

United States
Department
of Agriculture



Economic
Research
Service

Technical
Bulletin
Number 1918

February 2008

Equilibrium Displacement Mathematical Programming Models

Methodology and a Model of the U.S. Agricultural Sector

David H. Harrington and Robert Dubman



www.ers.usda.gov

Visit Our Website To Learn More!

You can find additional information about ERS publications, databases, and other products at our website.

www.ers.usda.gov

National Agricultural Library

Cataloging Record:

Harrington, David H.

Equilibrium displacement mathematical programming models : methodology and a model of the U.S. agricultural sector.

(Technical bulletin (United States. Dept. of Agriculture); no. 1918)

1. Programming (Mathematics).
2. Agriculture—Economic aspects—United States—Mathematical models.
3. Agriculture—Economic aspects—United States—Computer programs.
4. Agriculture and state—United States.

I. Dubman, Robert.

II. United States. Dept. of Agriculture. Economic Research Service.

III. Title.

QA402.5

Photo credit: PhotoDisc.

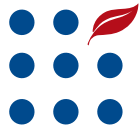
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and, where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.



United States
Department
of Agriculture

Technical
Bulletin
Number 1918
February 2008



A Report from the Economic Research Service

www.ers.usda.gov

Equilibrium Displacement Mathematical Programming Models

Methodology and a Model of the U.S. Agricultural Sector

David H. Harrington and Robert Dubman

Abstract

The objective of this research is to extend and generalize the equilibrium displacement methodology by combining it with mathematical programming methods and existing knowledge of farm sector relationships to develop sectoral adjustment models that can operate in pure competition, monopoly/monopsony, or mixed-competition. A model of the U.S. agricultural sector at the national aggregate level is presented to illustrate the methods. An appendix contains a user's manual describing the operation of the model. Further appendices contain documentation of the structure of the spreadsheets, the programming tableau, and the SAS solution program.

Keywords: Equilibrium displacement models, mathematical programming, positive mathematical programming, U.S. agricultural sector, U.S. farm programs, direct payments, counter-cyclical payments, loan deficiency payments, marketing loan gains, conservation reserve program, wetlands reserve program, crop insurance

Contents

Summary	iv
Introduction	1
EDMP Methodology	2
Review of Literature	2
Theoretical Development	3
The EDMP Formulation	5
Modeling the Supply Side	8
Modeling the Demand Side	10
Modeling Agricultural Policies and Programs	11
Payment Bases	11
Decoupled Payments	11
Counter-Cyclical Payments	11
Loan Deficiency Payments and Marketing Loan Gains	12
Conservation Reserve, Wetlands Reserve, and Grassland Reserve Programs	13
Working Lands Conservation Programs	14
Crop Insurance Subsidies	14
Superseded Agricultural Programs	15
Model Calibration	16
What Do Gradients Mean?	17
Structure of the Model	18
Commodities	18
Specified Resources	18
Specified Purchasable Inputs	19
Processes	19
Agricultural Policies and Programs	20
Solving the Model	22
Supply Parameters	23
Implicit Acreage- and Supply-Response Elasticities	26
Demand Parameters	28
Government Program Parameters	30
Post-Optimal Calculations of Performance Variables	32
Net Farm Income and Net Cash Flow	32
Government Budgetary Exposure	33
Consumer and Producer Surpluses	33
Commodity Cash Incomes, Expenses, and Margins	34

References 36
Appendix I: User’s Manual 39
Appendix II: The SAS Excel Link Program 45
Appendix III: Model Spreadsheets 53

Appendix III model spreadsheets are accessible by contacting David Harrington, 202-694-5571, davidh@ers.usda.gov