of Oscillatory Time Series," and "A Note on a Maximum-Likelihood Estimate" (both in Cowles Commission Papers, New Series, No. 21).

"Identification and Estimation in Factor Analysis" presented at New York City, April 18, 1947, before the Statistical Techniques Group of the New York Chapter of the American Statistical Association.

(With L. Hurwicz) "Errors and Shocks in Economic Relationships," presented at Washington, D.C., September 8, 1947, before the Econometric Society at the International Statistical Conferences. (Abstract in *Econometrica*, Vol. 16, January 1948, pp. 36-37).

"Estimation of Parameters of Certain Stochastic Processes Applied to Economic Models," presented (in Swedish) at Stockholm, Sweden, October 23, October 31 and November 6, 1947, before the Seminar of the Institute of Mathematical Statistics of the University of Stockholm.

"On the Distribution of the Circular Serial Correlation Coefficient of Residuals from a Fourier Series defined by the Least Squares Method," presented at Uppsala, Sweden, December 9, 1947, before the Seminar of the Statistical Institute of Uppsala University.

(With R. L. Anderson) "Distribution of the Circular Serial Correlation Coefficient for Observations Adjusted for a Simple Harmonic Trend," presented at New York City, December 30 before the Institute of Mathematical Statistics.

(With Herman Rubin) "Estimation of the Parameters of a Single Stochastic Difference Equation in a Complete System," mimeographed, 62 pages.

KENNETH J. ARROW

Kenneth J. Arrow, who joined the Cowles Commission in April, 1947 (see biographical notes in the 1942-46 report), has published or presented during 1947 the following papers:

Review of Jean Ville, "Sur les conditions d'existence d'une ophelimité totale et d'un indice du niveau des prix," *Ann. Univ. Lyon, Sec. A* (3) 9, 32-39 (1946) *Mathematical Reviews*, Vol. 8, July-August, 1947, pp. 396-397.

Review of C. Radhakrishna Rao, "Minimum variance and the estimation of several parameters," (*Proc. Cambridge Philos. Soc.* 43, 280-283 (1947)), *Mathematical Reviews*, Vol. 8, September, 1947, p. 478.

Review of C. Radhakrishna Rao, "Note on a problem of Ragnar Frisch," (*Econometrica*, Vol. 15, 245-249 (1947)), *Mathematical Reviews*, Vol. 8, November, 1947, p. 592.

Contribution to a Round Table on "The Business Outlook," presented at Chicago, June 18, 1947, before the Chicago Chapter of the American Statistical Association.

"Forecasting National Income": three public lectures presented at Chicago, November 13, 18, and 20, 1947, under the auspices of the Division of the Social Sciences, University of Chicago.

"Summarizing a Population of Behavior Patterns" presented at Chicago, December 27, 1947, before the Econometrica Society (Abstract in *Econometrica*, Vol. 16, April 1948).

EDWARD BOORSTEIN

Edward Boorstein continued his work with the study group on the economic aspects of atomic energy until December, 1947 when he went to Berlin, Germany, to work as an economist-statistician with the U.S. Army Occupation Forces. Boorstein addressed an University class on Social and Economic Planning, on October 22, 1947 his subject being: "Possible Use of Atomic Energy in Industrialization Programs."

HERMAN CHERNOFF

Herman Chernoff (B.A., College of the City of New York, 1943; Sc.M., Brown University, 1945; National Research Council Predoctoral Fellow 1946-7) became a research assistant with the Cowles Commission in June, 1947. He has been adapting computations of multi-equation estimates to International Business Machines equipment and the relay calculator at Watson Laboratories, Columbia University, New York City. He is the author of the following papers:

"Complex Solutions of Partial Differential Equations," *American Journal of Mathematics*, Vol. 68, No. 3, July, 1946, pp. 455-478.

"A Note on the Inversion of Power Series," *Mathematical Tables and Other Aids to Computation*, Vol. 2, No. 20, pp. 331-335.

GERSHON COOPER

During the Spring Quarter, Gershon Cooper participated in the leadership of an University seminar on Agricultural Demand Analysis. He became a research associate of the Cowles Commission on July 1, 1947. During 1947 he has presented the following paper:

"The Role of Econometric Models in Economic Research," presented at Green Lake, Wisconsin, September 10, 1947, before the American Farm Economic Association.

