SEVENTH EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY

Oviedo, Spain
September 25-29, 2001

Program

Universidad de Oviedo

TUESDAY 25

SESSION 1.A PRODUCTIVITY IN AGRICULTURE	*SESSION 1.B* OUTLIERS AND DEA	*SESSION 1.C* REGULATED SECTORS	*SESSION 1.D* MALMQUIST INDEX
SESSION 2.A BANKING	*SESSION 2.B* HEALTH	*SESSION 2.C* AGRICULTURE	*SESSION 2.D* PUBLIC SECTOR

WEDNESDAY 26

SESSION 3.A HIGHER EDUCATION	*SESSION 3.B* HEALTH I	*SESSION 3.C* AGRICULTURE	*SESSION 3.D* FINANCIAL MARKETS
SESSION 4.A DISTANCE FUNCTIONS	*SESSION 4.B* ADVANCES IN PRODUCTIVITY	*SESSION 4.C* SFA APPLICATIONS	*SESSION 4.D* DEA INNOVATIVE APPLICATIONS I
SESSION 5.A PRODUCTION DYNAMICS	*SESSION 5.B* DEA APPLICATIONS I	*SESSION 5.C* INDEX NUMBERS	*SESSION 5.D* COMPARING METHODS
SESSION 6.A ECONOMETRIC ISSUES	*SESSION 6.B* THEORETICAL ISSUES	*SESSION 6.C* REGULATION AND EFFICIENCY	*SESSION 6.D* STOCHASTIC DEA

THURSDAY 27

SESSION 7.A NONPARAMETRIC APPROACHES	*SESSION 7.B* ENVIRONMENT I	*SESSION 7.C* ECONOMIC GROWTH	*SESSION 7.D* DEA INNOVATIVE APPLICATIONS II
SESSION 8.A TECHNICAL CHANGE	*SESSION 8.B* DEA METHODS	*SESSION 8.C* HEALTH II	*SESSION 8.D* MANAGEMENT AND FIRM ORG.
SESSION 9.A HOSPITALS	*SESSION 9.B* ENERGY	*SESSION 9.C* PRODUCTIVITY	*SESSION 9.D* BANKS AND CREDIT UNIONS
SESSION 10.A EDUCATION	*SESSION 10.B* TRANSPORT	*SESSION 10.C* FISHERIES	*SESSION 10.D* ENVIRONMENT

Tuesday, 25

10:00 – 12:00 **Registration**

12:00 - 12:30 **Opening Remarks**
Antonio Alvarez (University of Oviedo)

12:30 - 13:30 **Keynote Address (Chair: *Scott Atkinson*)**

New Developments in the Estimation of Stochastic Frontier Models with Panel Data
Speaker: *William Greene (New York University)*
Comment: *Knox Lovell (University of Georgia)*

14:00 - 15:30 Lunch

15:45 - 17:00 **SESSION 1-A: Productivity in Agriculture (Chair: *Sveinn Agnarsson*)**

Incorporating Environmental Impacts in the Measurement of Agricultural Productivity Growth
Eldon Ball, Knox Lovell, Hung Luu, Richard Nehring

Capacity Utilisation, Productivity and Efficiency of Food Firms
Holger Thiele

Evaluating the Performance of E.U. Agriculture, 1974-1991: A Parametric Input Distance Function
Giannis Karagiannis, Christos Pantzios

15:45 - 17:00 **SESSION 1-B: Outliers in DEA (Chair: *Paul Wilson*)**

Nonparametric Frontier Estimation: A Robust Approach
Catherine Cazals, Jean-Pierre Florens, Leopold Simar

Super Efficiency Evaluations Based on Potencial Slack
Peter Bogetoft, Jens Hougaard

Some General Techniques for the Detection of Influential Observations in DEA
Jesús Pastor, José Luis Ruiz, Inmaculada Sirvent

15:45 - 17:00 **SESSION 1-C: Regulated Sectors (Chair: *Sergio Perelman*)**

How Different is the Efficiency of Public and Private Water Companies in Asia?
Antonio Estache, Martin Rossi

The Impact of Regulation on Technical Efficiency in the Italian Hospital Sector
Daniele Fabbri, Luigi Siciliani

Deregulation, Markups and Productivity Change: The Case of Spanish Banks
Subal Kumbhakar, Ana Lozano

15:45 - 17:00 **SESSION 1-D: Malmquist Index (Chair: *Emili Grifell*)**

Luenberger and Malmquist Productivity Indexes: A Theoretical and Empirical Comparison
Jean-Philippe Boussemart, Walter Briec, Jean-Christophe Poutineau, Kristiaan Kerstens

Measure of Innovation and Diffusion of Technology in the United States
Shawna Grosskopf, Kathy Hayes, Lori Taylor

On an Extended Decomposition of the Malmquist Productivity Index
Subhash Ray

17:00 - 17:30 Coffee-Break

SPECIAL SESSIONS: CLASSICAL FIELDS OF APPLICATION

17:30 - 19:15 **SESSION 2-A: Banking (Chair: *Harold Fried*)**

Bank Efficiency and Economic Growth: The Case of ASEAN
Gary Ferrier

Inefficient Banks or Inefficient Assets?
Emili Tortosa

Efficiency Analysis of Italian Banks: A Comparison of Error Decomposition Techniques
Davide Pettenuzzo, Federico Perali

Bank Mergers in France: An Econometric Analysis Based on Cost and Revenue Subadditivity
Mohamed Chaffai, Michel Dietsch, V. Oung

17:30 - 19:15 **SESSION 2-B: Health (Chair: *Shawna Grosskopf*)**

Doing Better by Doing Worse: Efficiency Dynamics in the National Institute of Health
Kingsley Haynes, Stephane Philogene, Mustafa Dinc, Roger Stough

Efficiency in Performing Laparoscopic Cholecystectomy: Evidence from Massachusetts Hospitals
Suthathip Yaisawarng, Shelton Schmidt

On the Impact of Ownership Structure and Hospital Efficiency in Italy
Gian Paolo Barbetta, Gilberto Turati, Angelo Zago

DEA-based Incentive Regimes in Health-care Provision
Per Agrell, Peter Bogetoft

17:30 - 19:15 **SESSION 2-C: Agriculture (Chair: *George Battese*)**

A Meta-Analysis of Technical Efficiency in Farming: A Multi-Country Perspective
Boris Bravo-Ureta, Teodoro Rivas, Abdourahmane Thiam

A Nonparametric Approach to Measuring Cost Efficiency of Dairy Farms in Japan
Yasutaka Yamamoto

Policy Reform and Productivity Change in Chinese Agriculture: A Distance Function Approach
Bernhard Brümmer, Thomas Glauben, Wencong Lu

Dairy Farming in Iceland: Do Quota Transactions Increase Efficiency?
Sveinn Agnarsson

17:30 - 19:15 **SESSION 2-D: Public Sector (Chair: *Vivian Valdmanis*)**

Productivity Growth in Public Libraries: The Role of Deregulation and Socio-Economic Variables
Bruno De Borger, René Goudriaan, Kristiaan Kerstens, Philippe Vanden Eeckaut

Cost Efficiency Frontier Evaluation. An Application to Catalan Councils
Víctor Giménez, Diego Prior

Is the Technical Efficiency of a Public Training System Biased by the Presence of "New" Inputs?
Kostas Tsekouras

Assessing the Efficiency of Non-Profit Organizations: A Comparative Analysis
Sergio Destefanis, Ornella Maietta

20:00 – 22:00 Welcome reception at *Plaza de Trascorrales*, located right by the City Hall (Ayuntamiento)

Wednesday, 26

9:00 - 10:15 **SESSION 3-A: Efficiency in Higher Education (Chair: *Javier Salinas*)**

A Stochastic Distance Function for Measuring the Trade-Off Between Teaching and Research
Alfredo Moreno, David Trillo

Identifying Good Practice in Central Administrative Services in U.K. Universities
Barbara Casu, Emmanuel Thanassoulis

Efficiency in Swedish Public Education
Staffan Waldo

9:00 - 10:15 **SESSION 3-B: Health I (Chair: *Shelton Schmidt*)**

How Much Confidence Should We Place in the Results of Efficiency Analysis?
Andrew Street

Scale, Efficiency and Organisation in Norwegian Psychiatric Outpatient Clinics for Children
Vidar Halsteinli, Sverre Kittelsen, Jon Magnussen

Efficiency of Homes for the Mentally Disabled in the Netherlands: A Shadow Cost Function Model
Evelien Eggink, Jos Blank

9:00 - 10:15 **SESSION 3-C: Agriculture (Chair: *Boris Bravo-Ureta*)**

Technical Efficiency in Food Distribution Units
Victoria Vicario, Rafaela Dios

Technical Inefficiency of Milk Production and Udder-Related Diseases in Danish Dairy Herds
Lartey Lawson, Jens Agger, Mogens Lund

Technical Change and Technical Efficiency in Finnish Grass Silage Production for 1990-2000
Timo Sipilainen

9:00 - 10:15 **SESSION 3-D: Financial Markets (Chair: *Lennart Hjalmarsson*)**

Technological Developments and Concentration of Stock Exchanges in Europe
Heiko Schmiedel

Economic Efficiency and Value Maximization in Banking Firms
Ana Isabel Fernández, Fernando Gascón, Eduardo González

Portfolio Performance Evaluation in Mean-Variance Skewness Framework
Tarja Joro, Paul Na

10:15 - 10:45 Coffee-Break

10:45 - 12:00 **SESSION 4-A: Distance Functions (Chair: *Rolf Färe*)**

Generalized Distance Functions and Technical Efficiency: A Parametric Approach
Rafael Cuesta, Subal Kumbhakar, José Zofio

Rent-Seeking Measurement by Means of Labour Unrest: A Distance Function Approach
Ana Rodríguez, Ignacio del Rosal, José Baños

Aggregation of Directional Distance Functions and Industrial Efficiency
Walter Briec, Benoit Dervaux, Hervé Leleu

10:45 - 12:00 **SESSION 4-B: Advances in Productivity (Chair: *Robert Russell*)**

Productivity? of U.S. Airlines after Deregulation
Rolf Färe, Shawna Grosskopf, Robin Sickles

Measuring Productivity and Growth within a Broader Concept of Development using DEA
Bernhard Mahlberg, Michael Obersteiner

The 'Appropriate Technology' Explanation of Productivity Growth: An Empirical Approach
Bart Los, Marcel Timmer

10:45 - 12:00 **SESSION 4-C: SFA Applications (Chair: *Scott Atkinson*)**

The Matching Efficiency of Regional Labour Markets: A Stochastic Production Frontier Model
Aomar Ibourk, Bénédicte Maillard, Sergio Perelman, Henri Sneessens

Technological Flexibility and Efficiency in Portuguese Manufacturing Firms Using SFA
Ana Faria, Paul Fenn, Alistair Bruce

One-Step Modelling of Production Frontiers and Determinants of Technical Inefficiency
Hung-Jen Huang, Peter Schmidt

10:45 - 12:00 **SESSION 4-D: DEA Innovative Applications (Chair: *Emmanuel Thanassoulis*)**

Selling Picasso Paintings: The Efficiency of Auction Houses
Finn Forsund, Roberto Zanola

Output-Specific Efficiency of UK Secondary Schooling
Dieter Gstach, Andrew Somers, Susanne Warning

Using DEA and Negative DEA in Credit Risk Evaluation
Mette Asmild, Joseph Paradi, Paul Simak

12:00 - 12:30 Coffee-Break

12:30 - 13:30 **Keynote Address (Chair: *Daniel Primont*)**

Using Production Frontier Methods (DEA) to Analyze International Macroeconomic Convergence
Speaker: *Robert Russell (University of California - Riverside)*
Comment: *Harold Fried (Union College)*

14:00 - 15:30 Lunch

15:45 - 17:00 **SESSION 5-A: Production Dynamics (Chair: *Carlos Arias*)**

Dynamic Profit Functions: Adjustment Costs, Productivity and Efficiency
Frank Asche, Subal Kumbhakar, Ragnar Tveteras

The Dynamics of Capital Structure: Evidence from Swedish Micro and Small Firms
Almas Heshmati

Nonparametric Dynamic Efficiency Analysis
Elvira Silva, Spiro Stefanou

15:45 - 17:00 **SESSION 5-B: DEA Applications I (Chair: *Jesús Pastor*)**

Valuing Private Companies: A DEA Approach
Joseph Paradi, Burcu Anadol

Multi-Stage DEA
Boaz Golany, Ury Passy, Steve Hackman

Measuring Productivity of Research in Economics: A Cross-Country Study Using DEA
Martin Kocher, Mikulas Luptacik, Matthias Sutter

15:45 - 17:00 **SESSION 5-C: Index Numbers (Chair: *Subhash Ray*)**

Performance Evaluation in an Oligopoly Environment: Combining DEA Window Analysis with the Malmquist Index Approach
Mette Asmild, Joseph Paradi, C. Schaffnit, D. Rosen

An Economic Approach to Achievement and Improvement Indexes
Osman Zaim, Rolf Färe, Shawna Grosskopf

Using Divisia Indexes to Decompose Changes in Fuel Intensity in the Spanish Industry
Paula Fernández, Rigoberto Pérez

15:45 - 17:00 **SESSION 5-D: Comparing Methods (Chair: *Federico Perali*)**

Cost Efficiency in European Banking: A Comparison of Frontiers Techniques
Laurent Weill

Comparing Performance of Efficiency Techniques in Non-Linear Production Functions
Daniel Santín, Aurelia Valiño

Comparing Regression Analysis, DEA and Discriminant Analysis to Measure Overall Performance
Alex Ruiz, Francisco López

17:00 - 17:30 Coffee-Break

SPECIAL SESSIONS: METHODOLOGICAL ISSUES

17:30 – 18:45 **SESSION 6-A: Econometric Issues (Chair: *Peter Schmidt*)**

A Second-Stage Approach for Explaining Efficiency Differentials in Stochastic Frontier Models
Giannis Karagiannis, P. Midmore, Vangelis Tzouvelekas

Econometric Implications of Index Orientation for Technical Efficiency Analysis
Carlos Arias, Subal Kumbhakar

Measuring Technical Efficiency in Multi-Species Fisheries Using a Primal Approach
Antonio Álvarez, Luis Orea

17:30 – 18:45 **SESSION 6-B: Theoretical Issues (Chair: *Peter Bogetoft*)**

Inada Conditions and The Law of Diminishing Returns
Rolf Färe, Daniel Primont

Stochastic Frontiers and Asymmetric Information Models
Philippe Gagnepain, Marc Ivaldi

Efficiency Evaluation with Convex Pairs
Jorgen Tind

17:30 – 18:45 **SESSION 6-C: Regulation and Efficiency (Chair: *Martin Rossi*)**

Productivity and Spanish Regulation of Electricity Distribution
Leticia Blázquez, Emili Grifell

International Benchmarking and Regulation of European Electricity Distribution Utilities
Tooraj Jamasb, Michael Pollitt

The Relative Performance of Electricity Distribution Firms in South America
Antonio Estache, Martin Rossi, Christian Ruzzier

17:30 – 18:45 **SESSION 6-D: Stochastic Nonparametric Frontiers (Chair: *Leopold Simar*)**

Stochastic DEA: A Semi-Parametric Approach
Evangelina Desli, Subhash Ray

European Airlines: A Stochastic DEA Study of Efficiency with Market Liberalisation
Meryem Duygun Fethi, Peter Jackson, Tom Weyman-Jones

A Consistent Test of Technical Efficiency Based on Nonparametric Methods
Carmen Murillo, Juan Rodríguez

Thursday, 27

9:00 - 10:15 **SESSION 7-A: Nonparametric Statistical Methods (Chair: *Philippe Vanden Eeckaut*)**

How to Improve the Performances of DEA Estimators in the Presence of Noise?
Leopold Simar

Technical Efficiency Measures and Duration Models in Ivorian Manufacturing Firms
Karine Chapelle, Patrick Plane

Nonparametric Tests for Cost Differences Among U.S. Hospitals
Teresa Harrison, Paul Wilson

9:00 - 10:15 **SESSION 7-B: Environment (Chair: *Mette Asmild*)**

Nonparametric Production Analysis of Pesticides Use
Alfons Oude Lansink, Elvira Silva

Accounting for Bads in the Measurement of Productivity Growth: A Cost Indirect Malmquist Index
Eldon Ball, Rolf Färe, Shawna Grosskopf, Osman Zaim, Richard Nehring

Eco-Efficiency Analysis of an Economy
Mikulas Luptacik

9:00 - 10:15 **SESSION 7-C: Economic Growth (Chair: *Giannis Karagiannis*)**

International Spillovers as a Source of Economic Growth: Experience from Japan, Korea and Taiwan
Yir-Hueih Luh

Reconciling Accumulationists and Assimilationists. A New Framework for Measuring Efficiency
Marcel Timmer

