OUTPUT, INPUT, AND PRODUCTIVITY MEASUREMENT
Output, Input, and Productivity Measurement

STUDIES IN INCOME AND WEALTH
VOLUME TWENTY-FIVE
BY THE CONFERENCE ON RESEARCH
IN INCOME AND WEALTH

A REPORT OF THE
NATIONAL BUREAU OF ECONOMIC RESEARCH, INC.

PUBLISHED BY
PRINCETON UNIVERSITY PRESS, PRINCETON
1961
NATIONAL BUREAU OF ECONOMIC RESEARCH
1960

OFFICERS
George B. Roberts, Chairman
Arthur F. Burns, President
Theodore W. Schultz, Vice-President
Murray Shields, Treasurer
Solomon Fabricant, Director of Research
Geoffrey H. Moore, Associate Director of Research
Hal B. Lary, Associate Director of Research
William J. Carson, Executive Director

DIRECTORS AT LARGE
Wallace J. Campbell, Nationwide Insurance
Solomon Fabricant, New York University
Crawford H. Greenewalt, E. I. du Pont de Nemours & Company
Gabriel Hauge, Manufacturers Trust Company
Albert J. Hettinger, Jr., Lazard Frères and Company
H. W. Ladler, League for Industrial Democracy
Shepard Morgan, Norfolk, Connecticut
George B. Roberts, Larchmont, New York
Harry Scherman, Book-of-the-Month Club
Boris Shishkin, American Federation of Labor and Congress of Industrial Organizations
George Soule, South Kent, Conn.
J. Raymond Walsh, New York City
Joseph H. Willits, The Educational Survey, University of Pennsylvania
Leo Wolman, Columbia University
Donald B. Woodward, Richardson-Merrell Inc.
Theodore O. Yntema, Ford Motor Company

DIRECTORS BY UNIVERSITY APPOINTMENT
V. W. Bladen, Toronto
Arthur F. Burns, Columbia
Melvin G. de Chazeau, Cornell
Frank W. Fetter, Northwestern
Harold M. Groves, Wisconsin
Gottfried Haberler, Harvard
Walter W. Heller, Minnesota
Maurice W. Lee, North Carolina
Lloyd G. Reynolds, Yale
Theodore W. Schultz, Chicago
Jacob Viner, Princeton
William J. Winn, Pennsylvania

DIRECTORS APPOINTED BY OTHER ORGANIZATIONS
Percival F. Brundage, American Institute of Certified Public Accountants
Harold G. Halcrow, American Farm Economic Association
Theodore V. Houser, Committee for Economic Development
S. H. Ruttenberg, American Federation of Labor and Congress of Industrial Organizations
Murray Shields, American Management Association
Willard L. Thorp, American Economic Association
W. Allen Wallis, American Statistical Association
Harold F. Williamson, Economic History Association

DIRECTORS EMERITI
Oswald W. Knauth, Beaufort, South Carolina
N. I. Stone, New York City

RESEARCH STAFF
Moses Abramovitz
Gary S. Becker
Gerhard Bry
Arthur F. Burns
Phillip Cagan
Morris A. Copeland
Frank G. Dickinson
James S. Earley
Richard A. Easterlin
Solomon Fabricant

Milton Friedman
Raymond W. Goldsmith
Millard Hadley
Daniel M. Holland
Thor Hultgren
F. Thomas Juster
C. Harry Kahn
John W. Kendrick
Simon Kuznets
Hal B. Lary
Rush P. Mack

Ilse Mintz
Geoffrey H. Moore
Roger F. Murray
Ralph L. Nelson
G. Warren Nutter
Richard T. Selden
Lawrence H. Seltzer
Robert P. Shuy
George J. Stigler
Leo Wolman
Herbert B. Woolley
RELATION OF NATIONAL BUREAU DIRECTORS TO PUBLICATIONS REPORTING CONFERENCE PROCEEDINGS

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.

(Resolution adopted July 6, 1948 and revised November 21, 1949)

Edward R. Chamberlin
Irwin F. Neumann
Raymond C. Fair
George J. Stigler
John B. Kendrick

Ex
R

This volume devoted to a report 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.

(Resolution adopted July 6, 1948 and revised November 21, 1949)
Prefatory Note

This volume of Studies in Income and Wealth is devoted to an appraisal of the measurement of output, input, and productivity. It contains the papers that were prepared for the Conference on Research in Income and Wealth held in October 1958 at the Carnegie Endowment International Center in New York City, together with the comments of participants. The Program Committee consisted of John W. Kendrick as chairman, Harold Barger, T. C. Schelling, and Irving H. Siegel; the Conference Editor was John W. Kendrick; the National Bureau Staff Reading Committee, in addition to Dr. Kendrick, was composed of Daniel M. Holland and G. Warren Nutter.