HAROLD T. DAVIS

Harold T. Davis continued as research consultant during 1947. In addition to the mimeographed "Political Statistics" mentioned in Section III. 2, he has issued the following papers and presented the following addresses:

Review of "*Tables of Fractional Powers* by the New York and Bureau of Standards Mathematical Tables Project," *Mathematical Tables and Other Aids to Computation*, Vol. 2, 1947, pp. 205-206.

Review of "*Harmonic Analysis and Synthesis Schedules for Three to One Hundred Equidistant Values of Empiric Functions*," (by L. W. Pollack with assistance of C. Heilfron), *Mathematical Tables and Other Aids to Computation*, Vol. 2, 1947, pp. 306-307.

"The Women of Mathematics," presented at Chicago, March 14, 1947, before the joint meeting of the Women's and Men's Mathematical Clubs of Chicago.

"Florian Cajori, His Life and Times," presented at Wheaton, Illinois, May 9, 1947, before the Illinois Section of the American Mathematical Association.

The Spanish edition of Davis-Nelson's "Elements of Statistics", was received this year. It was translated by Olegario Fernandez Baños, Professor at the University of Madrid, under the title, "Elementos de Estadística" and published in Madrid (Editorial Dossat, S.A.), pp. XI + 431.

BAREND DEVRIES

Barend DeVries continued as research assistant and graduate student in economics. He is the holder of a departmental scholarship at the University of Chicago for 1947-48. His duties with the Cowles Commission include the supervision of all computations which are carried on at Chicago and which apply the methods developed by the Commission during the last few years.

EVSEY D. DOMAR

Evsey D. Domar became a research associate in July, 1947. He holds a B.A. from the University of California at Los Angeles, 1939; M.A. in Mathematics from the University of Michigan, 1941; M.A. and Ph. D. from Harvard (1943-47). His doctoral thesis was on the *Economics of Expansion*. Domar was a teaching fellow at Michigan (1940-41) and Harvard (1941-43). In 1943 he joined the Division of Research and Statistics of the Board of Governors of the Federal Reserve System. In 1946 he returned to academic pursuits as an assistant professor of economics at the Carnegie Institute of Technology, and in 1947 joined the University of Chicago with the same rank. He also taught at George Washington University (summer 1944) and University of Michigan (summer 1946). Papers by Domar during 1947 were as follows:

"Expansion and Employment," *American Economic Review*, Vol. 37, March, 1947, pp. 34-55.

Review of Harold Loeb "Full Production without War," *American Economic Review*, Vol. 37, March, 1947, pp. 208-11.

Review of A. C. Pigou "Lapses from Full Employment," *Journal of Political Economy*, Vol. 55, August, 1947, pp. 362-3.

"The Determination of Income and Employment in the Keynesian System," presented at Washington, D.C., on April 16, 1947, before the International Monetary Fund.

"The Problem of Continuous Full Employment," presented at Ann Arbor, April 21, 1947, before the Economics Club, University of Michigan.

"Capital Accumulation and the End of Prosperity," presented at Washington, D.C., September 16, 1947, before the Econometric Society at the International Statistical Conferences (Abstract in *Econometrica*, Vol. 16, January 1948, pp. 98-101).

"The Accumulation of Capital in an Expanding Economy," presented at Chicago, November 14, 1947, before the Political Economy Club, University of Chicago.

MEYER A. GIRSHICK

Meyer A. Girshick continued as research consultant with the Cowles Commission. He was with the U. S. Bureau of the Census until October, 1947 when he accepted a position as a statistician with the Douglas Aircraft Corporation, Santa Monica, California. During 1947 he published or presented the following papers:

(With T. Haavelmo) "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations" (in Cowles Commission Papers, New Series, No. 24).

(With D. Blackwell) "A Lower Bound for the Variance of Some Unbiased Sequential Estimates," *The Annals of Mathematical Statistics*, Vol. 18, June, 1947, pp. 277-280.

"The Reduced Form Method for Estimating Simultaneous Economic Relationships," presented at Atlantic City, January 26, 1947, before the Econometric Society, Institute of Mathematical Statistics and Biometric Section of the American Statistical Association (Abstract in *Econometrica*, Vol. 15, April, 1947, pp. 157-58).