Does Farm Growth Lead to Improved Technical Efficiency?
Carlos Arias, AntonioAlvarez

9:00 - 10:15 **SESSION 7-D: DEA Applications II (Chair: *Sergio Destefanis*)**

Developing a Decomposable Measure of Profit Efficiency Using DEA
Maria Portela, Emmanuel Thanassoulis

Benchmarking Austrian Physicians' Efficiency with DEA
Matthias Staat

Weight Restrictions and Production Trade-offs in DEA Models
Victor Podinovsky

10:15 - 10:45 Coffee-Break

10:45 - 12:00 **SESSION 8-A: Efficiency and Technical Change Change (Chair: *Angelo Zago*)**

Robustness of the Battese and Coelli (1995) Model
Luigi Benfratello

Efficiency and Technical Change in a Panel DEA Framework
Natalia Aldaz, Joaquín Millán

Measuring Technical Change in Input-Output Models by Means of DEA
José Zofío, Angel Prieto, Francisco Parra

10:45 - 12:00 **SESSION 8-B: DEA Methods (Chair: *Joseph Paradi*)**

Modeling Uncertainty in Weight Restriction DEA Using Fuzzy Set Theory
Kostas Triantis, Amit Kabnurkar, Dorota Kuchta

Are All Scales Optimal in DEA? Theory and Empirical Evidence
Finn Forsund, Lennart Hjalmarsson

Multiple Solutions in DEA: Mavericks and Specialization
Francesca Fumero

10:45 - 12:00 **SESSION 8-C: Health II (Chair: *Per Agrell*)**

A Modified Three-Stage DEA: Application to Homes for Mentally Disabled in the Netherlands
Jos Blank, Vivian Valdmanis

Efficiency of the Norwegian Nursing Homes
Dag Edvardsen

Incorporation of Quality Dimensions in DEA
Tor Beltov, Ole Olesen, Niels Petersen

10:45 - 12:00 **SESSION 8-D: Firm Organization and Management (Chair: *Holger Thiele*)**

Resource Allocation Based on Efficiency Analysis
Pekka Korhonen, Mikko Syrjänen

Efficiency as a Contractable Route to Quality Management
Robert Weaver, Taeho Kim

On Benchmarking a Pharmaceutical Sales Force Using DEA
Leonard Parsons

12:00 - 12:30 Coffee-Break

12:30 - 13:30 **Keynote Address (Chair: *Rafael Cuesta*)**

Stochastic Frontier Analysis and Metaproduction Functions
Speaker: *George Battese (University of New England)*
Comment: *Peter Schmidt (Michigan State University)*

14:00 - 15:30 Lunch

15:45 - 17:00 **SESSION 9-A: Hospitals (Chair: *Suthathip Yaisawarng*)**

A Multi-Level Model of Efficiency and Quality in E.U. Hospitals
Rowena Jacobs, Vania Sena

The Impact of Ownership, Location and Case Mix on U.S. Hospital Productivity
Ila Alam, Gerald Granderson

Comparing French and U.S. Hospital Technology: A Directional Distance Function Approach
Benoit Dervaux, Gary Ferrier, Hervé Leleu, Vivian Valdmanis

15:45 - 17:00 **SESSION 9-B: Energy (Chair: *Sverre Kittelsen*)**

Technological Externality and Economies of Vertical Integration in Electric Utility Industry
Jiro Nemoto, Mika Goto

Assesment of Cost Efficiency in Finnish Electricity Distribution
Pekka Korhonen, Mikko Syrjänen

Scale and Cost Efficiency in the Swiss electricity Distribution Industry: A Cost Frontier Approach
Massimo Filippini, Jörg Wild, Michael Kuenzle

15:45 - 17:00 **SESSION 9-C: Productivity (Chair: *Alfons Oude Lansink*)**

Technological and Pecuniary Externalities Due to Agglomeration and Productivity Measurement
Ragnar Tveteras

A Hedonic Price Index for Airline Travel
David Good, Robin Sickles, Jesse Weiher

Impact of Ownership Type in Romanian Manufacturing
Voicu Boscaiu, Costea Munteanu

15:45 - 17:00 **SESSION 9-D: Banks and Credit Unions (Chair: *Gary Ferrier*)**

Cost Efficiency and Profitability in European Commercial Banking
Gilberto Turati

Credit Union Scale Economies
Harold Fried, Knox Lovell, Suthathip Yaisawarng

Efficiency and Productivity of Credit Unions: A Comparison between Hawaii and Puerto Rico
Roberto Mosheim

17:00 - 17:30 Coffee-Break

SPECIAL SESSIONS: NEW FIELDS OF APPLICATION

17:30 – 18:45 **SESSION 10-A: Education (Chair: *Finn Førsund*)**

Do Institutions Make a Difference in Educational Management?
Javier Suárez, Manuel Muñiz

The Efficiency of Public Education in the Upper Peninsula of Michigan
Michael Shields, Yongil Jeon

Student Time and Efficiency: A Stochastic Frontier Analysis
Peter Dolton, Oscar Marcenaro, Lucía Navarro

17:30 - 18:45 **SESSION 10-B: Transportation (Chair: *Kristiaan Kerstens*)**

Yardsticks on the Road: Regulatory Contracts and Cost Efficiency in the Norwegian Bus Industry
Dag Morten Dalen, Andrés Gómez

The Exact Measurement of Allocative Inefficiency: An Application to Ports
Juan José Díaz, Eduardo Martínez, Sergio Jara

Benchmarking Train Operating Company Performance
Luisa Affuso, Álvaro Angeriz, Michael Pollitt

17:30 18:45 **SESSION 10-C: Fisheries (Chair: *Catherine Morrison Paul*)**

Identifying Mis-Recording in Fisheries Catch Data Using DEA
Sean Pascoe, Inés Herrero

Economic Efficiency of Fishing Units in the Sistan Area
Karim Koshteh, Ahmad Akbari, Mohammad Rezazadebahi

Capacity and Capacity Utilization in Fisheries: A Comparison of Approaches
Catherine Morrison Paul, James Kirkley, Dale Squires

17:30 - 18:45 **SESSION 10-D: Environment (Chair: *Knox Lovell*)**

Estimating Economic and Environmental Efficiency Using Directional DEA and 2-Step Analysis
Mette Asmild, Jens Hougaard

Accounting for Greenhouse Gases in the Productivity Performance of Canadian Businesses
Tarek Harchaoui, Pierre Lasserre

Measuring Productivity Growth in the Presence of Undesirable Outputs
Scott Atkinson, Jeffrey Dorfman

20:00 – 22:00 Workshop Dinner

Saturday, September 29
POST-CONFERENCE SESSIONS

10:00 – 12:00 **SESSION 11-A: Parametric Applications (Chair: *Antonio Álvarez*)**

Cost and Labour Use Efficiency in the Swedish Banking Industry: A Stochastic Frontier Approach
Matilda Gjirja

Regulation, ownership and efficiency in the Swiss nursing home industry
Luca Crivelli, Massimo Filippini, Diego Lunati

Stochastic Frontier Estimation Using Simulated Annealing
Luiza Badin, Roxana Ciumara

Determinants of Technical Efficiency in a Fishery
Leví Pérez

10:00 - 12:00 **SESSION 11-B: Non-Parametric Applications (Chair: *José Luis Zofío*)**

Avoiding Unfeasibility in Multipliers DEA Models with Weight Restrictions
Marcos Estellita, Angela Silva

Benchmarking the Performance of U.K. Electricity Distribution Utilities Using DEA
Susila Munisamy-Doraisamy, Robert Dyson, Victor Podinovski, Catherine Mitchell

Efficiency and Total factor Productivity in the Ukrainian Agriculture in Transition
Alexej Lissitsa, Martin Odening

Measuring Technical Efficiency in Sow Farms using DEA
Lluis Plá, Marga Moltó

12:00 - 12:30 Coffee-Break

12:30 - 13:30 Panel of experts: " On the Main Problems when Trying to Publish an Efficiency Paper"

14:00 - 15:30 Lunch

16:00 - 17:30 **SESSION 12-A: Parametric Applications (Chair: *Luis Orea)***

Measurement of Information Technology: Thailand and U.S.
Romesh Diwan, Orachat Leingpeboon

Cross-Country Output Decomposition: A Stochastic Frontier Approach
Yasmina Limam

Technical Efficiency in Hospitals with Panel Data: Parametric and Nonparametric Techniques
Luigi Siciliani

16:00 - 17:30 **SESSION 12-B: Non-Parametric Applications (Chair: *Tarja Joro*)**

Formative Evaluation in Primary Health Care – Towards a Critical Realist Use of DEA
Carla Amado

3D-Illustrations of DEA -and FDH- models
Katrin Allen

Using DEA to Design Contracts under Adverse Selection: An Application to Agricultural Policy
Glenn Sheriff

SEVENTH EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY

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Book of Abstracts

Universidad de Oviedo

TUESDAY
15:45 - 17:00 SESSION 1-A: *Productivity in Agriculture*

Incorporating Environmental Impacts in the Measurement of Agricultural Productivity Growth

Eldon Ball (*Economic Research Service, USDA*)
Knox Lovell (*University of Georgia)*
Hung Luu (*Merrill Lynch Capital Markets Bank Ltd., Germany*)
Richard Nehring (*Economic Research Service, USDA*)

The USDA uses index number procedures to calculate the growth and relative levels of productivity for the 48 contiguous states. However agricultural production has adverse environmental impacts. We merge recently developed indicators of environmental impacts with the USDA's input and output price and quantity indexes to form a state- by-year panel for 48 states over the period 1960-1996. Lacking prices for the environmental impact indicators, we calculate a conventional Malmquist productivity index and an environmentally sensitive Malmquist productivity index. We also calculate shadow prices of the environmental impacts, which we use in the construction of an environmentally sensitive Fisher productivity index. We find environmentally sensitive productivity indexes to behave very differently than conventional productivity indexes.

Capacity Utilisation, Productivity and Efficiency of Food Firms

Holger Thiele (*University of Kiel*)

This paper tests the capacity and competition idea of the industrial economic literature by looking at the relationship between productivity, efficiency, and capacity utilisation in a sample of twenty-eight food product industries. It is tested whether the rate of capacity utilisation negatively or positively effect the efficiency and productivity change over time. A non-parametric Malmquist total factor productivity index is solved in the first-stage analysis involving traditional inputs and outputs. In the second stage, technical efficiency change growth, technological change and productivity change are regressed upon capacity utilisation and other environmental variables applying a dynamic panel data regression analysis which allows to estimate fixed and random effect models. The influence of the rate of economic capacity utilisation of the capital stock on the rate of efficiency and productivity growth is assessed for 28 branches of the highly concentrated food industry sector in Germany. First preliminary empirical results suggest that capital in this sector has been underutilised in many branches throughout 1976-94 and underutilisation positively effect the productivity and efficiency change.

Productivity and Aggregation in U.S. Dairy Products Sector

Pinar Celikkol, Spiro Stefanou *(Pennsylvania State University)*

A model is developed presenting a theoretically consistent methodology in measuring total factor productivity growth at plant-level and analyzes the multifactor bias of technical change in the Dairy Products Industry from 1972 through 1995. In the TFP growth decomposition, analyzing the growth and its components according to the quartile ranks show that scale effect is the most significant element of TFP growth except for the plants in the 75% quartile rank where technical change dominates for the time periods 1976-1995. Throughout the time period, exogenous input bias results show that technical change is 1) capital using and declining; 2) material saving and increasing; 3) alternating direction of bias the labor input for five-year time periods; and, 4) energy saving and increasing after 1980. One of this study's findings confirms is that there is not a significant productivity change during the time period 1973-1995 when we remove the product diversity via four-digit industry effects and separate the time effect.

TUESDAY
15:45 - 17:00 SESSION 1-B: *Outliers in DEA*

Nonparametric Frontier Estimation: A Robust Approach

Catherine Cazals, Jean-Pierre Florens (*Université de Toulouse I*)
Leopold Simar (*Université Catholique de Louvain*)

Most nonparametric methods for estimating production frontiers (DEA/FDH) are based on envelopment techniques. Statistical inference based on these estimators is available but, by construction, they are very sensitive to extreme values or outliers. We propose a nonparametric estimator, which is more robust to these extreme values. It is based on a concept of expected minimum input function (or expected maximal output function). We show how this function is related to the efficient frontier itself. The resulting estimator is related to the FDH estimator but it will not envelop all the data. The asymptotic theory is provided. Our approach includes the multiple input and multiple output cases.

Super Efficiency Evaluations Based on Potencial Slack

Peter Bogetoft (*Royal Agricultural University)*
Jens Hougaard (*University of Copenhagen)*

Super efficiency evaluations are introduced along the lines of the potential improvements approach in Bogetoft and Hougaard (1999). Both a reference selection and a related super efficiency index is defined. The new (potential slack) super efficiency index is compared to a Farrell-beased super efficiency index (as in Andersen and Petersen (1993) with respect to convex envelopment technologies.

Some General Techniques for the Detection of Influential Observations in DEA

Jesús Pastor, José Luis Ruiz, Inmaculada Sirvent (*Universidad Miguel Hernández*)

We discuss here some general ideas that may be used to design several techniques for detecting influential observations in DEA models. This general approach will lead to different influence measures depending on whether we use radial or non-radial models, both oriented and non-oriented, for the efficiency evaluation. These influence measures are intended to assess the influence of given DMU in the sample on the efficiency of each of the remaining units. Eventually, the units detected as influential, on the basis of the observed values of their corresponding influence measures, will be classified for a further investigation. Then, the analyst will have to decide whether they are contaminated by errors or not and, consequently, whether they should be removed from the sample or not. It should be pointed out that influential observations may provide some useful information that may be of interest for the remaining units.

TUESDAY
15:45 - 17:00 SESSION 1-C: *Regulated Sectors*

Efficiency Gains from Port Reform in Mexico. The Potential for Yardstick Competition

Antonio Estache (*World Bank Institute and ECARES*)
Marianela González, Lourdes Trujillo (*Universidad de Las Palmas de Gran Canaria*)

This paper shows how relatively standard methodologies can help measure the efficiency gains from reform in the organization of ports infrastructures. It also shows how these measures can be used to promote competition between ports and be built-in incentive driven regulation. The illustration is based on a study of the effects of the 1993 Port reform in Mexico and is the first efficiency analysis of port restructuring in a developing country. It covers the 1996-1999 period and relies on a stochastic production frontier. It shows that, overall, Mexico has achieved 6-8% annual efficiency gains in the use of ports infrastructure since assigning their management to independent decentralized operators. The evolution of the relative performance rating is also quite revealing as it identifies consistent sets of leaders and laggards, including some which would not have been identified by partial productivity indicators commonly used in the sector. This information could be built into an explicit incentive based regulatory regime aiming at promoting catch-up by laggards.

Regulation and Over-Capitalisation in Spanish Ports

Jose Baños (*Universidad de Oviedo*)

Spanish ports have been placed under regulation in recent years. This industry, which is regulated, not allowed earning a higher rate of return than the regulated level. As theoretically shown by Averch and Johnson (1962), a firm subject to such a regulated rate of return will inefficiently overcapitalise. Then, the main objective of this paper is to see whether overcapitalisation has occurred in Spanish ports. To do this, we introduce significant differences in the Spann (1974) model, which we have used as reference. More specifically, the procedure followed has consisted of estimating a system of equations, formed by a translog production function and the associated share equations for each input, assuming that overcapitalisation may be possible and keeping in mind a price-fixing competition model among ports. The sample covers annual panel data of 27 Spanish ports from 1986 to 1997. The results suggest that the Spanish ports significantly overcapitalise as expected by the Averch-Johnson model.

Deregulation, Markups and Productivity Change: The Case of Spanish Banks

Subal Kumbhakar (*State University of New York at Binghamton*)
Ana Lozano (*Universidad de Málaga*)

Previous research on bank deregulation mostly focused on either the performance of banks or bank behavior with the evolution of deregulation. In contrast, this paper focuses on deregulation, performance and pricing behavior of banks using a unified approach. In doing so we accommodate the effects of different types of deregulation on productivity, technical change and markup in output prices. We measure total factor productivity (TFP) growth in such way that it avoids the discrepancy found in the literature between the nonparametric (the Divisia) and the parametric measures of TFP change, irrespective of the functional form chosen to represent the production technology. For this we use the definition of productivity growth as an additional equation in estimating the dual multiple output translog cost function. Empirically, we use panel data (1986-1998) on Spanish savings and commercial banks, which went through several deregulatory changes (both at the national and international level) taking place at different points in time. This gave us a unique opportunity to examine whether deregulatory experiences of savings banks were different from those of commercial banks.

