

**Quantitative Studies on  
Production and Prices**

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Edited by  
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Springer-Verlag Berlin Heidelberg GmbH  
1983

CIP-Kurztitelaufnahme der Deutschen Bibliothek

**Quantitative studies on production and prices /**  
ed. by W. Eichhorn . . . . – Würzburg ; Wien : Physica-  
Verlag, 1983.

NE: Eichhorn, Wolfgang [Hrsg.]

ISBN 978-3-7908-0275-7      ISBN 978-3-662-41526-9 (eBook)  
DOI 10.1007/978-3-662-41526-9

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Ursprünglich erschienen bei Physica-Verlag, Rudolf Liebing GmbH + Co., Würzburg 1983.



**Ronald W. Shephard †**

## Ronald William Shephard †

Ronald W. Shephard, co-editor of this book, passed away on July 22, 1982. We have lost a great scholar, teacher, colleague and, above all, our beloved friend.

He was by nature kind, compassionate, considerate and humourous, though occasional seen by some as tough, absolutely unbending and unyielding to the extent of being stubborn and opinionated.

About five years ago, the Administration of his University (Berkeley) in its infinite wisdom, decided that the fourth floor of Etcheverry Hall needed to have its doors painted in various bright colors. Only one door, Ronald Shephard's, was not painted. The painters would have had to physically move him out of the way, as he would not tolerate an expenditure for paint for his door at the same time budgets for educational programs were limited.

The welfare of the students and the University was always uppermost in his mind. We remember him as someone who caused the Administration great annoyance, as he steadfastly clung to the now-radical but really traditional notion that staff and administrators existed to serve the faculty.

Ronald Shephard must be remembered as a man of tradition and history, possessing an almost romantic vision of the University. He was a living link with the University's past for the students, as he would frequently entertain them with stories of his career — stories of putting himself through California during the depression by caddying golf and selling newspapers; of having to stay out of school one semester because he could not raise \$ 25 for tuition; stories of working with his teacher Griffith Evans as a graduate student; of roping a blackboard to the roof of his car, driving to Evans' house in the Berkeley Hills, interrupting a garden party, and the two of them sorting out a difficult theoretical problem with the blackboard set up in Evans' garage.

The human touch of his philosophizing and reminiscing in the classroom and in research meetings was well known and highly praised.

We must also remember him as a man of tremendous energy and courage. In his last years his hands were badly bruised and discolored, his spine was terribly curved, his breath very short. Even in his last days he still continued to write and work with his graduate students.

Ronald Shephard is for us what the University is all about, and why we are proud to be members of universities.

He deeply believed in the ideals that belong perhaps to a bygone era: the superiority of the intellect, the pursuit of truth and beauty, honour and duty, the rights of an individual and more importantly his obligations. With his foresight and intellectual prowess, he developed Production Theory as his keen perception of truth led him, little concerned about how far he was leaving the rest of us behind. He was relentless in upholding the excellence of scholarship and the duty of higher education, treated his students as equal as colleagues, and challenged them accordingly to fight tooth and nail for what they believe to be true. He was far-sighted and pioneered the organization of Operations Research as a graduate field of study. Around 1960, he set up in Industrial Engineering the Operations Research area and invited three of us (Dantzig, Jewell, Oliver) to join him. The O.R. center at Berkeley became a research laboratory of the Department of Industrial

Engineering chaired by him. Today the graduates of his pioneering effort dominate the field.

There are many experts who see Ronald Shephard as the foremost production theorist ever. His success as a theorist, however, grew out of practical insights into real world problems. The classic work on duality theory, essentially stating that under certain conditions a production unit can be modelled either in the primal (factor) space or in the dual (price) space, grew out of his observation that production data are most frequently presented in monetary terms. His work on duality theory published in the book "Cost and Production Functions" (Princeton University Press 1953), has been called by Dale Jorgensen, in the preface of a reprint of the book, "the most original contribution to economic theory of all time".