TRYGVE HAAVELMO

In March 1947 Haavelmo left Chicago and became research consultant to the University Institute of Economics, Oslo. He has continued his connection with the Cowles Commission as a research consultant. The following papers were published or presented by Haavelmo during 1947:

"Methods of Measuring the Marginal Propensity to Consume," Cowles Commission Papers, New Series, No. 22.

(With M. A. Girshick) "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations," Cowles Commission Papers, New Series, No. 24.

Review of André Bérard "La Statistique dans la production et les échanges, Paris," (Marcel Rivière et Cie, 1939), *Journal of Political Economy*, Vol. 55, April, 1947, p. 185.

"Family Expenditures and the Marginal Propensity to Consume," *Econometrica*, Vol. 15, October, 1947, pp. 335-341.

"Quantitative Research in Agricultural Economics: The Interdependence between Agriculture and the National Economy," *Journal of Farm Economics*, Vol. 29, November 1947, pp. 910-924 (also presented at Atlantic City, January 24, 1947, before the Econometric Society, the Institute of Mathematical Statistics and the Biometric Section of the American Statistical Association).

LEONID HURWICZ

Leonid Hurwicz continued actively as a research consultant of the Cowles Commission, coming regularly from Ames, Iowa to staff meetings. He was elected chairman of the 1947-48 Social Science Seminar, Iowa State College. During the second half of the year he acted intermittently as consultant to the U.S. Bureau of Standards. He is associate editor of the *Journal of the American Statistical Association*, and was elected Fellow of the Econometric Society. Hurwicz's addresses and papers are listed below:

"Some Problems Arising in Estimating Economic Relationships," *Econometrica*, Vol. 15, July, 1947, pp. 236-240.

Review of Arthur F. Burns and Wesley Mitchell "Measuring Business Cycles," *Journal of the American Statistical Association*, Vol. 42, September, 1947, pp. 461-467.

"Estimation of Economic Relationships, and Multivariate Regression," presented at Atlantic City, January 24, 1947, before the Econometric Society, Institute of Mathematical Statistics and the American Statistical Association (abstract in *Econometrica*, Vol. 15, 1947, p. 160.)

"Business Cycles and Secular Stagnation," presented at Atlantic City, January 25, 1947, before the Econometric Society (abstract in *Econometrica*, Vol. 15, April, 1947, pp. 168-9).

(With T. W. Anderson) "Errors and Shocks in Economic Relationships," presented at Washington, D.C., September 8, 1947, before the Econometric Society at the International Statistical Conferences (Abstract in *Econometrica*, Vol. 16, January 1948, pp. 36-37).

LAWRENCE R. KLEIN

Lawrence R. Klein was a research associate until July, 1947 when he obtained a travelling Fellowship of the Social Science Research Council to study economic planning in Norway. Before going to Norway, Klein spent a few months in Canada as a consultant to the Director General of the Economic Research Branch, Department of Reconstruction and Supply, Government of Canada. His publications and addresses are listed below.

"Remarks on the Theory of Aggregation" (in Cowles Commission Papers, New Series, No. 19).

"The Use of Econometric Models as a Guide to Economic Policy" (in Cowles Commission Papers, New Series, No. 23); (also presented at Atlantic City, January 25, 1947, before the Econometric Society).

"The Keynesian Revolution," New York, Macmillan Company, 1947, XII + 218 pp.

Second draft of "Economic Fluctuations in the U.S. 1921-1941," June, 1947, mimeographed, 190 pp., 12 charts.

"Theories of Effective Demand and Employment," *Journal of Political Economy*, Vol. 55, April, 1947, pp. 108-131.

Review of Ernst W. Swanson and Emerson P. Schmidt "Economic Stagnation or Progress: A Critique of Recent Doctrines on the Mature Economy, Oversavings, and Deficit Spending," *Journal of Political Economy*, Vol. 55, April, 1947, pp. 168-170.

Review of Seymour Harris "Inflation and the American Economy," *Review of Economic Statistics*, Vol. 29, August, 1947, pp. 206-209.

Review of David McCord Wright "The Economics of Disturbance," *Journal of Political Economy*, Vol. 55, December, 1947, p. 576.