TUESDAY
15:45 - 17:00 SESSION 1-D: *Malmquist Index*

Luenberger and Malmquist Productivity Indexes: A Theoretical and Empirical Comparison
Jean-Philippe Boussemart *(GREMARS, Université Catholique de Lille)*
Walter Briec (*University of Perpignan*)
Jean-Christophe Poutineau (*CERESUR, University of La Reunion*)
Kristiaan Kerstens (*Université Catholique de Lille*)

This contribution establishes, from a theoretical viewpoint, the relations between the Malmquist productivity indices, that measure in either input or output orientations, and the Luenberger productivity indices, that can simultaneously contract inputs and expands outputs, but that can also measure in either input or output orientations. The main result is that a Malmquist productivity index overestimates productivity changes, since it provides productivity measures that are nearly twice those given by the Luenberger productivity index looking for simultaneous contractions of inputs and expansions of outputs. This relationship is empirically illustrated using data from 20 OECD countries over the 1974-1997 period.

Measure of Innovation and Diffusion of Technology in the United States
Shawna Grosskopf (*Oregon State University*)
Lori Taylor (*Federal Reserve Bank of Dallas*)
Kathy Hayes (*Southern Methodist University*)

The question of the impact of public capital on technology and productivity has been discussed frequently in the literature. This paper offers multiple innovations in the measurement of TFP in the United States. First, we have refined the standard data on public and private capital stocks to better reflect year-to-year variations, and to generate new estimates of the private capital stock in technology sensitive industries such as electronics. Second we use the Malmquist productivity indexes to measure productivity growth. Our strategy allows us to decompose productivity growth into a measure of innovation and a measure of diffusion. Finally, we use our measures of innovation and diffusion to examine spillovers and agglomeration effects among industries, and to examine in detail the impacts on innovation and diffusion of the full array of fiscal policy instruments (taxes, public services and public capital stocks).

On an Extended Decomposition of the Malmquist Productivity Index
Subhash Ray *(University of Connecticut)*

In two recent papers, Wheelock and Wilson (WW) (1999) and Zofio and Lovell (1999) introduce an extended 4-factor decomposition of the Malmquist productivity index. Although the new decomposition is algebraically the same in both WW and ZL, the authors interpret the fourth factor in quite different ways. WW call the fourth factor *the change in the scale of the technology* ($\Delta\, ScaleTech$) and claim that 'any changes indicated by $\Delta ScaleTech$ can only be due to changes in the shape of the technology, since the reference points are fixed'. In the ZL decomposition the fourth component, ΔTS, measures what they call *scale bias of technical change*. Further, they argue that 'if ΔTS equals unity, technical change is neutral with respect to scale because it has not altered the technically optimal scale'. This paper takes a closer look at the new decomposition and examines the validity of the various claims made by the authors about the new factor in their extended decomposition

TUESDAY
SPECIAL SESSIONS: CLASSICAL FIELDS OF APPLICATION

17:30 - 19:30 SESSION 2-A: *Banking*

Bank Efficiency and Economic Growth: The Case of ASEAN
Gary Ferrier (*University of Arkansas*)

The underlying relationship between an economy's financial system and its overall economic growth has long been discussed in the economics literature. Previous empirical literature on the topic has focused on the 'size' of the financial sector and its link to economic growth. This paper uses an endogenous growth model to link the 'efficiency' of the financial sector to overall economic growth. This link is examined empirically by measuring the efficiency of national banking systems in ASEAN and using the efficiency scores as one explanatory variable in a reduced form growth model. A positive, statistically significant link between bank performance and economic growth is found.

Inefficient Banks or Inefficient Assets?
Emili Tortosa *(Universitat Jaume I)*

Policies to promote competition, such as deregulation and liberalization, have been implemented in most Western European banking industries. However, efficiency gains have been minor. This study shows that conclusions may vary if both the dynamic nature of inefficiency and the structure of the banking industry---which differ greatly from one country to another---are controlled for. In particular, the accurate analysis of the entire distributions of efficiency scores shows that notable changes in firms' relative positions exist over the sample period (1985--97), and that when the particular structure of the Spanish banking system where few very large institutions dominate---is considered, inefficiency decreases substantially.

Efficiency Analysis of Italian Banks: A Comparison of Error Decomposition Techniques
Davide Pettenuzzo *(Bocconi University)*
Federico Perali (*University of Verona*)

The paper uses data about the Italian banking sector to compare different decomposition techniques while controlling for heterogeneity. Our modeling strategy first chooses the best technique to incorporate heterogeneity to ensure that the measurement of inefficiency does not include differences in bank characteristics. We then contrast the approach of estimating allocative efficiency by adding structure to the error term against the approach which uses price variation. The latter method is an extension of the price scaling modifying technique used in demand analysis. The comparison shows that the choice over the best approach can critically affect the measurement of allocative efficiency.

Bank Mergers in France: An Econometric Analysis Based on Cost and Revenue Subadditivity
Mohamed Chaffai *(Université de Sfax)*
Michel Dietsch (*Université Robert Schuman de Strasbou*)
V. Oung (*Commission Bancaire*)

In this paper, we will extend the concept of cost subadditivity to the revenue case. We will compare both the cost advantage for pairs of banks, which will merge their activities, and the revenues obtained after merging. We estimate a cost and a revenue function for the French banks, the sample used is a panel data 1993-1999; in that period we observe a real consolidation of the financial institutions in France. As a matter of fact, our sample is suitable to extrapolate the revenue or the cost function, keeping in mind that the methodology we use needs to extrapolate the cost and the revenue functions, so in the sample, we need observations on real cases of banks which have merged their activities. Our first result shows that there exist opportunities for decreasing costs by merging in the French banking industry over the period studied. We also observe that on average, cost advantages have slightly increased over the period. The second result obtained shows that merging activities could be profitable in terms of revenue too. These results are very stable in that period.

TUESDAY
SPECIAL SESSIONS: CLASSICAL FIELDS OF APPLICATION

17:30 - 19:30 SESSION 2-B: *Health*

Doing Better by Doing Worse: Efficiency Dynamics in the National Institute of Health
Kingsley Haynes, Stephane Philogene, Mustafa Dinc, Roger Stough (*George Mason University*)

This paper investigates the relative efficiency of the General Clinical Research Centers (GCRC) of the U.S. National Institutes of Health by using a multiperiod DEA. These Centers are located through out the US to stimulate clinically based medical research. We assess their relative efficiency for different periods, and use a modified regression approach to evaluate regional, environmental and situational variables not captured in the DEA. We also use the Malmquist efficiency index to diagnosis the character of inefficiency. We find a decaying frontier but a generally improving efficiency pattern. This leads to some difficulty in developing appropriate policy recommendations.

Efficiency in Performing Laparoscopic Cholecystectomy:Evidence from Massachusetts Hospitals
Suthathip Yaisawarng, Shelton Schmidt (*Union College*)

This paper assesses the success of the laparoscopic surgical procedure in treating patients with symptomatic gallbladder disease. The data set, constructed from approximately 4,800 patient records in 1999, represents 66 hospitals in Massachusetts. Data Envelopment Analysis (DEA) is used to measure hospitals' efficiency in transforming the pre-existing conditions of an average patient with specific risk factors into desirable outputs, e.g., a shorter length of stay, a lower rate of major complications, and a lower readmission rate. The efficiency results will be related with treatment costs and other hospital characteristics to identify hospitals that provide the best possible care for patients.

On the Impact of Ownership Structure and Hospital Efficiency in Italy
Gian Paolo Barbetta, Gilberto Turati (*Universita' Cattolica S. Cuore*)
Angelo Zago (*University of Verona*)

In the paper we propose to evaluate the efficiency of hospitals in Italy. We compare parametric and non-parametric methodologies and evaluate the impact of ownership structure on efficiency. In the first stage, we measure the efficiency using DEA and COLS. We model the technology using a distance function approach. For the Data Envelopment Analysis we use an output orientation approach since we believe it is more appropriate within a PPS system. For the parametric estimation of the output distance functions we specify a translog functional form. The comparison of the two alternative methods allows us to assess the robustness of the results to the estimation methodologies. In the second stage, we evaluate the impact of the ownership structure and other policy variables using a second stage regression, OLS or Tobit. We also use other methodologies to check the impact of policy variables and the robustness of results.

DEA-based Incentive Regimes in Health-care Provision
Per Agrell (*Université Catholique de Louvain*)
Peter Bogetoft (*Royal Agricultural University*)

Analyzing the strengths and weaknesses of using Data Envelopment Analysis (DEA) in the design of activity based reimbursement schemes, we argue that health care provision constitutes a good area of application. First, the uncertainty of the underlying activity is primarily structural, while data quality is acceptable. Second, the management of the health care sector is hampered by the presence of conflicts of interest among stakeholders. Both characteristics are convincingly addressed by the DEA regimes, allowing a flexible production function and minimal assumptions on preference weights. Finally, a non-technical review of the basic properties of DEA and the basic results linking DEA to the contracting and regulation theories is provided.

TUESDAY
SPECIAL SESSIONS: CLASSICAL FIELDS OF APPLICATION

17:30 - 19:30 SESSION 2-C: *Agriculture*

A Meta-Analysis of Technical Efficiency in Farming: A Multi-Country Perspective
Boris Bravo-Ureta, Teodoro Rivas, Abdourahmane Thiam (*University of Connecticut*)

A meta-analysis of 126 technical efficiency (TE) studies on the agricultural sector of developing and developed countries was undertaken. The results suggest that stochastic frontier models generate higher mean technical efficiency estimates than deterministic models, while parametric frontier models yield lower estimates than non-parametric. The difference between parametric and non-parametric frontiers is reduced when the translog specification is used. In addition, frontier models using cross-sectional data produce lower estimates than those based on panel data. The results also suggest that low-income countries present a lower mean TE than high-income countries. A more detailed analysis reveals that Western European countries and Australia present, on average, the highest levels of mean TE among all regions after accounting for some methodological features of the studies. Eastern European countries exhibit the lowest estimate followed by Asian and African countries, while studies from Latin America and Caribbean countries, and from North American countries are in an intermediate position.

Evaluating the Performance of EU Agriculture 1974-1991:A Parametric Input Distance Function
Giannis Karagiannis (*University of Ioannina)*
Christos Pantzios *(University of Patras)*

Parametric and non-parametric estimates of an output-oriented Malmquist productivity index, as well as its components (i.e., technical efficiency changes, scale efficiency changes, neutral technical change and biased technical change) are compared and contrasted using panel data on 10 E.U. member-states agricultural sector over the period 1974-1991. The technical inefficiency effect model and a translog specification are used to obtain parametric estimates of Malmquist productivity index within a stochastic frontier approach. On the other hand, DEA is used within the deterministic and non-parametric approach.

A Nonparametric Approach to Measuring Cost Efficiency of Dairy Farms in Japan
Yasutaka Yamamoto *(Hokkaido University)*

The purpose of this paper is to analyze the cost efficiency of dairy farms in Japan. The overall cost efficiency measure is decomposed into two components (Fare and Grosskopf, 1985): (1) the weak cost efficiency measure; (2) the scale efficiency measure. Linear programming techniques are used in calculating the efficiency measures for a sample of dairy farms in Japan during the year 1989. The study demonstrates an overall cost inefficiency, which is not due to scale inefficiency, but rather to weak cost inefficiency.

Policy Reform and Productivity Change in Chinese Agriculture: A Distance Function Approach
Bernhard Brümmer, Thomas Glauben (*Christian-Albrechts-Universität Kiel*)
Wencong Lu (*University of Zhejiang, Hangzhou, China*)

Agricultural policy reform has been an important source of change in the Chinese agricultural sector. The reforms led to productivity growth and helped China in pursuing its self-sufficiency goal especially in the grain sector. To analyse whether observable productivity growth stems from technologically induced components, or from the market induced parts, a multi-input-multi-output model is derived using an econometric distance function framework. A decomposition allows to distinguish allocative effects, scale effects, technological change, and technical efficiency change. Data on farms in Zhejiang from 1985 to 1999 are used to analyse the impact of policy reform.

TUESDAY
SPECIAL SESSIONS: CLASSICAL FIELDS OF APPLICATION

17:30 - 19:30 SESSION 2-D: *Public Sector*

Productivity Growth in Public Libraries: Role of Deregulation and Socio-Economic Variables
Bruno De Borger *(University of Antwerp)*
René Goudriaan (*Erasmus University Rotterdam*)
Kristiaan Kerstens (*Université Catholique de Lille*)
Philippe Vanden Eeckaut (*Université Catholique de Louvain*)

The present paper assesses the impact of decentralization on local government performance by studying the case of municipal public libraries in the Netherlands. Our research extends the previous literature on public library performance in at least three ways: a) We avoid the controversial behavioral assumptions embedded in previous studies, such as cost minimization with exogenous outputs. b) We use panel data instead of cross-section data. Performance is gauged using recently developed nonparametric Luenberger productivity indices. c) We study whether changes in performance over time -both frontier shifts and changes in efficiency- are related to developments of population characteristics in the service areas as well as the changing regulatory environment. We use a unique homogeneous panel data set of large municipal public libraries in the Netherlands, covering the period 1979-1999.

Cost Efficiency Frontier Evaluation. An Application to Catalan Councils
Víctor Jiménez, Diego Prior *(Universitat Autonoma de Barcelona)*

This paper introduces a new model that analyses the efficiency in total cost, providing the excess of costs that separates all inefficient production units from their potential levels on the frontier. Additionally, it offers the relative importance of four specified factors: a) the technical inefficiency, depending on the type of organization, on the quality of the factors or on the behaviour of the human factor b) the composition of the variable factors with their impact on potential costs savings, c) the disposability of fixed factors and their degree of utilization and, finally, d) the scale of operations. Our empirical application applies the proposed model to Catalonian councils. The results confirm the existence of significant variance in costs, taking into account the optimal frontier levels.

Is the TE of a Public Training System Biased by the Presence of "New" Inputs?
Giannis Karagiannis (*University of Iannina*)
Thanasis Karalis, Christos Pantzios, Konstantinos Tsekouras (*University of Patras*)

For the last two decades, the Greek state has been operating a training system for the public that offers free courses on skill improvement to trainees selected on various social criteria. In 1996 the state reduced national funding to the 52 Prefectural Training Offices (PTO) of this system forcing them to competitively seek EU funding. The present paper examines the hypothesis that this reduction affected positively the PTO's technical efficiency. A translog input distance function is used to compute PTO efficiency scores for the 1989-1999. EU funding is treated as a "new" input and it is econometrically handled with a technique introduced by Battese (1997). In this context, significant changes in technical efficiency scores would justify the public policy of national funding reduction. In the opposite case, national funding reduction *per se* may not be sufficient in improving technical efficiency.

Assessing the Efficiency of Non-Profit Organizations: A Comparative Analysis
Sergio Destefanis (*Università di Salerno*)
Ornella Maietta (*Universitá di Napoli Federico II*)

Empirical evidence on the efficiency of non-profit organisations is at present scarce and far from conclusive. In the present work, we analyse this issue by relying on a new data-set about Italian for-profit and non-profit organisations engaged in the provision of merit goods. While most of the existing evidence relates to health-care organisations only, our data-set also surveys organisations involved in other personal services. The results indicate that the efficiency of non-profit organisations does not significantly differ from that of other organisations.

WEDNESDAY
9:00 - 10:15 SESSION 3-A: *Efficiency in Higher Education*

A Stochastic Distance Function for Measuring the Trade-Off Between Teaching and Research

Alfredo Moreno, David Trillo (*Universidad Rey Juan Carlos)*

Shepard's distance function (1970) has been used to calculate efficiency levels of several different decision-making units in a scenario of multiple inputs and outputs. With the data envelopment analysis we may directly include the above-mentioned concept, but this model does not allow for an analysis of causality between variables. On the other hand, parametric models can be used to study this causality; however, it is difficult to include multiple inputs or outputs as a dependent variable. Parametric distance functions can be employed to solve this problem. In this paper, and basing our study on Fare et al. (1993) and Coelli y Perelman (1996), we study the relationships between indicators of quality research and teaching activities in the departments at the Polytechnical University of Catalonia, a university which has initiated a process of strategic planning which links objectives and budget allocation. Making use of a stochastic panel data model, we shall calculate the derivatives of the adjusted function in relation to each of the inputs and outputs, and in the case of the latter, we shall analyze whether they are substitutive or complementary. In addition, a sensitivity analysis of the model to different specifications of efficiency evolution over time will be carried out. This analysis aims to demonstrate if the university's strategic planning has produced positive or negative effects in department management.

Identifying Good Practice in Central Administrative Services in U.K. Universities

Barbara Casu, Emmanuel Thanassoulis *(Aston University)*

This paper describes an attempt to identify good management practices in UK university central administration. The funding councils of UK universities have progressively evolved elaborate systems for measuring university performance in teaching quality and research. Indeed, funding of universities is linked to their performance in research. The allocation of resources between academic and administrative activities, on the other hand, has so far not been subject to scrutiny. Yet, expenditure on administration is typically some 30% of that allocated to academic activities. This paper sets up a DEA framework to identify practices leading to cost-efficient central administrative services in UK universities. The problems in defining the unit of assessment and the relationship between the inputs and the outputs are clearly demonstrated.

