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Output, Employment, and Productivity in the United States After 1800

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Output, Employment, and Productivity in the United States After 1800

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Since the present volume is a record of conference proceedings, it has been exempted from the rules governing submission of manuscripts to, and critical review by, the Board of Directors of the National Bureau. It has, however, been reviewed and accepted for publication by the Director of Research.

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This volume of Studies in Income and Wealth contains most of the papers presented at the joint sessions of the Economic History Association and the Conference on Research in Income and Wealth, held at Chapel Hill, North Carolina, in September 1963. We are indebted to the University of North Carolina for making its facilities available to us; to the Planning Committee, which consisted of William N. Parker (chairman), Richard A. Easterlin, and Raymond W. Goldsmith; to Dorothy S. Brady, who served as Conference Editor with the assistance of Richard A. Easterlin, William N. Parker, and Albert Fishlow; to Marie-Christine Culbert and Joan R. Tron, who prepared the volume for press; and to H. Irving Forman, who drew the charts.

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Introduction

DOROTHY S. BRADY

UNIVERSITY OF PENNSYLVANIA

This thirtieth volume of Studies in Income and Wealth presents papers on output, employment, and productivity in the United States after 1800. It manifests the continued interest of a group of scholars in extending coherent systems of observations on the magnitudes of economic activities back into ever earlier historical periods. With Volume 24 of these studies,[1] the 1840's became an outpost. Observations on some activities were extended as far back as 1790 and 1800, and some estimates for periods after 1869 were significantly improved in concept and in coverage. Like that earlier volume, the present one stems from a joint meeting of the Conference on Income and Wealth and the Economic History Association,[2] and it presents the results of more extensive and more intensive explorations. With skill and ingenuity, with imagination and plain hard work, the authors have extended the measurement of related economic magnitudes for the entire economy back to the 1840's and for particular industries and even for individual firms back almost to their beginnings.

The Significance of Measurement

The trouble with measurement is the deceptive simplicity, clarity, and finality of the results. The columns of numbers presenting observations of phenomena are all too neat, too ready for use in the discovery or testing of hypotheses. Despite the pages of footnotes, annotations, and evaluations, the work of measurement, to the uncritical reader, seems to be an operation something like the totaling of entries in an accountant's journal. The "quantifier" with his routines contributes to the advance of knowledge by producing the empirical estimates of magnitudes for

[1] *Trends in the American Economy in the Nineteenth Century*, Studies in Income and Wealth 24, Princeton for NBER, 1960.

[2] The meeting was held at the University of North Carolina, Chapel Hill, September 4 and 5, 1963. Four of the papers presented at the meeting were published in the *Journal of Economic History*.

the purposes of the analyst. Upon publication, the estimates are all too readily accepted as reliable observations.

If measurement were simply a matter of counting and totaling, there would be no way to determine which of two observations was the more credible. In reality, the process of measurement is an essential part of a theory and specifies how its propositions are to be related to experience. Inevitably, theories have two connections with the world of events, both of which are established by measurements. One is that the observations produced by measurement fill in the detail of a theory; the other is that the logical extensions of the theory must then be confronted with new sets of observations. The instruments of measurement determine how the nature of the observations is prescribed by the theory and how the logic of the theory is supported by the observations. With the progress of quantification, theories became bodies of propositions about observed magnitudes, and this development has made up much of the history of aggregative economic theory.

Observations that are the result of measurement relate the abstractions of theoretical concepts to documentary evidence of economic activity. The crude material that measurement converts into observations is found in the many kinds of records which preserve information about persons, events, activities, and transactions. Even with censuses and surveys, observers of the economic scene can have little influence on the nature of the information, because typically the primary data for their compilations have been recorded according to the customary practices or legal requirements of the time. Our knowledge of the world of economic activities comes through the kind of evidence contemporaries put on paper, and forgetting this medium leads to greatly oversimplified conceptions of the processes of measurement and the meaning of observations.

Knowledge of the source material necessarily becomes more important as the observer attempts to construct measurements of economic activities in remote periods. Methods and procedures pertaining to customs and usages of the present time must be adapted to the historical material in order to maintain consistency over time in the meaning of the measured magnitudes. Extending the province of measurement involves a greater understanding of the nature of the source materials and also the collection of information from sources not hitherto utilized. The papers in this volume show both expanded use of the comprehensive sources (the Censuses and other government collections of data) and considerable advance in the fusion of materials from diverse sources into estimates for sectors and segments of the economy.

The contributions of additional information gathered from "old" and "new" sources appear on several levels. The quality of the existing estimates for Census years or other benchmarks may be improved through the association of data coming from different sources. New annual series on elements of the aggregates may lead to substantial improvements in the estimates of year-to-year changes. Information on the rates and relationships between associated magnitudes that could be utilized in the estimation of aggregates or in their evaluation may expand the possibilities of interpolation or extrapolation. Thus measurements are accumulated, improved, and extended. The importance of this work is to be gauged by the questions raised about interrelationships of particular developments in the course of economic growth and change and the answers that are suggested.

Explanation in Measurement and Observation

The work of measurement in different investigations is carried on within the same framework of accounting, i.e., the same general scheme of identification and classification, and all studies use modern statistical concepts and techniques to weigh the historical evidence found in the various sources relating to the same time period. As studies accumulate, two or more based on different procedures and source materials may lead to estimates of the same magnitude, say, employment in industry i during year t. Such replications of observations are a sign of real progress in measurement, for the comparison of two estimates, particularly if they are discordant, provides a testing ground for the blend of explanatory relationships and source materials used in their derivation. Examination of the divergence between two or more estimates of the same magnitude, an operation known as reconciliation, may ultimately result in sharper tools of measurement and, consequently, in increased validity of the observations. As the scope of measurement is extended, reconciliation becomes an integral part of the work of estimation, for investigators must build on interpretations of the results of earlier work, sometimes their own.