Review of John H. G. Pierson "Full Employment and Free Enterprise," *Journal of Political Economy*, Vol. 55, December, 1947, pp. 576-577.

TJALLING C. KOOPMANS

Koopmans continued as research associate of the Cowles Commission and associate professor of economics at the University of Chicago. He published or presented the following papers during 1947:

"Measurement without Theory," review of Burns and Mitchell's "Measuring Business Cycles" (in Cowles Commission Papers, New Series, No. 25).

"Statistical Methods of Measuring Economic Relations," Lectures, University of Chicago, Autumn, 1947 (mimeographed, 126 pp.)

"Stochastic Processes in Economics," presented at New York City, April 24, 1947, before the Institute of Mathematical Statistics.

"Optimum Utilization of the Transportation System," presented at Washington, D.C., September 12, 1947, before the Econometric Society during the International Statistical Conferences (Abstract in *Econometrica*, Vol. 16, January 1948, pp. 66-68).

"The Identification of Economic Relationships," presented at Chicago, December 27, 1947, before the Econometric Society (Abstract in *Econometrica*, Vol. 16, April 1948).

DICKSON H. LEAVENS

Leavens resigned from the staff of the Cowles Commission, effective on June 30, 1947, and in September moved to 1632 Wood Avenue, Colorado Springs, Colorado. He is continuing as Managing Editor of *Econometrica*. His publications and addresses are as follows:

"Accuracy in the Doolittle Solution" (in Cowles Commission Papers, New Series, No. 20).

"Silver" (Review of 1946), *Engineering and Mining Journal*, Vol. 148, February, 1947, pp. 76-78.

"Francis Galton, Pioneer Statistician," presented at Evanston, Illinois, February 28, 1947, before the Northwestern University Chapter of Pi Mu Epsilon.

JACOB MARSCHAK

Jacob Marschak continued as research director of the Cowles Commission and professor of economics at the University of Chicago. In 1947 he was chairman of the Conference for Research in Income and Wealth organized under the National Bureau for Economic Research. He was vice-presi-

dent of the American Statistical Association, director of its Chicago Chapter and collaborating editor of the *Journal of the American Statistical Association*; he was elected Fellow of that Association. He participated in the Conference of the Norman Wait Harrison Memorial Foundation Institute, devoted to problems of the world community. He was active in the organization of the International Statistical Conferences which were held in September, 1947 in Washington, D.C.; he is a member of the publications subcommittee of the Conferences. His addresses and publications in 1947 were as follows:

"Mathematics for Economists" (in Cowles Commission Papers, New Series, No. 25).

"Economic Structure, Path, Policy and Prediction," *American Economic Review*, Proceedings of the American Economic Association, Vol. 37, May, 1947, pp. 81-84 (presented at Atlantic City, January 24, 1947, before the joint session of the Econometric Society and American Economic Association; also reprinted in the Five-Year Report of the Cowles Commission, 1942-1946).

Reply to R. M. Fréchet's "Première enquête scientifique" on "Possibilities and limits of application of mathematics, and especially of the theory of probability, to economic and social phenomena," *Revue de l'Institut International Statistique*, March, 1947, pp. 23-25 and 32.

"Theory of Income and Employment," 18 lectures given at the University of Chicago, Autumn, 1947 (mimeographed).

Review of R. Bentzel and H. Wold, "On statistical demand analysis from the viewpoint of simultaneous equations," (*Skand. Aktuarietidskr.* Vol. 29, 95-114 (1946)), *Mathematical Reviews*, Vol. 8, April, 1947, p. 216.

Review of L. Amoroso, "La trasformazione di valore nel processo produttivo" (*Giorn. 1st Ital. Attuari*, Vol. 11, 89-100, 1940), *Mathematical Reviews*, Vol. 8, April, 1947, pp. 216-217.

Review of T. C. Schelling, "Raise profits by raising wages?" (*Econometrica*, Vol. 14, July, 1946, pp. 227-234), *Mathematical Reviews*, Vol. 8, July-August, 1947, p. 396.

"Why Do We Measure Economic Relations?" presented at Madison, Wisconsin on April 17, 1947, before the John R. Commons Club; University of Wisconsin.