Efficiency in Swedish Public Education

Staffan Waldo (*Lund University*)

The provision of education by public schools is often criticized for an inefficient use of resources. Using Data Envelopment Analysis (DEA) we estimate efficiency in secondary schools and analyse the influence on efficiency from two often discussed issues: competition from private schools and teacher characteristics. A production model with the student as the primary input is developed. Efficiency is estimated for 851 of Sweden's approximately 1000 secondary schools in 1994/95. The results imply that the schools can use 7-17% less resources on average, still achieving the same results. In the paper the influence on efficiency from teacher characteristics and private school competition is studied in a Tobit regression model. Our primary findings are that competition from private schools has a positive influence on the efficiency in public education and that the teacher characteristics do not significantly explain any efficiency differences.

WEDNESDAY
9:00 - 10:15 SESSION 3-B: *Health I*

How Much Confidence Should we Place in the Results of Efficiency Analysis?

Andrew Street *(University of York, Universidad Autonoma de Barcelona)*

Relative performance evaluation has been suggested as a means to overcome information asymmetry between regulators and organisations when assessing efficiency. By comparing similar organisations the relationship between costs and effort can be better isolated. The English Department of Health has undertaken relative performance evaluation in comparing the unit costs of acute hospitals using ordinary least squares (OLS) methods. After adjusting for exogenous influences in costs, residual unexplained cost differences are deemed to represent inefficiency. This paper questions the econometric model and official interpretation of the OLS residuals. The OLS model is re-estimated as a stochastic cost frontier. Confidence intervals are calculated around the inefficiency component of the residuals. It is concluded that the English acute hospital sector exhibits less inefficiency than is implied by official estimates and that estimates of relative hospital efficiency are highly sensitive to estimation decisions.

Scale, Efficiency and Organisation in Norwegian Psychiatric Outpatient Clinics for Children

Vidar Halsteinli *(SINTEF Unimed NIS)*
Sverre Kittelsen *(Frisch Centre, Oslo)*
Jon Magnussen *(SINTEF Unimed NIS)*

Norwegian government policy is trying to increase the supply of psychiatric services to children and young persons, in part by reorganising and increasing productivity in the psychiatric outpatient clinics (BUP). While measures of output in mental health care are even harder to find than in other health care activities, some indicators are available. The problem is to select the output variables that best reflect the use of resources, in the sense that these variables have a significant impact on measures of efficiency. The paper analyses cross-sectional data on the psychiatric outpatient clinics of Norway using DEA, and tests the variable specification using statistical tools recently introduced in the literature. The importance of different profession or educational groups on efficiency is examined. The paper finds substantial efficiency potentials and significant diseconomies of scale. The marginal productivity of university educated staff is no higher than that of other staff, indicating a lack of ability to utilise specialised skills.

Efficiency of Homes for the Mentally Disabled in the Netherlands: A Shadow Cost Function Model

Evelien Eggink, Jos Blank *(Social and Cultural Planning Office, Netherlands)*

This paper investigates the efficiency of homes for the mentally disabled in the Netherlands. The model is based on the shadow cost function model, which decomposes cost efficiency into an allocative and a technical component. The allocative efficiency component is modeled by using shadow prices, which make technical efficient homes also allocatively efficient. The technical efficiency component is added linearly to the shadow cost function. The computational problems in the implementation of this model are avoided by using an iterative procedure proposed by Blank and Eggink (2000). This method allows the allocative and technical efficiencies to be both home and time varying. In this paper we introduce environmental characteristics into the model, in such a way that they may affect both minimum costs and the efficiency of the homes. In addition, we measure technical change by adding time-specific dummy variables rather than trend variables to the minimum cost function. The empirical analyses are conducted on a panel data set of homes for the mentally disabled containing about 100 homes for each year in the time period 1984-1998.

WEDNESDAY
9:00 - 10:15 SESSION 3-C: *Agriculture*

Efficiency of the Small New York Dairy Farms

Loren Tauer *(Cornell University)*

Many believe that small dairy farms cannot survive because costs of production per unit of milk are thought to be higher than the cost of production on larger farms. Dairy farm business records in New York show that smaller dairy farms do have higher average costs of production. However, modeling cost of production as a frontier cost function and a separate efficiency component, using 1999 data from a group of 314 New York, showed that most of the empirical high cost observed on many small dairy farms is due to inefficiency. The frontier cost of production for a 50-cow farm was $13.61 per hundred pounds (45.5 kg) or $0.299 per kg, only slightly over 4% more than costs for a 500-cow farm ($13.03 per hundred pounds or $0.287 per kg). The implication is that the efficient small dairy farm can compete with the efficient large dairy farm.

Technical Inefficiency of Milk Production and Udder Related Diseases in Danish Dairy Herds

Lartey Lawson, Jens Agger (*The Royal Veterinary and Agricultural University*)
Mogens Lund (*Danish Institute of Agricultural and Fisheries Economics*)

Recent structural development suggests that the survival of a Danish dairy herd is dependent on the efficiency of the production unit. Efficiency measures of dairy farm performance and the impacts of specific management factors are well known in economic literature studies. However, none of the studies evaluated the impact of reported production diseases as management related. This study investigated the relationship between technical inefficiency and udder related production diseases using the stochastic frontier production function estimation method. Data from a representative random sample of 589 dairy farms in 1996 on production variables (eg. Milk and feed) and reported treatment cases of mastitis, udder lesions, dry cow treatment and the number of bulk-tank somatic cell counts of above 400,000 cells per ml of milk deliveries were used. The results indicated a relationship between technical inefficiency and udder related production diseases which tend to be in line with other studies within veterinary epidemiology.

Dairy Farming in Iceland: Do Quota Transactions Increase Efficiency?

Sveinn Agnarsson *(University of Iceland)*

Milk production in Iceland takes mostly place on specialised dairy farms, with each farm being allocated a certain production quota each year. Since 1992 these quotas have been transferable between farmers, and in this paper we analyse how farmers reacted to these changes by measuring the development of efficiency in 1993-1999 for 54 dairy farms. In particular, a stochastic frontier Cobb-Douglas production function is estimated, where technical efficiency is assumed to be a function of several variables including quota transactions and a time trend. Although some of these variables are found to be statistically significant, quota transactions do not appear to have affected efficiency significantly. However, this could be due to the short time that has elapsed since the quota transactions took place, as the farmers may not reap the benefits of the increased quota holdings immediately.

WEDNESDAY
9:00 - 10:15 SESSION 3-D: *Financial Markets*

Technological Developments and Concentration of Stock Exchanges in Europe
Heiko Schmiedel *(Hamburg Institute of International Economics)*

The paper deals with an empirical analysis of the existence, extent and explanation of technical inefficiencies among financial exchanges in Europe. This paper employs a single-stage stochastic cost frontier model to obtain exchange inefficiency scores based on a unique unbalanced panel data set for all major European exchanges during the years 1985-1999. Cost efficiency estimates indicate high-level deviations from the efficient benchmark. The results affirm that reorganisations in exchange government structure, diversification in trading service activities and adoption of automated trading systems influence significantly the efficient provision of trading services in Europe. Over the sample period, European exchanges improved considerably their ability to manage output and input resources more efficiently.

Economic Efficiency and Value Maximization in Banking Firms
Ana Isabel Fernández, Fernando Gascón, Eduardo González (*Universidad de Oviedo*)

The objective of this paper is to study economic efficiency in 142 financial intermediaries of twenty countries over the 1989-1998 period and the relationship between efficiency, productivity change and shareholders wealth maximization. A non-parametric frontier analysis (DEA) is applied to estimate the relative efficiency of commercial banks of different geographical areas. Then, a Malmquist decomposition is carried out in order to separate efficiency change from technical change. We evaluate the relationship between economic efficiency and wealth maximization and we identify the characteristics of financial intermediaries that lead to an optimal use of resources. Results show different productivity patterns among the three geographical areas (North America, Japan and Europe) over the sample period. The estimates of economic efficiency and productivity changes are consistent with the wealth maximization criterion in financial intermediaries.

Portfolio Performance Evaluation in Mean-Variance Skewness Framework
Tarja Joro *(University of Alberta)*
Paul Na *(Bayerische Landesbank, New York Branch)*

Astronomical amounts of money are being invested in financial markets. Consequently the evaluation of portfolio performance has created a great deal of interest among practitioners as well as academic researchers. The literature suggests that portfolio efficiency based on mean-variance-skewness is more desirable than the one based on mean-variance. However, there are no well-established procedures to measure efficiency in this framework, mainly due to the computational difficulties. The aim of this paper is to develop a portfolio performance measure based on mean-variance-skewness framework by utilizing Data Envelopment Analysis. The distinguishing feature of our model is that it forms a nonlinear (nonconvex) efficient frontier, whereas traditional Data Envelopment Analysis is a linear model where the efficient frontier is a linear of convex combination of the efficient units. The efficient frontier generated from our approach coincides with the true mean-variance-skewness efficient frontier and thus our model takes into account the portfolio effect.

WEDNESDAY
10:45 - 12:00 SESSION 4-A: *Distance Functions*

Generalized Distance Functions and Technical Efficiency: A Parametric Approach

Rafael Cuesta (*Universidad de Oviedo, CajAstur*)
Subal Kumbhakar (*State University of New York at Binghamton*)
José Luis Zofío (*Universidad Autónoma de Madrid*)

Distance functions are gaining relevance as alternative representations of production technologies. Different techniques, non parametric-DEA and parametric-SFA, have been used in order to calculate such functions but in the latest case no study is known to have relaxed the restrictive input or output orientation. What we propose is to relax such partial dimensionality by defining and estimating a graph parametric distance functions based on a global -input and output- representation of the technology. In order to show their potential in efficiency analysis we introduce a Generalized Distance Function in its translog form. We show how this function complements the standard analysis and we demonstrate that the Output Distance Function and the Hyperbolic Distance Function are nested in this new specification. An empirical application using the International Sectoral Data Base published by the ODCE is included.

Rent-Seeking Measurement by Means of Labour Unrest: A Distance Function Approach

Ana Rodríguez, Ignacio del Rosal (*Universidad de Oviedo*)

The purpose of this work is to discuss an empirical method to estimate the social cost originated by the rent seeking behaviour in declining industries. Due to competition from imports, the factors of one particular industry undergo losses in real income, and have incentives to seek protection. In the case of declining industries, workers play a central role and the losses in output due to strikes are used to quantify the social cost of rent seeking. In our model, strikes are considered as an undesirable intermediate input into the production process. By using an input distance function to model technology we need to assume only weak disposability of inputs, which is especially useful for our objectives. This approach is applied to the case of Spanish coal mining. We have estimated a system of equations formed by the input distance function and cost shares using annual data over the period 1974-1997. Using this procedure we have calculated the cost that strikes impose on the sector.

Aggregation of Directional Distance Functions and Industrial Efficiency

Walter Briec (*University of Perpignan*)
Benoit Dervaux, Hervé Leleu (*Université Catholique de Lille / CNRS*)

Consistent aggregation of individual economic relations into macro relations has a long history in economics. The problem of aggregation has been studied in various fields such as consumption, production or investment. Four our concern, it is also crucial in the field of efficiency measurement ofproduction units. Three main objectives are pursued in this paper. First, we intend to analyze the aggregation problem of directional distance functions from constructive viewpoint. We provide necessary and sufficient conditions concerning the structural properties of the production technology and the nature of groups of firms. Indeed, exact aggregation holds for a linear technology and for a direction solely defined in the output space. Second, since these conditions are somewhat restrictive, we are interested to provide a measure for the aggregation bias through the relationship between industrial and structural technical efficiency. Finally, we show that this aggregation bias is a lower bound for industrial allocative efficiency.

WEDNESDAY
10:45 - 12:00 SESSION 4-B: ***Advances in Productivity***

Productivity? of U.S. Airlines after Deregulation
Rolf Färe, Shawna Grosskopf (*Oregon State University*)
Robin Sickles (*Rice University*)

In this paper we employ an alternative measure of TFP based on a generalization of the Shephard distance functions to analyze TFP growth in the U. S. airline industry since deregulation wherein an index of circuity and timliness are used to proxy the nonfreedisposable and undesirable outputs of airline travel. Inputs are specified as labor, energy, materials, long and short haul flying capital; characteristics of capital equipment such as the average size of the planes in the fleet, average age of the fleet, and a fuel efficiency index; characteristics of the system network as measured by average stage length of the carrier's flights and system load factor. The two 'good' outputs are scheduled and nonscheduled revenue passenger miles. Our findings confirm anecdotal accounts of a decline in service since deregulation, yielding in general lower rates of productivity growth in our sample when bads such as indirect routing and delays are explicitly introduced into the technology.

Measuring Productivity and Growth within a Broader Concept of Development using DEA
Bernhard Mahlberg (*Vienna University)*
Michael Obersteiner (*Institute for Advanced Studies, Austria)*

In this paper we empirically try to estimate productivity and growth of the world's economies by selected indicators measuring sustainability, equity, and the state of democratic rights and civil liberties. We use models from the Data Envelopment Analysis (DEA) literature to compare productivity levels in a multiple output setting. This productivity level can then be interpreted as a new human development indicator. In fact, in one I/O relation we re-estimate with the method of the DEA the human development index by using the indicators that define the index. Country clusters that are similar to each other in their transformational pattern are identified, while also interesting outliers can be singled out. Such outliers are either frontier societies or countries that are locked in an underdevelopment trap. Finally, we discuss the key principles of a development strategy that are based on broader criteria and indicators on the transformation of societies.

The 'Appropriate Technology' Explanation of Productivity Growth: An Empirical Approach
Bart Los, Marcel Timmer *(University of Groningen)*

In the Basu and Weil (1998) model of economic growth, productivity divergence in the world economy is driven by localised innovation and differences in the speed of technology upgrading. Using panel data from the Penn World Tables in a data envelopment analysis, this paper testifies to the empirical relevance of these forces. Labour productivity growth is decomposed into growth due to innovation, catch up to the frontier and technology upgrading. Innovation appears to take place mainly at high levels of capital intensity. Global convergence is driven by processes of technological upgrading, but many less advanced countries failed to move up the technology ladder. They seem to be stuck at low technology levels with little potential for further growth by means of spillovers.

WEDNESDAY
10:45 - 12:00 SESSION 4-C: *SFA Applications*

The Matching Efficiency of Regional Labour Markets: A Stochastic Production Frontier Model

Aomar Ibourk *(Université de Marrakech)*
Bénédicte Maillard *(Université Catholique de Lille)*
Sergio Perelman *(University of Liege)*
Henri Sneessens (*Université Catholique de Louvain*)

We evaluate the determinants of matching efficiency changes through a stochastic Cobb-Douglas production frontier model extended to allow the efficiency coefficient to depend on variables meant to capture workers and firms characteristics. We apply this methodology to examine regional disparities in France over the period 1990-1995. About half of the efficiency changes observed both over time and across regions can be explained in terms of changes in firms and workers characteristics. Regional differences in matching efficiency are fairly stable over time and negatively correlated to the regional unemployment rates.

Technological Flexibility and Efficiency in Portuguese Manufacturing Firms using SFA

Ana Faria *(Minho University)*
Paul Fenn, Alistair Bruce (*Nottingham University Business School*)

This paper aims to test whether a given type of process innovation, namely flexible production technologies (FPTs), contributes to increased firm efficiency. Using one-year firm data from Portuguese manufacturing industry and applying a parametric stochastic frontier approach, technical and cost efficiencies are obtained and their determinants estimated, using a single-step procedure recently proposed by Battese and Coelli (1995). The results support the hypothesis that technological heterogeneity is important in explaining differences in efficiency. Furthermore, given the specifications of the stochastic frontier function, the null hypothesis that Portuguese firms are fully technically efficient and cost efficient are rejected. Finally, individual technical and cost efficiency measures are obtained for the entire sample.

One-Step Modelling of Production Frontiers and Determinants of Technical Inefficiency

Hung-Jen Huang, Peter Schmidt (*Michigan State University*)

This paper proposes a class of models that allow one-step estimation of the production frontier and determinants of inefficiency. The paper argues that one-step models should have a scaling property that not all such models in the literature have. Simulation evidence is provided to show how misleading two-step procedures can be.