The explanation of a difference between two estimates may be traced through careful accounting to identification of a missing element in the sources. If the size of the difference, at various points of time, accords with historical facts about the changing importance of the activity, the explanation provides a basis for estimation of its magnitude. Much of the work described in Gallman's paper on his measures of the gross national product for the Census years between 1834 and 1909 and in Lebergott's paper on his measures of employment depended on tracing differences between estimates to their explanation.

The methods for estimating missing observations are many, but the investigator's choice may be severely limited by available information. When observations made of related magnitudes in particular years form a complete set, missing observations for other years may be estimated through a projection of ratios or regression coefficients that quantify the association between two or more magnitudes. Clearly the form of the explanatory relationship has a determining effect on the estimates but generally only the comparison with estimates from other studies can give an indication of the range of possibilities. Studies of particular industries, like those in this volume by Mrs. Eliasberg on coal, by Herfindahl on metal mining, by Williamson, Andreano, and Menezes on oil, and by Fishlow on railroads, may lead to industrywide estimates of magnitudes—value of output, employment, investment—which, in procedures and sources, are independent of the estimates of the same magnitudes obtained for the studies of the entire economy. The interpretation of the differences between estimates will, very likely, focus on the nature of the relationships projected. Some references to divergent estimates and attempts at reconciliation will be found in the papers in this volume, but, since much of the work represents additions to the stock of measurements, thorough reconciliation and absorption into a general framework will require more time for study of the results.

Missing observations may be estimated from information on a segment of a total, as when estimates of the year-to-year changes in a total value for a group of commodities are based on the changes in the value of a subgroup or on changes in the total in one geographic area. Studies like those of Davis and Stettler on the New England textile industry, McDougall and Robertson on machine tools, and Gottlieb on construction in Ohio offer explanatory detail about changes from year to year that will ultimately lead to a better understanding of the variations in annual movements from region to region, among the commodities in a group, and among the firms in an industry. The use of indexes as interpolators and extrapolators can then be given a firmer empirical base than can be proffered at the present time.

When the general sources do not permit disaggregation below a certain level, those ratios which are based on primary aggregates, various input-output ratios, may be estimated from existing evidence on their magnitude in individual situations. In his study of productivity in cereal production, Parker assembled enough evidence on employment per acre from agricultural publications, manuscripts, and other sources to permit averages to be drawn and statistical analysis to be undertaken. Although the exploration of the sources requires much time and effort, this kind of

evidence will be sought increasingly as the work of measurement is focused on more and more detailed explanations of the course of economic change.

The Directions of Research

Do these empirical studies provide any guideposts that indicate where further research might make the greatest contributions? The general interest in national accounts has given some unity to work in progress and work in view. The order of studies undertaken is of little consequence as long as they fill in the records of the national wealth and income and add to related accounts. Even where investigations seem to have exhausted the general source material, there is still much that can and will be done as individuals pursue their own interests in the work of measurement. The results of their studies are certainly additions to knowledge and of great general value.

This second meeting of the Conference with the Economic History Association pointed to the need for other general frames of reference, in particular some kinds of input-output tables and geographic distributions. Investigations of the reasons for productivity changes and descriptions of diffusion processes can lead to a mass of isolated bits of information unless their integration is assured through some common perspective. Although the completion of an input-output table for even one year in the nineteenth century might take a long time, the design for the matrix could exert a salutary influence on the conduct of research in the immediate future. It could stimulate research in areas where information is wanting, but, of more significance, it could make investigators aware of the kinds of observations needed to relate the results of different studies. The plan for the matrix with a detailed examination of the problems of measurement would make a large contribution to the advance of knowledge by demonstrating one way to combine the results of different studies. Geographic distributions provide another frame that could be developed into a general scheme for tracing the interrelationships in the diffusion of new commodities and techniques of production.

The papers presented at the meeting, including those published in the *Journal of Economic History*, invite some synthesis in the form of proposals for analytic summaries that could enhance the value of new research on specific topics.[3] Changes in outputs and inputs between and within

[3] Paul H. Cootner, "The Role of Railroads in U.S. Economic Growth," Nathan Rosenberg, "Technological Change in the Machine Tool Industry, 1840–1910," and Peter Temin, "The Composition of Iron and Steel Products, 1869–1909," in the *Journal of Economic History*, December 1963, and Dorothy S. Brady, "Relative Prices in the Nineteenth Century," in *ibid.*, June 1964.

geographic areas are found in the Parker study of cereal production, in the Davis and Stettler study of cotton textiles, in the studies of machine tools by McDougall and Robertson, and in the study of power in manufacturing by Fenichel. These papers and others from the Conference including Rosenberg's on machine tools and mine on prices suggest that, in the design of an input-output frame, it would be necessary to use narrowly defined product classes and to make explicit provisions for the production of equipment and materials for "own use" in manufacturing and other activities. Fishlow's and Parker's analyses illustrate the potential value of the input columns for at least two years that mark off a period of migration and diffusion of new techniques. The problems encountered in drawing up the general plans could give the impetus toward work on historical measurements that would have the greatest likelihood of deepening our understanding of the processes of growth and change.

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