Ronald Shephard's interest in the planning of production made him raise the question: "What can be obtained when expenditures are given?" To answer this question, he developed an axiomatic theory of indirect production functions. In the book "Indirect Production Functions" (Mathematical Systems in Economics, No. 10, Anton Hain, Meisenheim 1974) he showed the relationships between production functions, indirect production functions and cost-benefit analysis. He also developed the logic of accounting (shadow) prices as proxies for market prices.

"Imagine that you visit a shipyard" he stated in the preface to the monograph "Dynamic Theory of Production Correspondences" written by him and Rolf Färe (Mathematical Systems in Economics, No. 50, Anton Hain, Meisenheim 1980). "Day by day a tremendous amount of production activity of great variety is carried on, yet no ships are turned out. This goes on for a long time. Eventually a ship emerges. What is being produced day by day all during this time? It is clear that the daily, weekly, monthly outputs of the system were intermediate products. The shipbuilding production system, like construction, is a dynamically evolving process. Thus . . . I was prompted to undertake the development of a dynamic theory of production correspondences". The monograph represents an essential progress in the theory of production. By working in a function space of input and output rate histories, the crucial notion of time was successfully incorporated into production theory.

Among his papers, Ronald Shephard liked "Proof of the Law of Diminishing Returns" (*Zeitschrift für Nationalökonomie* 30, 1970, 7–34) most. It was judged by Oskar Morgenstern as a benchmark in theoretical economics. Ronald Shephard's approach to prove this law, initially formulated by Turgot in 1767, established a fundamental set of axioms for production theory.

For a long time he did not receive the recognition that his continuous contributions to the foundations of Production Theory deserve. However, at the end of his life he was honoured not only by praising remarks on his work as mentioned above. In 1980, he was awarded a Ph. D. honoris causa by the Faculty of Economics of the University of Karlsruhe, where he had held several Visiting Research Scholarships in the years before.

Our sympathies go to his wife, Mrs. Hilda Shephard. We shall never forget him.

George B. Dantzig  
Wolfgang Eichhorn  
Rolf Färe  
William S. Jewell

Robert C. Leachman  
King-Tim Mak  
Robert M. Oliver

## Preface

This book consists of 18 contributions that can be classified as quantitative studies on production and prices. Oral presentations and discussions of several of the topics first took place at a symposium held at the University of Karlsruhe, June 23 – July 4, 1980. This symposium focussed on *Natural Resources and Production*, but there was a group of scholars known throughout the world participating who concentrated on topics concerning production and prices rather than natural resources. Since their contributions are very worth reading, we take the liberty and have the privilege of editing them in this volume.

As far as the natural resources topic is concerned, a substantial part of the symposium proceedings on this subject is contained in a book entitled *Economic Theory of Natural Resources*, which was issued by the same editors and publisher.

Each paper has been reviewed by two anonymous referees. Consequently, the articles of this book are revisions or, in many cases, revised revisions of the original papers.

The contributions are organized in four parts. Part I contains five papers on production correspondences and laws of returns.

The five papers of Part II are devoted to dynamic structures of production. In two of them optimization problems are treated.

Turning next to topics of measurement and aggregation in the context of production and prices, Part III consists of four contributions involving single and multiple output production technologies as well as input price subindexes.

The concluding Part IV consists of four econometric studies whose underlying models are implemented by data of the U.S. or (West) German economy.

We take this opportunity to acknowledge indebtedness to Stiftung Volkswagenwerk (Volkswagen Foundation), Alfried Krupp von Bohlen und Halbach-Stiftung (Krupp Foundation) and Fritz Thyssen Stiftung (Thyssen Foundation) for providing the financial means to carry out the symposium. In addition, the Karlsruher Hochschulvereinigung (including alumni and friends of the University of Karlsruhe) provided the funds that made publication of this book possible. To all sponsors we express our sincere appreciation for their support.

Karlsruhe und Berkeley  
June 1981

W. Eichhorn, R. Henn  
K. Neumann, R.W. Shephard  
Editors

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