WEDNESDAY
10:45 - 12:00 SESSION 4-D: *DEA Innovative Applications*

Technical Efficiency Measures and Duration Models in Ivorian Manufacturing Firms

Karine Chapelle (*University of Le Havre*)
Patrick Plane (*University of Auvergne*)

We analyse the Ivorian manufacturing sector by investigating the relationship between firm survival and their technical efficiency as measured by a non parametric DEA model. Efficiency scores are calculated by following the *four-stage procedure* as presented by Fried Schmidt and Yaisawarng (1999). In other words the initial DEA scores are adjusted to take into account the impact of the external operating environment on the input use. Technical efficiency scores are then decomposed into three elements: the pure managerial effect, the impact of the scale and the technological effect. The respective influence of these elements is then tested in duration models. The empirical analysis suggests that technological as well as the pure managerial components play a significant role on firm survival This influence complement the indirect measure of inefficiency as proxied by the more traditional measure through the size of organisations.

Output-Specific Efficiency of UK Secondary Schooling

Dieter Gstach (*Vienna University of Economics*)
Andrew Somers (*King Harold School*)
Susanne Warning (*University of Konstanz)*

In the light of an ongoing political debate we quantitatively assess the efficiency of UK secondary, private schools in providing quantity resp. quality of Graduates on a per output basis. To that end a new technique based on the concept of target output-ratios will be introduced, which estimates output-specific efficiencies by integrating Data Envelopment Analysis into a Bayesian estimation framework analyzed via Markov Chain Monte Carlo techniques. The results clearly indicate systematic differentials in schools abilities to cope with the issues of quality resp. quantity, but also that these abilities are positively correlated.

Using DEA and Negative DEA in Credit Risk Evaluation

Mette Asmild, Joseph Paradi, Paul Simak (*University of Toronto*)

This paper suggests the use of the so called Negative DEA approach, to evaluate the risk of bankruptcy. Negative DEA aims at identifying the worst performers in a sample, not just by swapping inputs and outputs, but by defining variables that indicates bad performance. This model formulation is combined with a layering technique, whereby different levels of credit risk are identified. Empirical results show this approach to be a very promising tool in credit risk evaluation.

WEDNESDAY
15:45 - 17:00 SESSION 5-A: *Production Dynamics*

Dynamic Profit Functions: Adjustment Costs, Productivity and Efficiency

Frank Asche *(Stavanger University College)*
Subal Kumbhakar (*State University of New York at Binghamton*)
Ragnar Tveteras (*Stavanger University College)*

It is well known that there are adjustment costs associated with many input factors, delaying the firm's reponse to changes in relative prices. However, although adjustment costs is implicitly acknowledged when cost function specifications is used rather then profit functions, little attentions has been given to adjustment costs for outputs. In this paper we formulate the firms optimization problem as a profit function where there may be adjustment costs for all factors. Form this specification one can test for no adjustment cost, and using reduced rank tests also test for fixedness of factors.

The Dynamics of Capital Structure: Evidence from Swedish Micro and Small Firms

Almas Heshmati (*Stockholm School of Economics)*

Capital structure studies have generally been aimed at studying the determinants of optimal leverage. Empirically, the focus is, however, on studying the association between observed leverage and a set of explanatory variables. This approach has a number of shortcomings. First, the observed leverage deviates from the optimal leverage. Second, the empirical analyses are static. Third, adjustments are non-constant. In this paper, we formulate a dynamic adjustment model. We specify and estimate the unobservable optimal capital structure using observable determinants. The optimal level varies, allowing for deviations of observed leverage from optimal leverage. This model is specified such that the speed of adjustment towards the optimal level is firm- and time-specific. Identification of determinants and estimation of the level of optimal capital structure and speed of adjustment allow for flexible determination and adjustment of the effective level of capital structure. Empirical analysis is based on a large sample of Swedish micro and small firms.

Nonparametric Dynamic Efficiency Analysis

Elvira Silva *(University of Porto)*
Spiro Stefanou (*Pennsylvania State University*)

Dynamic efficiency is analyzed in a nonparametric dual cost framework using DEA and the concept of dynamic input distance function. Nonparametric measures of technical, allocative and scale efficiency are derived for each firm under the hypothesis of differences in technology across observations. These efficiency measures are temporal in nature by describing the degree of efficiency of the firm at a particular point along its adjustment path. The dynamic production efficiency measures are empirically illustrated using a panel data set of Pennsylvania dairy operators. Production efficiency is investigated in the long-run context for each dairy operator during the period 1986-1992. Dynamic efficiency measures are generated for quasi-fixed factors separately and for all factors of production.

WEDNESDAY
15:45 - 17:00 SESSION 5-B: *DEA Applications I*

Selling Picasso Paintings: The Efficiency of Auction Houses

Finn Forsund (*University of Oslo*)
Roberto Zanola (*Università degli Studi del Piemonte Orientale*)

Previous works applying hedonic price technique to determine the formation of auction prices of objects of art have found no conclusive result about the impact of auction houses on final prices. In these studies the object of art has been the unit, and influence of auction houses is analysed by testing whether auction house impact on price is significant or not within a framework of central tendencies. In order to focus on auction houses as a unit we have applied a benchmarking technique, DEA, developed for efficiency studies. Categorical and continuous variables are used as inputs and auction prices as outputs. Performance indicators are defined and calculated giving an insight into auction house differences impossible to obtain using hedonic price approach.

Multi-Stage DEA

Boaz Golany, Ury Passy (*Israel Institute of Technology*)
Steve Hackman (*Georgia Tech*)

We develop a productivity measurement framework for multi-stage systems that simultaneously computes the efficiency of both the aggregate system and each stage within the system. In lieu of applying conventional productivity analysis to each stage separately, our approach enables a more accurate and objective assessment of the relative performance of each stage as well as the whole system. At the heart of our integrated approach lies the more flexible manner in which we model production alternatives via the options of outsourcing, acquiring and transferring resources among stages.

WEDNESDAY
15:45 - 17:00 SESSION 5-C: *Index Numbers*

Problems with (Dis)Aggregating Productivity, and Another Productivity Paradox

Kevin Fox (*University of New South Wales*)

Using a standard definition of productivity growth, a country may be more productive than another in each sector, but may be less productive overall. This observation has significant implications for the aggregation and disaggregation of productivity growth estimates, and the interpretation of productivity convergence studies that have used cross-country sectorial data. In addition, it is shown that an increasingly popular method for aggregating sectorial estimates of productivity growth has a serious problem---it is not invariant to the units of measurement. Hence, published results using this method are essentially arbitrary. An index-number method that avoids these aggregation problems is introduced.

An Economic Approach to Achievement and Improvement Indexes

Osman Zaim (*Bilkent University)*
Rolf Färe, Shawna Grosskopf *(Oregon State University)*

This study proposes a useful alternative to the "aggregate deprivation index" which is used to measure the well-beings of individuals in different countries or geographic locations. Furthermore, we also propose an improvement index which alleviates well known difficulties associated with overtime comparisons of "aggregate deprivation index". While deriving our indexes, we pursued an economic approach to index numbers theory and relied on the assumptions of optimizing behavior. The proposed achievement index has its roots in the theory of quantity indexes whose axiomatic properties are well established. The roots of our improvement index on the other hand, is well grounded in the productivity growth literature. All our measures will depend upon computation of distance functions which are complete characterizations of production technology. The study also provides a numerical example.

Using Divisia Indexes to Decompose Changes in Fuel Intensity in the Spanish Industry

Paula Fernández, Rigoberto Pérez (*Universidad de Oviedo*)

Energy efficiency is usually measured through energy/production ratio, also called aggregate energy intensity. Nevertheless, this ratio is not only influenced by efficiency factors but also by structural ones. Thus, studying energy efficiency evolution and understanding energy demand would involve the decomposition of this ratio. Focused on the Energy Intensity Approach, this paper deals with decomposition of changes in aggregate fuel intensity in the Spanish industry in the period 1979-1992. The scope of the application includes two general parametric Divisia methods and six specific decomposition methods. The obtained results question the contribution of the structural change to substantial reductions in aggregate fuel intensity and defend innovation, development, diffusion and access to more efficient technologies as relevant contributors to energy/production ratio reduction.

WEDNESDAY
15:45 - 17:00 SESSION 5-D: *Comparing Methods*

Cost Efficiency in European Banking: A Comparison of Frontier Techniques

Laurent Weill *(Université Robert Schuman)*

Our aim here is to provide evidence about the consistency of efficiency frontier methods on European banking samples. We measure the cost efficiency of banks from five European countries (France, Germany, Italy, Spain, Switzerland) with three approaches: stochastic frontier approach, distribution-free approach, data envelopment analysis. We compare the means, the correlations, the diagnosis about two public policy issues, and the correlation with standard measures of performance. We broadly conclude in favor of the lack of robustness between approaches, even if there are some similarities in particular between parametric approaches. However we observe the correlation of all efficiency scores with standard cost measures.

Comparing Performance of Efficiency Techniques in Non-Linear Production Functions

Daniel Santín, Aurelia Valiño (*Universidad Complutense de Madrid*)

Non-linear production functions are common in economic theory and in real life, specially in those cases with increasing and diminishing returns to scale but also in contexts where an increase of one input implies a decrease of one output. The aim of this paper is to test how non-linearities affect estimations of technical efficiency measurements obtained by ordinary and corrected least squares, by DEA with constant and variables returns to scale and by multilayer perceptron neural networks with backpropagation (MLP). To do this we construct a very simple non-linear one input-one output production function by using a pseudo-random number generator we obtain different synthetic data with 50, 100, 200 and 300 decision making units (DMUs) with a uniform distribution across the input dimension. Then we allow that the real output computed for each DMU varies adding different amounts of statistical noise in different scenarios. Afterwards we calculate real efficiency with the true production function and this result is compared with the values obtained with the techniques for measuring efficiency named before. The results of this study show how MLP is a more flexible alternative to fit production functions under non-linear contexts and how their results are superior to conventional techniques given that the correlation coefficient of the efficiency rankings obtained are closer to real ones.

Comparing Regression Analysis, DEA and Discriminant Analysis to Measure Overall Performance

Alex Ruiz, Francisco López (*University of Texas*)

Sets of Pareto Efficient Points represent cases where multiple productivity (or efficiency) measures are used to determine overall (relative) performance. This paper compares the results of a performance analysis on Sets of Pareto Efficient Points obtained using different methodologies, including Regression Analysis, Data Envelopment Analysis, and Discriminant Analysis.

WEDNESDAY
SPECIAL SESSIONS: METHODOLOGICAL ISSUES

17:30 - 19:15 SESSION 6-A: *Econometric Issues*

A Second-Stage Approach to Explain Efficiency Differentials in Stochastic Frontier Models
Giannis Karagiannis (*University of Ioannina*)
P. Midmore (*University of Wales)*
Vangelis Tzouvelekas *(University of Crete)*

In this paper it is shown that in some cases the second-stage approach for explaining efficiency differentials is not necessarily inconsistent. This occurs whenever in the second-stage efficiency scores that are calculated but not estimated at the first-stage are used. If an input distance function is used to estimate technical inefficiency at the first stage, the second-stage approach can consistently be used to explain input allocative and scale efficiency differentials using SUR. At the second-stage, parametric restrictions are used to take into account the estimated parameters of the inefficiency effect model at the first stage. These restrictions provide consistency between the two stages.

The Exact Measurement of Allocative Inefficiency: An Application to Ports
Juan José Díaz, Eduardo Martínez (*Universidad de La Laguna*)
Sergio Jara (*Universidad de Chile*)

The relationship between allocative inefficiency and costs used to be modelled in an ad hoc fashion. However, Kumbhakar (1997) found an exact relation between both concepts using a translog cost function, although his model is very difficult to. We follow the approach by Kumbhakar but in a context of a multioutput quadratic cost frontier system. We include statistical noise in input demand equations and we obtain the allocative inefficiency magnitudes, which are input and firm specific. The model is applied to stevedoring operations in Spanish ports for the period 1990-1998.

Econometric Implications of Index Orientation for Technical Efficiency Analysis
Carlos Arias (*Universidad de León*)
Subal Kumbhakar (*State University of New York*)

Theoretical analysis of efficiency indexes is done under the assumption of a known technology. However, in empirical work, the characteristics of the technology and the level of technical efficiency (TE) cannot be estimated independently. We claim that index choice might have critical implications for empirical results. This point has been mainly overlooked by existing empirical literature on efficiency analysis. The effects of TE on production decisions are different depending on index choice. For example, TE affect input ratios if inefficiency is introduced using an output oriented measure of TE. This effect does not exist is inefficiency is introduced using an input oriented measure of technical efficiency.

Measuring Technical Efficiency in Multi-Species Fisheries Using a Primal Approach
Antonio Álvarez, Luis Orea (*Universidad de Oviedo*)

The specificity of fishing activity raises some interesting modelling issues. For example, the literature has commonly accepted that fishing is a multi-output activity. This situation has prompted some researchers to use non-parametric methods that can easily account for several outputs. However, the empirical literature that follows a parametric approach has resorted in some sort of aggregation scheme for the outputs and finally ended up using single-output production models. In this paper we use different primal approaches to model the multi-output fishing technology. In the empirical section we compare the results of the estimation of three models: the single-output production function with aggregate output, the multi-output production function and the distance function.

WEDNESDAY
SPECIAL SESSIONS: METHODOLOGICAL ISSUES

17:30 - 19:15 SESSION 6-B: *Theoretical Issues*

Inada Conditions and The Law of Diminishing Returns
Rolf Färe (*Oregon State University*)
Daniel Primont (*Southern Illinois University*)

Inada (1963) provided properties of the production function that are useful in the study of economic growth. Shephard (1970a) provided an axiomatic approach to the study of production theory. He applied these axioms to give a formal statement of the law of diminishing returns (Shephard, 1970b). In this paper we demonstrate that these two sets of production function properties are fundamentally inconsistent. Thus one is forced to make a choice between the two models when studying productivity and growth.

Stochastic Frontiers and Asymmetric Information Models
Philippe Gagnepain *(Universidad Carlos III de Madrid)*
Marc Ivaldi *(University of Toulouse)*

This article is an attempt to shed light on the specification and identification of production frontiers. We consider the case of a regulated firm or industry. Applying a simple principal-agent framework that accounts for informational asymmetries allows us to derive the associated production and cost frontiers. This approach yields a decomposition of inefficiency into two components: The first one is a pure random term while the second depends on the unobservable actions taken by the agent (the firm). This result provides a theoretical foundation to the usual specification on stochastic frontiers. In this context, the production frontier appears to be overidentified. Then one should prefer estimating cost frontiers that are exactly identified. An application to a panel data set of French urban transport networks serves as an illustration.

Efficiency Evaluation with Convex Pairs
Jorgen Tind *(University of Copenhagen)*

We introduce a new approach to modeling technologies in productivity analysis. The approach uses pairs of associated input and output sets. It allow for different degrees of convexity in the overall production possibility set. Using blocking and antiblocking theory, we also develop the dual representation of the technology applying either non-negative variables or entirely positive variables. We show how this modelling framework contains the classical FDH and BCC models together with a variety of new models. In all cases, the resulting Farrell efficiency programs can be formulated as linear programming problems.

Dynamic Characterization of Allocative Efficiency
Spiro Stefanou (*Pennsylvania State University*)

The notion of efficient allocation of variable and quasi-fixed inputs in the long run can take on criterion based on stock efficiency or temporal efficiency. The inefficient investment decision is defined as a deviation from the marginal cost of adjustment equal to the marginal value of capital. If decisions are always made in the short run with a view to the long run, then efficiency is a temporal issue and not a comparison of trajectories. We then construct both actual and behavioral dynamic value functions, which lend themselves to econometric estimation and indicate how efficiency leads to deviations from long-run optimal decisions. The within and between period costs of allocative inefficiency are identified. Taking this approach allows us to generalize TFP growth decomposition to account for the presence of inefficiency on scale, technical and disequilibrium contributions to growth.

WEDNESDAY
SPECIAL SESSIONS: METHODOLOGICAL ISSUES

17:30 - 19:15 SESSION 6-C: *Regulation and Efficiency*

Productivity and Spanish Regulation of Electricity Distribution
Leticia Blázquez, Emili Grifell *(Universitat Autònoma de Barcelona)*

The aim of this paper is the productivity analysis of Spanish electricity distribution between 1952 and 1997. We pay special attention to the period 1987-1997, when Spain had a pioneering regulatory system based on the principles of yardstick competition. We have divided our period of study in two. The first one is 1952-1986 and the second one 1987-1997 and we apply different methodologies of study to each period. In the first case, a unique production frontier is defined for the whole period of time. So, we study the productivity variations by company along time with respect to this unique production frontier. In the second situation, we have more systematic data which allow us to construct a sequential frontier for each period of time from 1987 to 1997. As we know the standard cost by company, we can measure the productivity changes in terms of Bennet cost variation.

International Benchmarking and Regulation of European Electricity Distribution Utilities
Tooraj Jamasb, Michael Pollitt *(University of Cambridge)*

Due to the small number of electricity distribution utilities and increased mergers, energy regulators in some countries are looking to international benchmarking for help in price controls and incentive regulation. This paper presents a benchmarking study of 63 electricity distribution utilities in 6 European countries. The study illustrates the methodological and data issues encountered in the use of international benchmarking for the purpose of utility regulation and examines the effect of the choice of methods using DEA, COLS, SFA models. The paper also highlights the main issues of international benchmarking and how these can be overcome.

