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## CONTROL THEORY APPLICATIONS . . . MACROECONOMICS

BY DAVID KENDRICK AND EDISON TSE

The Fourth NBER Stochastic Control Conference was held in Cambridge, Mass. on May 21-23, 1975. The meeting was sponsored by the Conference on the Computer in Economic and Social Research of the NBER with funds provided to the NBER by the National Science Foundation.

Most of the papers were submitted in response to an announcement we circulated in January 1975. The program for the conference is included as an appendix to this introductory note. Twenty-eight papers were given on applications and methods in control theory. Among the persons who contributed significantly to running the conference were Peggy Mills, of the Project on Control in Economics at the Department of Economics of the University of Texas at Austin, and Anna Tremblay, of the NBER in Cambridge. Also Gregory Chow and Mike Athans who had been the originators of these conferences, and who had run the first three, were very helpful to us in providing guidance on this conference.

This volume and the one to follow, contains about half of the papers which were presented at the conference. The articles are grouped under the topics of macroeconomics, microeconomics, and methodology and the individual articles are on deterministic, stochastic, adaptive, and decentralization and conflict models and on estimation.

Seven papers on applications of control theory to macroeconomics have been included in this issue, with a survey by David Kendrick. Also, a comment on one of the papers has been added. The methods used range from deterministic to decentralization and conflict. Roger Craine, Art Havenner, and Peter Tinsley report on their work on the solution of a nonlinear deterministic macroeconomic model at the Federal Reserve Board in Washington, D.C. Bruno Oudet describes a similar effort on a French model solved at the University of Grenoble.

Next come two applications of stochastic control. Peter Walsh and Joe Cruz have extended the earlier results of David Kendrick and Joe Majors in doing stochastic control on Bob Pindyck's model. They have done this by adding to the model, a Kalman filter for state estimation. In tuning this model, they followed the usual engineering procedure of modifying the variance of the noise terms until acceptable results were obtained. This attracted the criticism of one of the referees, Benjamin Friedman. Since this is an issue that is frequently treated differently by engineers and economists, we asked Ben to provide a short note setting out these differences.

The other application of stochastic control methods to macroeconomics is in a paper by Franklin Shupp who applies open loop optimal feedback type methods to a small model. This paper is followed by two papers on conflict and decentralization. Bob Pindyck obtains the Nash equilibrium solution to a U.S.

macroeconomic model in which there is conflict between the fiscal policy and the monetary policy authorities. Finn Kydland's paper on decentralized stabilization policies then completes the section on macroeconomics.

A list of authors and papers included in the forthcoming issue on microeconomics and methodology is as follows:

David A. Kendrick and Edison Tse: "Introduction"

**MICROECONOMICS**

Steven Barta and Pravin Varaiya: "Stochastic Models of Price Adjustment"

D. D. Siljak: "Competitive Analysis of the Arms Race"

**METHODOLOGY**

Gregory C. Chow: "An Approach to the Feedback Control of Nonlinear Econometric Systems"

Alfred L. Norman: "First Order Dual Control"

Yaakov Bar-Shalom and Edison Tse: "Caution, Probing and the Value of Information in the Control of Uncertain Systems"

John B. Taylor: "Methods of Efficient Parameter Estimation in Control Problems"

Arnold M. Faden and Gordon C. Rausser: "Econometric Policy Model Construction: The Post-Bayesian Approach"

APPENDIX  
PROGRAM OF STOCHASTIC CONTROL  
CONFERENCE

Sponsored by  
NBER Conference on the Computer in Economic and Social Research

Cambridge, Mass., May 21-23, 1975

*Wednesday, May 21*

2:00-3:30 Macroeconomics I

*Chairman:* Ray C. Fair (Yale)

1. Roger Craine, Arthur Havenner and Peter Tinsley (FRB) "An Open-Loop Optimal Control Algorithm for Large Nonlinear Models"
2. Carl J. Palash (FRB, N.Y.) "Preliminary Results in Stabilization Policy Using Optimal Control Procedures with the MPS Model"
3. B. A. Oudet (Mathématiques appliquées, Université Scientifique et Médicale de Grenoble, France) "Use of the Linear Quadratic Approach as a Tool for Analysing the Dynamic Behavior of a Model of the French Economy"
4. Ruey-wen Liu and L. C. Suen (Notre Dame) "The MDR Method and a Comparative Study of the OMB Model"

4:00-5:30 Estimation and Identification

*Chairman:* Edison Tse (Stanford)

1. John Taylor (Columbia) "Methods of Efficient Parameter Estimation in Control Problems"
2. Kent Wall (NBER) and Thomas F. Cooley (NBER—Tufts University) "On the Identification of Time-varying Structures"
3. Turgay Ozkan and Michael Athans (MIT) "Application of Kalman Filter to Parameter Estimation of Macroeconomic Models"

*Thursday, May 22*

9:00-10:30 Microeconomics I

*Chairman:* Masanao Aoki (University of Illinois, Urbana)

1. D. D. Siljak (University of Santa Clara, Cal.) "Competitive Analysis of the Arms Race"
2. James Thurber and Andrew Whinston (Purdue) "Stochastic Control of a Stochastically Described Economic System"
3. Jong K. You (Rutgers College) "A Sensitivity Analysis of Optimal Stochastic Control Policies"
4. Nicholas Hope (Monash University, Australia) "Development Planning in South Korea"

11:00-12:30 Macroeconomics II

*Chairman:* James Pierce (FRB)

1. Franklin R. Shupp (University of Illinois, Urbana) "Uncertainty and Optimal Wage-Price Controls"
2. David Luenberger (Stanford) "Singular Dynamics in Economic Systems"
3. James McCabe (Yale) and David Sibley (Bell Labs) "Optimal Foreign Borrowing with Export Uncertainty"
4. J. B. Cruz, Jr. and Peter Walsh (University of Illinois, Urbana) "Neighboring Stochastic Control of an Econometric Model"

2:00-3:30 Open discussion of problems in the application of control theory to economics and of work in progress.

*Chairmen:* Michael Athans (MIT) and Gregory Chow (Princeton)

4:00-5:30 Microeconomics II

*Chairman:* Stanley Fischer (MIT)

1. S. Barta and Pravin Varaiya (MIT) "Models of Stochastic Price Adjustment"
2. Alex Levis (Systems Control) "A Dynamic Simulation of U.S. Food Production"

*Friday, May 23*

9:00-10:30 Adaptive Control I

*Chairman:* David Kendrick (Texas)

1. Gregory C. Chow (Princeton) "On the Control of Nonlinear Econometric Systems with Unknown Parameters"
2. Alfred L. Norman (Texas) "Alternative Control and Estimation Strategies"
3. Dov Pekelman (University of Pennsylvania) and Edison Tse (Stanford) "Adaptive Control in Advertising"
4. Carole Aldrich and David W. Peterson (Duke) "On Learning in Stochastic Linear Quadratic Models"

11:00-12:30 Adaptive Control II and Decomposition

*Chairman:* Y. C. Ho (Harvard)

1. Yaakov Bar-Shalom (Systems Control) and Edison Tse (Stanford) "Probing and Caution in the Control of Uncertain Systems"
2. Gordon Rausser and Arnold Faden (Iowa State) "Econometrics Policy Model Construction: The Post-Bayesian Approach"
3. Finn Kydland (Norwegian School of Economics) "Decentralized Stabilization Policies: Optimization and the Assignment Problem"
4. Robert Pindyck (MIT) "The Cost of Conflicting Objectives in Optimal Policy Formulations"