Executive Committee, 1959–60

Richard Ruggles, Chairman

Edward F. Denison
Irwin Friend
Raymond W. Goldsmith
George Jaszi
John B. Lansing

Frank Leacy
Stanley Lebergott
Charles F. Schwartz
Louis Weiner

Mildred E. Courtney, Secretary
Contents

INTRODUCTION
John W. Kendrick

PART I
Productivity and the Measurement of Real Outputs and Inputs

ON THE DESIGN OF CONSISTENT OUTPUT AND INPUT INDEXES FOR PRODUCTIVITY MEASUREMENT
Irving H. Siegel

COMMENT
Carl F. Christ

ECONOMIC PROBLEMS IN MEASURING CHANGES IN PRODUCTIVITY
George J. Stigler

COMMENT
Robert M. Solow
Morris A. Copeland
Raymond L. Richman
Robert Eisner

THE MEASUREMENT OF CHANGE IN NATURAL RESOURCE ECONOMIC SCARCITY
Harold J. Barnett

COMMENT
William Vickrey

EMPLOYMENT AND OUTPUT IN THE NATURAL RESOURCE INDUSTRIES, 1870–1955
Neal Potter and Francis T. Christy, Jr.

COMMENT
Vivian E. Spencer

DATA AVAILABLE FOR THE MEASUREMENT OF OUTPUT PER MAN-HOUR
Leon Greenberg

COMMENT
Raymond T. Bowman

viii

THE ESTIMATION OF FIPENDITURE CATEGORIES
V. R. Berlinguette

COMMENT
Milton Moss
Jack Alterman

INTERNATIONAL COMFDUCTIVITY BY FINAL E
Milton Gilbert at

COMMENT
Tibor Scitovsky
Paul Studenski

ESTIMATES OF REAL INDUSTRIAL SECTOR, I
Jack Alterman at

COMMENT
Charles L. Schul

INDUSTRY NET OUTPUT
Almarin Phillips

SOME DIFFICULTIES IN MEASUREMENT AND THE ADEQUATION
Edward F. Deni

COMMENT
George S. Tolley
Murray Wernick
## CONTENTS

### PART II

*The Estimation of Real Product in the Economy by Industries*

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Estimation of Real Domestic Product by Final Expenditure Categories and by Industry of Origin in Canada</strong></td>
<td>203</td>
</tr>
<tr>
<td>V. R. Berlinguette and F. H. Leacy</td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
</tr>
<tr>
<td>Milton Moss</td>
<td></td>
</tr>
<tr>
<td>Jack Alterman</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>International Comparisons of Real Product and Productivity by Final Expenditures and by Industry</strong></td>
<td>251</td>
</tr>
<tr>
<td>Milton Gilbert and Wilfred Beckerman</td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
</tr>
<tr>
<td>Tibor Scitovsky</td>
<td></td>
</tr>
<tr>
<td>Paul Studenski</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimates of Real Product in the United States by Industrial Sector, 1947–1955</strong></td>
<td>275</td>
</tr>
<tr>
<td>Jack Alterman and Eva E. Jacobs</td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
</tr>
<tr>
<td>Charles L. Schultze</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industry Net Output Estimates in the United States</strong></td>
<td>315</td>
</tr>
<tr>
<td>Almarin Phillips</td>
<td></td>
</tr>
</tbody>
</table>

### PART III

*The Estimation of Real Factor Inputs*

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Some Difficulties in the Concept of Economic Input</strong></td>
<td>331</td>
</tr>
<tr>
<td>Kenneth E. Boulding</td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
</tr>
<tr>
<td>Murray C. Kemp</td>
<td></td>
</tr>
<tr>
<td>Karl Borch</td>
<td></td>
</tr>
<tr>
<td>Reply by Author</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement of Labor Input: Some Questions of Definition and the Adequacy of Data</strong></td>
<td>347</td>
</tr>
<tr>
<td>Edward F. Denison</td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
</tr>
<tr>
<td>George S. Tolley</td>
<td></td>
</tr>
<tr>
<td>Murray Wernick</td>
<td></td>
</tr>
</tbody>
</table>
CONTENTS

CONCEPTS OF REAL CAPITAL STOCKS AND SERVICES 387
Richard and Nancy Ruggles

COMMENT
Evsey D. Domar
Milton Gilbert
G. Warren Nutter
Edward F. Denison

AN APPRAISAL OF LONG-TERM CAPITAL ESTIMATES: SOME REFERENCES 413
Daniel Creamer

COMMENT
Raymond W. Goldsmith
Zvi Griliches
Robert W. Burgess

FACTOR SUBSTITUTION AND THE COMPOSITION OF INPUT 451
Eric Schiff

COMMENT
Vernon W. Ruttan

AUTHOR INDEX 481
SUBJECT INDEX 483
AUTHOR INDEX TO VOLUMES 1-25 487
TITLE INDEX TO VOLUMES 1-25 497