The Impact of Regulation on Technical Efficiency in the Italian Hospital Sector
Daniele Fabbri *(University of Bologna)*
Luigi Siciliani *(University of York)*

In this paper we evaluate the impact of regulatory environments on hospital technical efficiency in Italy. We use DEA and FDH to estimate the efficiency scores. In the specification of the model we control for quality which is proxied through mobility indexes and conduct sensitivity analysis with respect of different specification of the output. We then compute bootrstrap confidence intervals to test to what extent the differences in the efficiency scores are due to noise. In a second stage we use a Tobit model to identify differential effects on TE generated by different regulatory settings across classes of providers. Data refer to four Italian regions characterised by different regulatory environments, during 1997 and 1998, containing about 540 hospitals each year.

The Relative Performance of Electricity Distribution Firms in South America
Antonio Estache (*World Bank Institute and ECARES*)
Martin Rossi (*University of Oxford*)
Christian Ruzzier (*Universidad Argentina de la Empresa*)

The main purpose of this paper is to analyze the relative efficiency of electricity distribution firms in South America, using stochastic frontier analysis and Data Envelopment Analysis, with a view to increase the transparency of performance of the restructured power sector and generate a weak form of yardstick competition between the countries. To achieve such a goal, we use different methodologies that allow the construction of several efficiency rankings, on which a consistency analysis is performed. The paper underscores the importance of conducting a consistency analysis whenever using efficiency measures in applied regulation.

WEDNESDAY
SPECIAL SESSIONS: METHODOLOGICAL ISSUES

17:30 - 19:15 SESSION 6-D: *Stochastic Nonparametric Frontiers*

Stochastic DEA: A Semi-Parametric Approach
Evangelina Desli, Subhash Ray (*University of Connecticut*)

One major limitation of the standard DEA approach is that it is deterministic and does not allow random noise in the data. In this paper, we visualize the measured DEA score of a firm as consisting of a one-sided efficiency component and a two-sided random disturbance component. Unlike in the standard stochastic frontier models, however, the production function is left parametrically unspecified and is measured at a given point by DEA. The main innovation in this paper is to decompose the DEA score, which is one sided by construction, into an (in)efficiency component and a random component. For this, we modify the composite disturbance term of Aigner, Lovell, and Schmidt (ALS) (1977) to be censored at 0. This requires specifying a Tobit model where the underlying distribution is the sum of a normal and a half-normal distribution. We subsequently employ the Jondrow, Lovell, Materov, and Schmidt (JLMS) (1982) approach to obtain the conditional expectation of the one-sided (in)efficiency term given an estimate of the composed error.

European Airlines: A Stochastic DEA Study of Efficiency with Market Liberalisation
Meryem Duygun Fethi (*University of Leicester*)
Peter Jackson (*University of Leicester*)
Tom Weyman-Jones (*Loughborough University*)

Stochastic DEA constructs production frontiers that incorporate both inefficiency and stochastic error. This results in a closer envelopment of the mean performance of the companies in the sample and diminishes the effect of extreme outliers. We use the Land, Lovell and Thore (1993) model incorporating information on the covariance structure of inputs and outputs to study efficiency across a panel of 17 European airlines in the 1990s during the early phase of liberalisation.

A Consistent Test of Technical Efficiency Based On Nonparametric Methods
Carmen Murillo, Juan Rodríguez (*Universidad de Cantabria*)

In standard deterministic frontier analysis, either DEA or FDH techniques allowed to determine inefficient units just but taking some measure between a point in the estimated frontier and the related output. Unfortunately, when we assume that some symmetric noise is present in the data the previous task becomes much harder. The problem is that noise and efficiency are not identified in this setting and therefore, without a statistical tool it is impossible to decide whether a firm is efficient or not. In this paper we propose a test for efficiency in a stochastic nonparametric frontier analysis. Under weak conditions on the specification of the production frontier, and under the null hypothesis of efficiency, we provide the asymptotic distribution of the test statistic. Furthermore, we show the test is consistent against a broad set of alternatives of inefficiency. Evidence of the good properties of the test is given by a simulation study. We also provide an application.

How to Improve the Performances of DEA Estimators in the Presence of Noise?
Leopold Simar (*Université Catholique de Louvain*)

In frontier analysis, most of the nonparametric approaches (DEA, FDH) are based on envelopment ideas which suppose that with probability one, all the observed units belong to the attainable set. In the presence of noise, this is no more true and envelopment estimators could behave dramatically since they are very sensitive to extreme observations that could result only from noise. The problem is difficult, since, in essence, the model is not identified. In this paper we summarize the basic tool used and describe their statistical properties. Then we show through simulated examples, how we can improve the performances of the classical DEA/FDH estimators in the presence of noise of moderate size, in terms of noise to signal ratios.

THURSDAY
9:00 - 10:15 SESSION 7-A: *Nonparametric Statistical Methods*

Estimating Cost Functions for Banks in the U.K. by the Asymptotically Ideal Model

Oliver Burkart (*Financial Services Authority, London*)

This study estimates multi-product cost functions for banks operating in the UK by a seminonparametric method, the asymptotically ideal model (AIM). The AIM is a very flexible form that imposes global homogeneity of degree one by construction, allows to account for global regularity through non negativity restrictions on the parameters, and reduces the risk of overfitting. The study also exploits partially unique data from 1993 to 1998 on employees in addition to the Bankscope accounting data whose coverage of labour inputs is incomplete.

Testing for Productive Efficiency with Errors-In-Variables

Timo Kuosmanen (*Helsinki School of Economics*)
Thierry Post (*Erasmus University Rotterdam*)
Stefan Scholtes (*University of Cambridge*)

We develop a nonparametric test of productive efficiency that accounts for the possibility of errors-in-variables. The test allows for statistical inference based on the extreme value distribution of the Loo norm. In contrast to the test proposed by Varian (1985): 'Nonparametric Analysis of Optimising Behaviour with Measurement Error', Journal of Econometrics 30, 445-458, our test can be computed using simple enumeration algorithms or linear programming. An empirical application for the Dutch electricity sector illustrates the proposed test procedure.

Nonparametric Tests for Cost Differences Among U.S. Hospitals

Teresa Harrison, Paul Wilson (*University of Texas*)

U.S. hospitals may be categorized by affiliation or non-affiliation with a medical school (i.e., teaching versus non-teaching hospitals), by ownership (e.g., non-profit, for-profit, or government ownership), by location (e.g., urban versus rural), and perhaps by other factors. Conventional wisdom holds that there are differences across these groupings among hospitals, although the empirical evidence is mixed, and in many cases clouded by possible specification errors. This paper examines and formally tests for differences in costs among US hospitals. We use annual observations on hospitals covering 1984--1996, and allow for possible technical change in hospital costs. We use local polynomial smoothers to estimate hospital cost functions. We introduce discrete covariates into our nonparametric regression to control for teaching status, ownership structure, etc. The discrete covariates are introduced by augmenting the usual local polynomial estimator with a second kernel function that has discrete support over the dummy variables. A second bandwidth is used in the new kernel function, and we use data-driven methods to choose values for the bandwidth. The discrete-support kernel function, in effect, allows us to smooth across the various groups defined by the discrete covariates. This approach avoids the usual curse of dimensionality in nonparametric regression estimators, in that convergence rates of our estimators are unchanged by introduction of the discrete covariates. We then use a bootstrap procedure to test for differences among the various hospital groups.

THURSDAY
9:00 - 10:15 SESSION 7-B: *Environment*

Nonparametric Production Analysis of Pesticides Use

Alfons Lansink (*Wageningen University*)
Elvira Silva *(University of Porto)*

This paper contributes to the literature by analysing the role of damage abatement inputs using a nonparametric approach. First, this paper calculates the value of the marginal product of damage abatement inputs and compares the results with outcomes from popular parametric specifications of the production function (i.e., quadratic and Cobb-Douglas). Second, this paper determines the effect of damage abatement inputs on the value of the marginal product of productive inputs in order to analyse interactions between damage abatement and productive inputs. The advantage of a nonparametric approach over a parametric is that it is more flexible, since it implicitly allows for interactions between damage abatement and productive inputs and since it does not assume a specific functional form for the production technology. The role of damage abatement inputs is investigated for a data set of Dutch specialised arable farms during the time period 1989-1992.

Accounting for Bads in the Measurement of Productivity Growth: A Cost Indirect Malmquist Index

Eldon Ball *(Economic Research Service, USDA)*
Rolf Färe, Shawna Grosskopf (*Oregon State University*)
Osman Zaim (*Bilkent University)*
Richard Nehring (*Economics Research Service, USDA*)

This paper starts with the basic premise that the conventional measures of productivity growth, which ignore joint production of good and bad outputs, are biased. We then construct an alternative productivity growth measure using activity analysis. An application to U.S. agriculture demonstrates its usefulness. More specifically, we show that the Törnqvist index of productivity is biased upward when production of undesirable outputs or "bads" is increasing. Conversely, this same measure of productivity is biased downward when externalities in production are decreasing.

An Index Number Approach to Evaluate Performance: The Spanish Ceramic Industry

Francesc Hernández, Andrés Picazo, Ernest Reig (*Universidad de Valencia*)

In a recent study, Färe, Grosskopf and Hernández-Sancho (2000) propose an environmental productivity index to measure the degree to which a firm succeeds in expanding its goods outputs while simultaneously accounting for bad outputs. This index consists of the ratio of a quantity index of good outputs and a quantity index of bad outputs. Each of the two indexes are based on distance functions. The quantity index of good outputs measures the success of a firm k in expanding its good outputs using the same level of inputs and producing the same level of bad outputs as another firm l, assuming that the disposal of bad outputs is not free. The quantity index of bad outputs shows the success of firm k in contracting its bad outputs keeping its good outputs and inputs at the same level as the firm l. This methodological approach is used to measuring the environmental performance of a sample of Spanish producers of ceramic goods. Moreover, an analysis of variance is carried out with the aim of assessing, at firm level, the relationships between the environmental performance index and some characteristics related to the management of the firms.

THURSDAY
9:00 - 10:15 SESSION 7-C: *Economic Growth*

International Spillovers as a Source of Economic Growth: Experience from Japan, Korea and Taiwan

Yir-Hueih Luh (*National Tsing Hua University*)

The objective of this paper is to analyze the sources of economic growth of three East Asian economies -Japan, Korea and Taiwan- with special emphasis on international spillovers. We calculate productivity growth and its components using distance-function-based Malmquist productivity indexes and linear programming methods following Fare, Grosskopf, Norris and Zhang (1994). The growth in productivity is decomposed into changes in efficiency (the catching-up effect) and technical progress (the innovation effect). To explore the implications of international spillovers for the endogenous models, regression analyses are conducted where the dependent variables areTFP growth and its two components. Because the multilateral data is panel in nature, fixed effect and random effect regressions that explicitly account for country-specific differences are applied to obtain coefficient estimates. Finally, various specification tests (the Hausman and RESET tests) are used to choose the final set of parameter estimates.

Reconciling Accumulationists and Assimilationists. A New Framework for Measuring Efficiency

Marcel Timmer *(University of Groningen)*

This paper attempts to shed new light on the debate between accumulationists and assimilationists concerning the sources of East Asian growth. Accumulationists stress the low productivity levels in East Asia. However, their neo-classical measurement framework is rejected by the assimilationists. Therefore, an empirical model is developed which measures technical efficiency from an assimilation perspective. The frontier is determined by means of a modified Data Envelopment Analysis. The standard assumption of convexity is loosened and data envelopment analysis is performed on a pooled data set rather than cross-section. This allows for historical benchmarking of East Asian performance. Results for seven manufacturing industries in South Korea and Taiwan show that the accumulationists were basically right in stressing the incomplete assimilation of new technologies in East-Asian manufacturing industries. However, contrary to accumulationists' wisdom, productivity performance in the electrical machinery industry has been exceptional good.

Technical Efficiency, Productivity Growth and Governance Structure in Chinese Firms using DEA

Qing Yang (*University of Surrey)*

This article seeks to investigate the dynamics of technical efficiency and productivity change and try to estimate the effect of economic reform upon enterprises' efficiency, and to analyse whether economic reform policy has achieved its main objective: efficiency improvement. It also try to shed lights upon the above puzzle. The data set used in the study is from northern China covering around 20,000 to 30,000 enterprises, which includes various ownership structure, administration structure, and financial information etc., during 1987-1996. In this study, around 3,000 enterprises from electrical engineering industry are selected. Methodology Based on Farrell's (1957) measurement of technical efficiency, Data Envelopment Analysis (DEA) is used to construct the production frontier and individual enterprise technical efficiency is measured against the constructed production frontier over the 10 year period. Second, by integrating weighted enterprise technical efficiency, the technical efficiency of the entire sector is calculated. Third, by measuring the shift of constructed production frontier, the technology advancement is estimated. Fourth, by taking into account the dynamics of industry, such as entry, exit and survival, the productivity change of the entire sector is calculated. Finally, econometric methods are used to evaluate the effect of different factors, such as ownership, administration, financial constraints, competition, different reform stages, etc, upon enterprise performance.

THURSDAY
9:00 - 10:15 SESSION 7-D: *DEA Applications II*

Developing a Decomposable Measure of Profit Efficiency Using DEA

Maria Portela (*Universidade Catolica Portuguesa, Aston University*)
Emmanuel Thanassoulis (*Aston University)*

In for-profit organisations efficiency measurement with reference to the potential for profit augmentation is particularly important as is its decomposition into technical, allocative and scale efficiency components. Two different profit efficiency definitions can be found in the literature, one that expresses efficiency as a percentage of actual to maximum attainable profit; and another that expresses efficiency as input and output adjustments required to reach the maximum attainable profit. These definitions give different measures of the relative profitability of a given unit. Moreover, their decomposition into technical, allocative and scale efficiency components gives again different results depending on the measure of profit efficiency used. The problem arises because maximum profit can be attained by a variety of relative adjustments to the observed input and output levels of a unit. The issue of profit efficiency measurement and its decomposition is addressed in this paper. A real-life example will be used to illustrate the concepts involved.

Benchmarking Austrian Physicians' Efficiency with DEA

Matthias Staat (*Mannheim University*)

At present, there is virtually no mechanism of cost containment or control implemented w. r. t. the outlays for the treatment of patients by general practitioners in Austria. Due to asymmetric information about cost, physicians are able to provide an excessive level of services or provide services at an excessive cost level. We argue, that benchmarking physicians' treatment strategy w. r. t. cost efficiency by means of DEA will allow the implementation of a reimbursement system that ensures quality services at an efficient cost level by minimising the ability of physicians to gain information rents.

Weight Restrictions and Production Trade-offs in DEA Models

Victor Podinovsky *(University of Warwick)*

This paper presents a new approach that, for the first time, explicitly links weight restrictions of any form used in DEA models to specific production trade-offs between the inputs and outputs, both under constant and variable returns to scale assumptions. This has a number of immediate implications for the practice and theory of DEA. First, our approach unambiguously explains the economic meaning of weight restrictions of any linear form, which provides a solid basis for their assessment. This in turn generally invalidates the use of "perceived importance" in the assessment of weight restrictions. Secondly, our approach provides a means by which managerial knowledge about production trade-offs can be explicitly accounted for in DEA analysis. Thirdly, it justifies the use of weight restrictions under the VRS assumption, which has been a controversial issue in DEA. Fourthly, it shows that, in practical situations, weight restrictions should be incorporated not in the CCR model but in its linear equivalents. Fifthly, it shows that a number of deep-rooted prejudices against certain types of weight restrictions and the situations in which they are used are unfounded. Sixthly, it affects the definition of the production possibility set and the two-stage computational procedures used in DEA.

THURSDAY
10:45 - 12:00 SESSION 8-A: *Technical and Efficiency Change*

Technical Change and Technical Efficiency in Finnish Grass Silage Production for 1990-2000

Timo Sipilainen (*University of Helsinki*)

Non-parametric Malmquist input-saving total factor productivity indexes are decomposed to a change in technical efficiency, consisting of a change in scale and pure technical efficiency, and technical change, which is decomposed to biased technical change and magnitude change. In a complete panel of 138 Finnish farms, annual TFP growth of silage production is approximately 2 percent. Technical progress is 3 percent per year, one fifth being caused by biased technical change. Technical efficiency decreases due to an equi-proportional fall in scale and pure technical efficiency. However, variation in productivity growth and its components is significant between periods, years and farms. Therefore, careful evaluation of sensitivity of results is needed. Results of non-parametric analysis are also compared to those of stochastic frontier analysis.