"Statistical Inference from Non-Experimental Observations: an Economic Example," presented at Washington, D.C., September 10, 1947, before the Econometric Society and the International Statistical Institute during the International Statistical Conferences. (Abstract in *Econometrica*, Vol. 16, January, 1948, pp. 53-55).

"Report on the work of the Conference for Research in National Income and Wealth" presented at New York, November 28, 1947, before the Universities National Bureau Committee.

KENNETH MAY

Kenneth May continued as research consultant of the Cowles Commission, coming from time to time from Carleton College, where he is assistant professor of mathematics, to participate in the Cowles Commission Seminars. He taught at the University of Minnesota Summer Session, 1947. His publications and addresses during 1947 were as follows:

"The Aggregation Problem for a One-Industry Model," and "Techno-

logical Change and Aggregation" (both in Cowles Commission Papers, New Series, No. 19).

"Dynamic Effects of Technological Change," presented at Atlantic City, January 26, 1947, before the Econometric Society (abstract in *Econometrica*, Vol. 15, April, 1947, pp. 165-66).

"Probabilities of Certain Election Results," presented at New Haven, Connecticut, September 2-5, 1947, before the Fifty-Third Summer Meeting of the American Mathematical Society, at Yale University (abstract in *Bulletin of the American Mathematical Society*, Vol. 53, September, 1947, p. 919).

"The Nature of the Aggregation Problem," presented at Stillwater, Oklahoma, December 1, 1947, before the Oklahoma Agricultural and Mechanical College Mathematics Colloquium.

"Instantaneous Indices," presented at Minneapolis, Minnesota, December 9, 1947, before the University of Minnesota Mathematics Colloquium.

"Variation of the Probability of Unfair Election Results," presented at Chicago, December 29, 1947, before Section A of the American Association for the Advancement of Science and the Institute of Mathematical Statistics (abstract in the *Bulletin of the American Mathematical Society*).

DON PATINKIN

Don Patinkin continued as research associate of the Cowles Commission. In June, 1947 he became assistant professor of economics at the University of Chicago. A list of his publications and addresses follows:

"Multiple-Plant Firms, Cartels and Imperfect Competition," *Quarterly Journal of Economics*, Vol. 61, February, 1947, pp. 173-205.

"Note on the Allocation of Output," *Quarterly Journal of Economics*, Vol. 61, August, 1947, pp. 651-657.

"Market Adjusting and Inventory Equations," presented at Atlantic City, January 27, 1947, before the Econometric Society (Abstract in *Econometrica*, Vol. 15, April, 1947, pp. 172-3).

GEORGE PERAZICH

The work of George Perazich for the atomic energy group is described in section II. His chapter drafts have been mimeographed and circulated to technical experts. In October, 1947 he left Chicago but continued as a part-time research consultant until the end of the year.

HERMAN RUBIN

Herman Rubin left the Cowles Commission in September, 1947 to become a research fellow with the Institute for Advanced Study, Princeton University. However, he continued to cooperate closely with the Cowles Commission as its research consultant. During 1947 he prepared in mimeographed form (44 pages) a draft of his Ph.D. thesis, "Symptoms of Linear Stochastic Equations." In addition, the following papers were presented and prepared by him during 1947:

"Asymptotic Properties of Maximum and Quasi-Maximum Likelihood Estimates," presented at Atlantic City, January 25, 1947, before the Institute of Mathematical Statistics.

"Some Results on the Distribution of Quadratic Forms from Gaussian

Stochastic Processes" (preliminary report) presented at New Haven, September 4, 1947, before the American Mathematical Society and the Institute of Mathematical Statistics.

"A Proof of the Asymptotic Analogue of the Theorem of Cramèr and Rao," presented at Chicago, December 29, 1947, before the joint session of the Institute of Mathematical Statistics, and Section A of the American Association for the Advancement of Science.

(With T. W. Anderson) "Estimation of the Parameters of a Single Stochastic Difference Equation in a Complete System," mimeographed, 62 pages.