Efficiency and Technical Change in a Panel DEA Framework

Natalia Aldaz (*Universitat de LLeida*)
Joaquín Millán (*Universidad Politécnica de Madrid)*

A new procedure for the measurement of efficiency and technical change is presented, using DEA with full panel data. Previously, it has been thought that pooling the data assumes that technology is unchanged, and so productivity change is entirely technical efficiency change. However, patterns of technology change and the decomposition in efficiency and technical change elements can be accomplished by means of restrictions on the general structure of the technology indexes. Under the assumption of non-regressive technical change, upper and lower bounds for efficiency and technical change are obtained, giving transitive measures of productivity growth. Moreover, the analysis allows a more detailed analysis of slack evolution through time for each decision making unit, identifying patterns in non-radial inefficiency through time that the usual Malmquist approach can hardly identify.

Measuring Technical Change in Input-Output Models by Means of DEA

José Luis Zofio (*Universidad Autónoma de Madrid*)
Ángel Prieto *(IRNA-Consejo Superior de Investigaciones Científicas*)
Francisco Parra (*Universidad Nacional de Educación a Distancia*)

The goal of the present research is to introduce a model to evaluate potential technical change in an input-output framework by means of Data Envelopment Analysis, DEA. This technique allows researchers to assess productivity trends in the form of technical coefficients (input requirements (variation. By constructing envelopment unitary isoquants within compatible technologies (their production functions have the same positive technical coefficients (DEA identifies as a benchmark those productive sectors which use the lowest amounts of inputs. Once these reference frontiers have been defined for a base period it is possible to compare previous years technologies with such benchmark and to assess how technical coefficients have reduced over time. These calculations allow us to compare potential productivity gains to those actually observed in the economy and to simulate what would have been the benefits of innovations from an economy-wide perspective if they had been available in previous years. The process is empirically illustrated making use of the 1985-1990 input-output tables of the Spanish region of Castilla y León.

THURSDAY
10:45 - 12:00 SESSION 8-B: *DEA Methods*

Modeling Uncertainty in Weight Restriction DEA Using Fuzzy Set Theory

Kostas Triantis, Amit Kabnurkar (*Virginia Tech/System Performance Laboratory*)
Dorota Kuchta (*Wroclaw University of Technology)*

The weight restriction DEA models impose upper and lower bounds on the input/output weights or on the ratios of these weights. Most of these models suffer from the limitation that the weight bound values are uncertain. We propose a fuzzy set theoretic approach so as to account for the uncertainty found in the bound values associated with the input/output weights. This involves replacing the bound values by fuzzy numbers that capture the intuitive concept of approximate numbers. Based on this notion, the crisp weight restriction DEA models become fuzzy weight restriction DEA formulations that are unsymmetrical in nature because their objective function is crisp and their constraints are fuzzy. Among the numerous types of weight restriction DEA models, we focus on the two of the more commonly used models i.e., the absolute weight restriction and the Assurance Region (AR) DEA models. Along with the solution methodology for each model, we provide implementation roadmaps that illustrate the solution methodology. Finally, we apply the proposed fuzzy weight restriction DEA models to the same data sets as those used by the corresponding crisp weight restriction DEA models from the literature and compare the results.

Are All Scales Optimal in DEA? Theory and Empirical Evidence

Finn Forsund (*University of Oslo*)
Lennart Hjalmarsson (*Göteborg University*)

For efficiency studies data envelopment analysis, DEA, is becoming increasingly popular, not the least because it easily accommodates multiple outputs. Assessments of scale efficiency and calculation of optimal scale sizes are also common. The purpose of this paper is to develop equations for calculating the scale elasticity in the multi-output case, and present empirical evidence on the nature of scale properties in the case of DEA. The results indicate that optimal scale may be found over almost the entire size variations in outputs, thus making policy recommendations about scale efficiency dubious.

Multiple Solutions in DEA: Mavericks and Specialization

Francesca Fumero (*Politecnico di Milano*)

Due to the special structure of DEA linear programs, degeneracy often occurs and the possible lack of uniqueness in optimal solutions may play a critical role in the interpretation of additional information provided by DEA models. We therefore suggest a two stage approach for detecting among the alternative optima particular "extreme" solutions. Moreover, a procedure is suggested for identifying an optimal solution as much balanced as possible with respect to effort distribution. The proposed analysis allows to accurately model the "production technology" of each DMU, identifying real strengths and weaknesses and isolating specialized behaviors. The methodology is applied to several data sets and compared to alternative approaches for mavericks identification.

THURSDAY
10:45 - 12:00 SESSION 8-C: *Health II*

A Modified Three-Stage DEA: Application to Homes for Mentally Disabled in the Netherlands

Jos Blank (*Social and Cultural Planning Office, Netherlands*)
Vivian Valdmanis (*Labores/CNRS)*

This paper describes the efficiency of homes for mentally disabled using the method of Data Envelopment Analysis (DEA). A modified three-stage DEA is used for correcting the efficiency measures for the operating environment. Instead of the common resource-oriented technical efficiency model we use the cost efficiency model. This approach also acounts for the effect of the environment on allocative efficiencies. DEA shows that on average cost efficiency for general homes is 89%. The cost efficiency varies between 66% and 100%. The main part of cost inefficiency is due to the "wrong" mix of resources (about 6%). Scale efficiency as well as technical efficiency amounts to 97%. After correction for environmental influences cost efficiency equals to 0.95. This is primarily due to an average increase in technical efficiency and scale efficiency. However, allocative efficiency increases as well.

Efficiency of the Norwegian Nursing Homes

Dag Edvardsen (*Norvegian Institute of Building Research*)

The municipalities in Norway are responsible for providing care for their inhabitants in need. The care takes two main forms: institutionalised care in nursing homes and home-based care. Based on cross-section data for 1995 and 1997 for 469 municipalities the efficiency of the care activity is investigated using the non-parametric DEA approach. Quality is regarded as important for the amount of resources spent, but measures that capture quality are very hard to come by. The available data source allows only single-bed rooms and protected wards as quality indicators for nursing homes, and only number of clients in various age groups as basis for output variables in general. For the three basic activities nursing homes, home based care and home based medical treatment six output variables are defined based on the two age groups; 0-66, and 67+. The forming of age groups are designed to reflect the severity of need for care in order to take care of the "patient-mix"- effect. In addition, short-term clients in nursing homes is used as an output, and psychologically handicapped as output in the home care sector, totalling to ten output variables. Nursing- and other man-years and other current expenses are the three inputs. There are no data for capital inputs, like buildings and equipment. Significant differences in efficiency between municipalities are revealed and efficient peers identified that can be studied by municipalities wanting to improve performance.

Incorporation of Quality Dimensions in DEA

Tor Beltov, Ole Olesen, Niels Petersen (*University of Southern Denmark)*

This paper is concerned with the incorporation of information on differences in quality of outputs into DEA. Difference in quality is measured by the probability that produced output at any given DMU is of good vs. bad quality. Probabilities are estimated by regression in a logit approach. Approaches for incorporation of these estimates in DEA are discussed. An application for the Danish hospital sector is presented.

THURSDAY
10:45 - 12:00 SESSION 8-D: *Banks and Credit Unions*

Cost Efficiency and Profitability in European Commercial Banking

Gilberto Turati *(Universita' Cattolica S. Cuore)*

In this paper I estimate the evolution of cost efficiency scores in European banking markets from 1992 to 1999. In order to obtain robust estimates of efficiency scores, I specify three different translog cost functions. All the three models consider 3 inputs (labour, physical capital and deposits) and 2 outputs (loans and other earning assets). Correlation between scores obtained with different specifications of the cost function are very high, whereas mean efficiency drops sharply when one considers a deterministic frontier as opposed to a stochastic frontier. I found no striking differences in mean efficiency among European countries. Mean efficiency across countries shows a decline from 1992 to 1998 and an increase from 1998 to 1999. Low correlations between cost efficiency scores and profitability call for the presence of market power in the banking industry.

Credit Union Scale Economies

Harold Fried *(Union College)*
Knox Lovell (*University of Georgia)*
Suthathip Yaisawarng (*Union College*)

This paper addresses the following questions: Are credit unions too large or too small? By how much can a credit union reduce its average cost by operating at the optimal scale? What are the cost implications of producing more or less of a particular service? Based on a sample of 8,000 credit unions operating in 1999, the paper classifies credit unions into four categories according to the sophistication of their products. There are 600– 3,000 credit unions per category. For each category, we estimates a hybrid translog cost function that includes five outputs representing different types of services, average wage, the price of capital and controls for equity, bad debt, and accounts per member. We also calculate returns to scale and output cost elasticities for all credit unions in each category.

Efficiency and Productivity of Credit Unions: A Comparison Between Hawaii and Puerto Rico

Roberto Mosheim (*University of Puerto Rico*)

Data Envelopment Analysis techniques are used to analyze the performance of 118 credit unions observed during 1998-2000. These associations are modeled following Sealy and Lindley (1977) who viewed credit unions as financial intermediaries that transform labor, capital and deposits into loans and security investments. Cost efficiency is decomposed into technical and allocative efficiency. Non-parametric tests are used to compare mean efficiency and technology between regions. A tobit regression is used to explain the efficiency scores in terms of location (U.S. territory vs. state), experience, delinquency rates and membership size.

THURSDAY
15:45 - 17:00 SESSION 9-A: *Hospitals*

A Multi-Level Model of Efficiency and Quality in E.U. Hospitals

Rowena Jacobs (*University of York*)
Vania Sena (*University of Leeds*)

This paper examines the relationship between efficiency and quality of health care in public hospitals in the Italian and English health care systems, using individual patient level discharge data for stroke patients. A multi-level model is used to obtain empirical measures of performance of how hospital services are managed in the two countries over a five-year period. A two-stage approach is used for the analysis: first, a Malmquist index is used to obtain measures of efficiency in the treatment of stroke patients in the two countries. Measures of quality are also introduced in the input / output set to control for their impact on the outcome of the productive process. In the second stage, the relationship between the obtained efficiency patterns and environmental factors (e.g. hospital characteristics) is analysed. The results show that the variability in the services' performance can be attributed to different regulatory settings.

The Impact of Ownership, Location and Case Mix on U.S. Hospital Productivity

Ila Alam (*Tulane University*)
Gerald Granderson (*Miami University*)

This paper uses DEA and the Malmquist Index to measure productivity growth and its decomposition into efficiency and technical change components for a sample of U.S. hospitals. We investigate whether differences in ownership (for-profit, government, and non-profit), location, teaching objective, and case mix heterogeneity impact productivity growth and its components. We further separate non-profit non-government hospitals into church operated versus other hospitals to determine if different types of non-profit hospitals behave dissimilarly. Rural hospitals (teaching hospitals) may treat a less complex and smaller distribution of cases compared to urban hospitals (non-teaching hospitals). Hospitals located in the same area may differ in the mix of cases they treat. Not accounting for these factors can lead to biased measures of productivity growth and its components. The data sample consists of 250 general medical and surgical hospitals operating in four Midwestern U.S. states (Illinois, Indiana, Ohio, and Wisconsin) from 1996 to 1999.

Comparing French and U.S. Hospital Technology: A Directional Distance Function Approach

Benoit Dervaux (*Université Catholique de Lille / CNRS*)
Gary Ferrier (*University of Arkansas*)
Hervé Leleu (*Université Catholique de Lille / CNRS*)
Vivian Valdmanis (*Labores / CNRS*)

We compare French and US hospital technologies using directional input distance functions. The aggregation properties of the directional distance function allow us to compare hospital industry performance in addition to standard firm-level performance with regard to efficiency. We further analyze the underlying causes of efficiency by separating its components-in the short run, congestion and technical inefficiency, and in the long run, scale inefficiency. By virtue of using the directional distance function, we also develop an estimate of a lower bound on allocative inefficiency. We find that French and US hospitals use quite different technologies. Long run scale inefficiencies cause most of the French hospitals' inefficiency while short run technical inefficiency is the main source of overall productive inefficiency in the US hospitals.

THURSDAY
15:45 - 17:00 SESSION 9-B: *Energy*

Technological Externality and Economies of Vertical Integration in Electric Utility Industry

Jiro Nemoto *(Nagoya University)*
Mika Goto (*Central Research Institute of Electric Power Industry*)

This paper aims at investigating economies of vertical integration of the electric utility industry, focusing on the technological externality between the generation and transmission-distribution stages. The electric power industry is characterized by strong technological links among different stages of the production process. The divestiture of an electric power company may thus cause a loss of cost efficiency even though it no longer exhibits a natural monopoly. We estimate cost function of the transmission-distribution stage to test whether there exist externality effects of the generation facilities on costs of the transmission-distribution stage. The cost function is specified by the symmetric generalized McFadden form and estimated with panel data of nine Japanese electric utilities 1981-1998. Being aware of divergences from efficient behavior due to regulatory bias and fixity of inputs, we employ a generalized cost function model from which demand equations for inputs are derived without assuming instantaneous adjustment. Marginal rates of substitution are constrained to equal ratios of the corresponding "shadow" prices and not market prices. Taking advantage of panel data, we measure firm specific productive inefficiencies varying over time. The results indicate that there exists technological externality between vertically related stages. It is suggested that vertical integration contributes to reduction in costs of the electric power industry.

Benchmarking the Performance of U.K. Electricity Distribution Utilities Using DEA

Susila Munisamy-Doraisamy, Robert Dyson, Victor Podinovski, Catherine Mitchell
(*University of Warwick*)

The regulator of the UK electricity industry, OFGEM, is currently seeking a way of monitoring electricity distribution utilities' performance on a different set of criteria: the ability to provide customers with services of sufficient quantity as well as quality. This paper suggests a service-orientated performance evaluation methodology that might serve the need of OFGEM and explores the productivity developments in the UK distribution utilities. The methodology incorporates the quantity and quality of the services distribution utilities provide their customers. This paper proposes a plausible set of quality measures that is attributable to the distribution businesses. The paper presents results of an analysis of the UK distribution utilities efficiency over the post-privatisation period 1990/91-1999/00, using Malmquist Indices. DEA is utilised to calculate Malmquist indices of productivity change, which are then decomposed into indices of efficiency change, quality change and technological change. The results of the on-going study will be reported at the meeting.

Scale and Cost Efficiency in the Swiss Electricity Distribution Industry: Evidence from a Frontier Cost Approach

Massimo Filippini (*Universita della Svizzera Italiana*)
Jörg Wild (*Centre for Energy Policy and Economics*)
Michael Kuenzle (*Centre for Energy Policy and Economics*)

The deregulation of the electricity is currently on the political agenda in many countries. In most countries, the deregulation of the sector is combined with a (re) regulation of the electricity networks in most of the countries. In this paper, we analyze the costs structure of 59 Swiss electricity distribution network operators with respect to cost and scale efficiency of the industry. A stochastic frontier model is applied to estimate the average costs of efficient network operators as a benchmark for the industry. Moreover, the heterogeneity of service areas is taken into account. The Swiss authorities might use our results to regulate the prices for the access to the distribution networks.

THURSDAY
15:45 - 17:00 SESSION 9-C: *Productivity*

Technological and Pecuniary Externalities Due to Agglomeration and Productivity Measurement

Ragnar Tveteras *(Stavanger University College)*

Agglomeration of production activities can lead to positive technological and pecuniary externalities to firms, where the size of these externalities is positively related to the level of industry concentration. The former class of externalities leads to positive shifts in the output frontier, and the latter leads to reductions in input prices due to increased competition in factor markets. In some instances agglomeration causes provision of services and materials that were previously not available from external suppliers, leading to outsourcing in the form of substitution of internal labor and capital inputs with materials and external services inputs. There are strong reasons to believe that pecuniary externalities are important benefits from agglomeration, despite the focus on technological externalities in econometric studies. This paper discusses measurement of internal and external influences on productivity when agglomeration externalities are present - both in a primal and dual model framework. Particular focus will be on separate identification of technological and pecuniary externalities in empirical measurement. To exemplify some of the measurement challenges, econometric models are specified and estimated on empirical data.

A Hedonic Price Index for Airline Travel

David Good (*Indiana University*)
Robin Sickles, Jesse Weiher (*Rice University*)

In 1996 the Boskin Commission concluded that changes in the Consumer Price Index (CPI) overestimated the change in the Cost of Living by about 1.1 percent. This bias was attributed to three factors: (i) having a fixed weight market basket neglects consumer substitution within commodities in the basket (substitution bias – measured at 0.4 percent); (ii) price collection within outlets neglects consumer substitution among outlets (outlet substitution bias measured at 0.1 percent); (iii) the change in the quality of existing commodities and the introduction of new commodities are not properly or adequately measured (quality change bias –measured at 0.6 percent). This paper deals with these factors and attempts to calculate a quality adjusted price index for the airline industry. This calculation is achieved using a hedonic price regression including relevant quality characteristics as well as time dummies on a one in a ten sample of all tickets sold on a quarterly basis. We compare our new price index with the index currently use by the BLS and discuss the reasons why the two indices diverge. Suggestions for a revision of the BLS practices are provided as well as data protocols for its implementation.