SAM H. SCHURR

Sam H. Schurr continued his work in directing and editing the study on economic aspects of atomic energy, and published or presented the following papers:

"Economic Aspects of Atomic Energy as a Source of Power" (in Cowles Commission Special Papers, No. 2); this was presented before the Cowles Commission Seminar on January 16, and later at Atlantic City before the American Economic Association on January 26, and published in the *Bulletin of Atomic Scientists*, Vol. 3, April-May, 1947, pp. 117-120, p. 125, as well as (with a discussion) in the *American Economic Review*, Vol. 37, pp. 98-108, 110-117; a German translation was published: "Atomenergie und Volkswirtschaft," *Die Amerikanische Rundschau*, 3 Jahrgang, Vierzehntes Heft, Juli, 1947; a Spanish translation was published in *Revista de Economia* (Mexico), December 31, 1947, pp. 13-18. A paper with a similar title but revised content was presented at Oak Ridge, Tenn., June 5, 1947, before the Training School, Clinton Laboratories.

HERBERT A. SIMON

Herbert Simon continued as research consultant of the Cowles Commission, and was active both in the study group on atomic energy and as the author of staff discussion papers on the mathematical theory of technological change. He acted as consultant to the U.S. Census Bureau in reviewing and revising the work program of the Governments Division. The list of his publications and addresses of this year follows:

"Administrative Behavior—A Study of Decision-Making Processes in Administrative Organization," New York, Macmillan Company, IX-XVI + 259 pages.

"Effects of Increased Productivity upon the Ratio of Urban to Rural Population," *Econometrica*, Vol. 15, January, 1947, pp. 31-42.

"A Comment on 'The Science of Public Administration'," *Public Administration Review*, Vol. 7, Summer, 1947, pp. 200-203.

"Atomic Power: What Does It Mean to Our Peacetime Economy?" *Illinois Tech. Engineer*, Vol. 13, October, 1947, pp. 13 ff.

"Some Economic Aspects of Technological Progress," presented at Chicago, November 6, 1947, before the Cowles Commission Seminar.

"Some Economic Effects of Technological Change," presented at Chicago, December 27, 1947, before the Econometric Society.

VII. STATISTICAL AND ECONOMETRIC TEACHING IN THE DEPARTMENT OF ECONOMICS OF THE UNIVERSITY OF CHICAGO.

Staff members of the Cowles Commission participate in the teaching activities of the University of Chicago, especially in the field of statistics and economic theory. Stress is laid upon the connection among mathematics, economics, and statistics. The following courses are listed by the Economics Department (but not all are given every year) :

INTRODUCTION TO STATISTICS. Elementary principles of statistics. Main topics: frequency distributions, averages, dispersion and skewness, time series, index numbers, simple correlation, elements of sampling, and statistical inference.

STATISTICAL INFERENCE (two two-course sequences). A survey of the principles of statistical inference, with emphasis on the techniques useful in applying these principles to the analysis of social, economic, and business data. Among the subjects treated will be: elements of probability; concepts of population, sample, and sampling distribution; choice of estimates in the light of their sampling properties; testing hypotheses with reference to specified alternatives; principles of sampling and sample design; analysis of proportions, means and standard deviations; simple, partial, and multiple regression and correlation. These courses are given in two sequences covering substantially the same statistical principles and procedures, one section making less use of explicit mathematical formulations than the other.

INTRODUCTION TO ECONOMETRICS. Statistical testing of economic theories. Numerical estimation of demand and cost functions and other functions occurring in the theory of the firm and household, the theory of markets, and the theory of national income. Estimation of economic models. Statistical prediction under conditions of changing economic structure and policy.

STATISTICAL METHODS OF MEASURING ECONOMIC RELATIONS. Systems of economic relationships. Prediction and structural estimation. Criteria for identifiability, and methods of estimation, of economic relations. Problems connected with time lags.

APPLICATIONS OF STATISTICAL ANALYSIS. The content of this course will vary from one year to another, but will concern applications of statistics to business, economic, and social data. For example, members of the class individually or jointly may carry through a statistical investigation; or a series of statistical studies in economics or business may be analyzed in detail; or some special field of application may be studied.

THE MAIN ECONOMIC MAGNITUDES. Survey of sources and methods for estimating national income, capital formation, consumption, balance of payments, monetary circulation, and prices. Attention is given to practical work. Students have opportunity to familiarize themselves with the sources and techniques relevant to the statistical study of the American Economy.

INTRODUCTION TO MATHEMATICS FOR ECONOMISTS. A survey of those parts of mathematical analysis which are used in economics. Fundamental

mathematical concepts: function, limits. Dimensions. Elementary calculus. The application to economics is stressed throughout.

PROBLEMS IN MATHEMATICAL ECONOMICS. Elements of advanced calculus and of ordinary and differential equations applied to fundamental economic problems. The material is arranged in the order of increasing mathematical difficulty.

ECONOMETRICS OF BUSINESS FLUCTUATIONS. Mathematical formulation and statistical testing of theories of economic change. Growth and fluctuations. Prediction and policy.

These courses are additional to the relevant courses given in the School of Business and the Departments of Education, Mathematics, Psychology, Sociology, and Zoology.

Staff members of the Cowles Commission are scheduled to give a large part of the courses listed above and of the following courses: **THE DIVISIONAL COURSE IN ECONOMICS**; and **THE THEORY OF INCOME AND EMPLOYMENT**.

VIII. ADVISORY COMMITTEE

The University of Chicago Advisory Committee of the Cowles Commission continued to act as a coordinator of the work of the Cowles Commission with other research and teaching work at the University. The chairman was Professor T. W. Schultz, Chairman of the Department of Economics. It is intended to reorganize the relationship between the Cowles Commission and the University to secure closer administrative collaboration.

IX. GRANTS

Acknowledgment is made to the Rockefeller Foundation, the Social Science Research Council, and the Social Science Research Committee of the University of Chicago for financial assistance in the research work of the Cowles Commission. It should also be added that the Cowles Commission has on occasion derived much benefit from visits of Fellows of the Rockefeller Foundation.

X. SARAH FRANCES HUTCHINSON-COWLES FELLOWSHIPS

Mrs. Kenneth J. Arrow (formerly Miss Selma Schweitzer) was the holder of the Sarah Frances Hutchinson Cowles Fellowship during the calendar year 1947; Mrs. Lawrence Klein (formerly Miss Sonia Adelson) continued her Fellowship until July, 1947. Miss Françoise M. S. Ferdinand-Dreyfus, formerly of the Institute of Statistics, University of Paris, became a Fellow in October, 1947.

XI. OFFICES, EQUIPMENT AND LIBRARY

The Commission's working library concentrates on quantitative economics and on statistics and mathematics. Additions to the library total 210 books, 405 pamphlets and 24 bound volumes of journals. 90 periodicals are received currently. The total collection consists of 2010 books, 3505 pamphlets, 376 bound journal volumes. In addition, the library of the late Professor Henry Schultz is kept in the Commission's offices; it contains 950 books and 1750 pamphlets.

There were no changes in office space or equipment except the acquisition of two modern computing machines. Two older models were turned in in exchange for one of the two new machines.

XII. THE ECONOMETRIC SOCIETY

The Cowles Commission offices have continued to serve as headquarters of the Econometric Society, an international society for the advancement of economic theory in its relation to statistics and mathematics. However, Dickson H. Leavens, the managing editor of the Society's journal, *Econometrica*, changed his residence during 1947 and continues this work in Colorado Springs. Several members of the Cowles Commission staff hold offices in the Society. Alfred Cowles is secretary-treasurer and business manager of *Econometrica*. Harold T. Davis is associate editor. Jacob Marschak, a member of the Council of the Econometric Society, was chairman of the program committee which organized the meetings of the Society at Atlantic City in January, and at Washington in September; Tjalling C. Koopmans was chairman of the program committee in charge of the Chicago meetings in December. The September meetings of the Econometric Society were held on the occasion of the International Statistical Conferences in which the following other associations participated: International Statistical Institute; United Nations World Statistical Congress; the Inter-American Statistical Institute; and the International Union for the Scientific Investigation of Population Problems. An International Association for Research in Income and Wealth was founded during the meetings. There were 616 participants, representing 56 countries.

During 1947 Volume 15 of *Econometrica* was published consisting of four quarterly issues totalling 368 pages. At the end of 1947 the regular mailing list consisted of 726 members of the So-

ciety and 540 nonmember subscribers, chiefly libraries. 418 members and 258 subscribers are in the United States, and the remainder in 50 foreign countries.