Impact of Ownership Type in Romanian Manufacturing

Voicu Boscaiu *(Center of Mathematical Statistics of Romanian Academy)*
Costea Munteanu *(Academy of Economic Studies, Bucharest)*

Romanian manufacturing industry, productivity, total factor productivity, ownership the study classifies the firms by the prevailing ownership type (as foreign-owned firms, Romanian private firms and state-owned firms). The classes were compared taking into account different productivity and efficiency criterions (also including a factorial analysis model). A static analysis of 2800 Romanian manufacturing firms is performed. The sample covers about 90% of the manufacturing aggregate turnover (referring to the year 1998). We located the analysis on the microeconomic level of firm but also, we defined some aggregated indices (at NACE subsections level). The comparison of the two approaches was considered.

THURSDAY
15:45 - 17:00 SESSION 9-D: *Firm Organization and Management*

Resource Allocation Based on Efficiency Analysis

Pekka Korhonen, Mikko Syrjänen (*Helsinki School of Economics*)

The purpose of this paper is to develop an approach to a resource allocation problem that typically appears in organizations with a centralized decision making environment like supermarket chains, banks, and universities. The central unit is supposed to be interested to maximize the total amount of outputs, which individual units can produce within the certain resources available. (The problem can also be considered as an input minimization problem.) The units can modify their production in a current production possibility set within certain assumptions. We will consider various assumptions concerning returns to scale and the ability of each unit to modify its production plan. An interactive formal approach based on DEA and Multiple Objective Linear Programming (MOLP) is developed to find the most preferred allocation plan. Numerical examples are used to illustrate the approach.

Efficiency as a Contractable Route to Quality Management

Robert Weaver, Taeho Kim (*Pennsylvania State University*)

Technical efficiency has long been exploited as a means of managing performance of a group of DMUs. In this paper, we consider the problem of managing quality in the supply chain. We suppose quality is assumed a joint product that is difficult and costly to observe. Processors face costs that are conditional on quality of input supply. Given asymmetric information with respect to quality, quality becomes a contractable control for supply chain performance. In this paper, we focus on the specific problem of contracting for improvement in technical efficiency associated with quality production. First, the underlying production technology is generalized to allow for jointness in quality production. Measurement of nonradial technical efficiency in production of quality is considered. The paper introduces an innovation by defining and applying a quantitative basis for identification of technical "peers" in an otherwise unsegmented sample of DMUs. Based on these peers, a quantitative basis for identification of a "benchmark" is presented. Implications for contracting over technical efficiency within the peer group and with respect to the benchmark is presented and demonstrated. An application is presented based on a cross section sample of crop production farms where pesticide residues are an indicator of quality. The processors are assumed to face costs due to the presence of residues. Results demonstrate the utility of generalized notions of technical efficiency in the management of quality in supply chains.

On Benchmarking a Pharmaceutical Sales Force using DEA

Leonard Parsons (*Georgia Institute of Technology*)

The American sales force of a large European pharmaceutical manufacturer was benchmarked to assess comparative representative performance. Data was available on six products by region, district, and territory. Sales, details, and samples for each major product, speaker bureau expenses, and telepromotion coverage were available. Pharmaceutical sales forces tend to be large (>500). A number of practical issues arose in modeling. For example, a field territory might be vacant. When territories are vacant, the professional communications department, if requested, will telepromote to specific audiences. There may be territories that are vacant be do not receive telepromotion. These practical problems are addressed and DEA results presented.

THURSDAY
SPECIAL SESSIONS: NEW FIELDS OF APPLICATION

17:30 - 18:45 SESSION 10-A: *Education*

Do Institutions Make a Difference in Educational Management?
Javier Suárez, Manuel Muñiz (*Universidad de Oviedo*)

The analysis of public policies from the most conventional neoclassic economic models trusts in a virtual "benevolent dictator" for the public management, avoiding any reference to the role of inside agents. Alternatively to this view, in the last years those views which are more concerned by institutional aspects and their influence on the decisions and, at last time, on the citizens welfare are been more and more used by economists. So, trying to include among the relevant variables the actions of agents as bureaucrats, politicians and interest groups or being concerned by the effects of the rules on the economy is common in the work the professionals of economics, and academic journals are full of papers using this approach. Our paper try to explore the effects that could be caused by a change in the regulation of education. In 1990 it was approved in Spain a new general law (LOGSE) supposed to globally reform Spanish educational system. The main objective is to identify and measure the eventual gains or loses of efficiency that the new regulation could cause in the performance and outcomes of the schools individually considered. To do this we use non parametric techniques.

The Efficiency of Public Education in the Upper Peninsula of Michigan
Michael Shields, Yongil Jeon *(Central Michigan University)*

In this paper, DEA is used to measure the efficiency of public education in the Upper Peninsula of Michigan. Then, community characteristics are used to explain differences in efficiency in a second stage of the empirical analysis. Despite the homogeneity of the Upper Peninsula, wide differences in the efficiency of education were found. The efficiency of high schools ranted from 1.0 to 0.784. Median family income was the most important explanatory variable, while the median value of housing was insignificant in part due to a funding formula based on state revenue instead of property taxes and in part due to the large number of vacation homes in the Upper Peninsula. Contrary to what many advocates of private schools have contended. Private school enrollments were unrelated to the efficiency of public education

Student Time and Efficiency: A Stochastic Frontier Analysis
Peter Dolton (*University of Newcastle*)
Oscar Marcenaro, Lucía Navarro (*Universidad de Málaga*)

The relationship between student study time allocation and examination performance is little understood. We model the allocation of student time into formal study (lectures and classes) and self study and its relationship to university examination scores using a stochastic frontier production function. The SF will allow the variance observed in student performance to be attributed not only to inefficiencies on the educational system but also to incomplete model specification or student heterogeneity. We will attempt to answer the question "how best should allocate their time between formal study in lecture attendance, self-study and leisure other activities? This case study uses unique time budget data and detailed personal records from one university in Spain. The results suggest that, within the formal system of teaching in Spain, both formal study and self study are significant determinants of exam scores but that the former may be up to four times more important than the latter. We also find that self study time may be insignificant if ability bias is corrected for.

THURSDAY
SPECIAL SESSIONS: NEW FIELDS OF APPLICATION

17:30 - 18:45 SESSION 10-B: *Transport*

Yardsticks on the Road: Regulatory Contracts and Cost Efficiency in the Norwegian Bus Industry

Dag Morten Dalen (*Norwegian School of Management*)
Andrés Gómez (*University of Chile*)

In this paper a cost frontier model is estimated for an eleven-year panel of Norwegian bus companies using the Battese and Coelli (1995) model. The main objective is to investigate to what extent different type of regulatory contracts affect company performance. The Battese and Coelli model allows for year/company specific efficiency measures. Thus, unobservable time invariant characteristic of the operating environment can be controlled for by analyzing the dynamics of measured productivity across time for firms regulated under different types of contracts, rather than relying solely on variations across companies during one time period. The main result of the paper is that the adoption of a more high-powered scheme based on a yardstick type of regulation significantly reduces operating costs. Our results confirm theoretical predictions regarding the incentive properties of high powered incentive schemes and in particular the dynamic benefits of yardstick competition.

Benchmarking Train Operating Company Performance

Luisa Affuso, Álvaro Angeriz, Michael Pollitt (*University of Cambridge*)

By 1997, British Rail, the state owned, vertically integrated monopoly had been unbundled into more than 100 companies and privatised. 25 train operating companies currently operate monopoly franchises for passenger rail services. This paper investigates how the efficiency of these train operating companies has evolved since privatisation using data envelopment analysis and corrected ordinary least squares. We look at the evolution of efficiency and productivity through privatisation and perform second-stage regression analysis of the efficiency scores using safety and environmental data. This analysis sheds some light on the successes and failures of the UK's most controversial privatisation to date.

THURSDAY
SPECIAL SESSIONS: NEW FIELDS OF APPLICATION

17:30 - 18:45 SESSION 10-C: *Fisheries*

Identifying Mis-Recording in Fisheries Catch Data Using DEA
Sean Pascoe (*University of Portsmouth*)
Inés Herrero (*Universidad de Huelva*)

Most analyses of efficiency use data that has been recorded by individuals in the industry under examination. In some cases, incentives exist to provide inaccurate data, which will result in the resultant analyses being distorted. This is particularly relevant in the case of fisheries, where significant incentives exist to mis-record output data under some management regimes, particularly under quota system. Several recent studies of efficiency in fisheries have suggested that apparent inefficiency may be partly due to mis-recording of the output data. In multispecies fisheries where only some species are subject to quota control, information on the output of non-quota species may be used to deduce the possible extent of mis-recording. In this paper, a method is developed to separate out potential mis-recording of output from true inefficiency using DEA techniques.

Economic Efficiency of Fishing Units in the Sistan Area
M.H.Karimkoshteh (*University of Zahedan*)
Ahmad Akbari Kerman (*University of Kerman*)
Mohammad Rezazadebahi (*Jihadkeshavarzi Ministry-Iran*)

Efficiency is one of the very important concepts in increasing of productivity, income and socioeconomic development. Income increasing has restriction due to scarcity of production factors and limited resources. Therefore, efficiency rising means income rising even without expanding basic resources and new technology. Thus, potential capacity and efficiency estimation can conduct economic adjustment. Objective of this research is estimating economic efficiency and determination of factors influencing fishing units in Sistan area of Iran. Data collection accomplished by personal interview and trough filling questionnaire. Economic efficiency was estimated by Cobb-Douglas frontier profit function. COLS and ML models were used respectively for estimation of determination and stochastic frontier profit function. Variables in Cobb-Douglas profit function were fuel cost, fishing equipment, labor force and maintenance. Socioeconomic factors influencing economic efficiency was considered by covariance analysis equation and indicated that education and laissez-passers were statistically significant. In this paper we analyze the outcomes and give some suggestions for efficiency increment.

Capacity and Capacity Utilization in Fisheries: A Comparison of Approaches
Catherine Morrison Paul (*University of California-Davis*)
James Kirkley (*Virginia Institute of Marine Sciences*)
Dale Squires (*U.S. National Marine Fisheries Service*)

Excess capacity of fishing fleets is one of the most pressing problems facing the world's fisheries and the sustainable harvesting of resource stocks. Capacity and excess capacity, are complex even to define, much less to measure and interpret in a consistent manner. This paper addresses these issues by overviewing the conceptual and theoretical bases for capacity and capacity utilization measurement. We base our analysis on the "technological-economic" approach for defining capacity output and utilization. Capacity output is expressed in terms of the maximum feasible output level given existing physical, environmental, and economic conditions, where "feasibility" is determined by observed output production. Many issues involved in carrying out such an exercise are overviewed, and an application to the North Atlantic Scallop fishery in the U.S. is reported.

THURSDAY
SPECIAL SESSIONS: NEW FIELDS OF APPLICATION

17:30 - 18:45 SESSION 10-D: *Environment*

Estimating Economic and Environmental Efficiency Using Directional DEA and 2-Step Analysis
Mette Asmild (*University of Toronto*)
Jens Hougaard (*University of Copenhagen*)

This paper demonstrates how economic and environmental efficiency of Danish pig farms can be estimated using DEA. Environmental variables are incorporated as nutrients applied with manure and nutrients removed with the crops. This is combined with a series of economic variables, including the costs of fertilizer. The model formulation is different from the traditional handling of environmental variables as undesirable outputs, and overcomes data limitations but has also a nice interpretation. Given the used economic inputs, the use of fertilizer and the nutrients applied through manure, the aim is to remove as much of the nutrients as possible with the crops and also to maximize the economic output. Directional DEA analysis and 2-step analysis are proposed in order to separate economic and environmental efficiency and investigate the trade-off between them.

Accounting for Greenhouse Gases in the Productivity Performance of Canadian Businesses
Tarek Harchaoui (*Statistics Canada*)
Pierre Lasserre (*Université du Québec*)

Despite the progress that have been accomplished in the measurement of the production structures, there has been no attempt to cast emissions within the joint-production framework. As a result, the empirical findings on firms cost structure and the related performance indicators that fail to account for this simple fact are likely to be biased. In this study we explore the relationship between goods and greenhouse gases within a detailed cost-function-based model of the production structure of the Canadian business sector. We find shadow values of greenhouse gases emissions to be significant, larger for the mining sector and increasing in magnitude over time. Our results also indicate that failing to account for greenhouse gases emissions understates productivity growth by half of a percentage point over the 1981-1996 period on average.

Measuring Productivity Growth in the Presence of Undesirable Outputs
Scott Atkinson, Jeffrey Dorfman (*University of Georgia*)

A substantial literature focuses on the measurement of efficiency in industries which produce undesirable outputs. We develop a new approach that allows the minimum of simplifying assumptions while also imposing relevant restrictions from economic theory. We estimate an input distance function with an "exogenous" technology shifter for the undesirable output (SO2 emissions), using data from a panel of 43 U.S. electric utilities with observations for 1980, 1985, 1990, and 1995. Our Bayesian framework uses informative priors to restrict the posterior support to the region of the parameter space which is consistent with economic theory. Gibbs sampling provides numerical estimates of the posterior distributions of interest under our informative priors, distributions which could not be derived analytically. An estimated shadow price of emissions of approximately $250/ton, provides us with an accurate estimate of the price of SO2 tradable emissions permits.

SATURDAY
POST-CONFERENCE SESSIONS

10:00 - 12:00 SESSION 11-A: *Parametric Applications*

Cost and Labour Use Efficiency in the Swedish Banking Industry: A Stochastic Frontier Approach

Matilda Gjirja (*Gothenburg University*)

The banking sector in Sweden has gone through a number of changes since the wind of deregulation swept through the industry in the middle of the 1980s. This paper analyses the impact of the deregulation and the subsequent banking crises on the cost and labour efficiency of the Swedish banking sector. The aim is to assess the efficiency of input utilization in general and specifically labour-use efficiency in the Swedish banking industry. An unbalanced panel of 192 Swedish banks is studied over the period, 1982 to 1998. A translog stochastic frontier model is adopted to estimate the total cost as well as the labour-use requirements in terms of the variables loans, deposits, guarantees, net provisions, number of branches and the year of observation. Furthermore, the inefficiency effects are modelled in terms of loan losses, total inventories, number of branches, the type of bank and the year of observation. The analysis suggests that there is capacity for substantial cost and labour efficiency improvements in the Swedish banking industry.

Regulation, Ownership and Efficiency in the Swiss Nursing Home Industry

Luca Crivelli, Massimo Filippini, Diego Lunati (*Università della Svizzera Italiana*)

Switzerland is a federal State where policy decisions and implementation regarding long-term care regulation are by rights incumbent to the regional and local governments (Canton and Town Council). This situation is in part responsible for the large number of small nursing homes operating in Switzerland. Moreover, long-term care for the elderly is supplied by private for-profit nursing homes, public nursing homes and non-profit nursing homes, respectively. The mixed economy which characterizes the long-term care market raises the interesting issue of the effects that the different regulatory settings and institutional forms can have on costs. The paper will consider an econometric estimation of a stochastic cost frontier using cross-section data for a sample of 835 Swiss nursing homes for elderly people operating in 1998. The results of this analysis are used to examine the relationship between cost efficiency and the alternative institutional and regulation forms.

Stochastic Frontier Estimation Using Simulated Annealing

Luiza Badin, Roxana Ciumara *(Academy of Economic Studies, Bucharest)*

In this paper, we perform Monte-Carlo simulations for evaluating the performances of the Simulated Annealing (SA) algorithm in a problem of estimating a stochastic frontier, assuming different distributions for the inefficiency term. For estimating the technical efficiency scores we apply a two-stage procedure. Ordinary least squares method is employed in a first stage to estimate the parameters of the model, regardless the distributional assumptions on the error components. In a second stage, we apply both the SA algorithm and DFP iterative method for maximizing the log-likelihood function, using the results from the first stage as starting points. The empirical applications on real data consist of technical efficiency analysis in different economic branches, using the stochastic frontier approach.

Determinants of Technical Efficiency in a Fishery

Leví Pérez (*Universidad de Oviedo*)

This paper examines the determinant factors of level of catches in a fishery. In particular we are interested not only in analyze the factors that influence on technical efficiency but also in differing these from luck and other time invariant variables, such as vessel characteristics, which are sometime confounded with technical efficiency. In the empirical approach a stochastic production function is estimated using Battese and Coelli (1995) model, which permits the estimation of technical efficiency as a function of an explanatory variables set based on skipper aptitudes and experience.

SATURDAY
POST-CONFERENCE SESSIONS

10:00 - 12:00 SESSION 11-B: *NonParametric Applications*

Avoiding Unfeasibility in Multipliers DEA Models with Weight Restrictions
Marcos Estellita, Angela Silva *(Federal University of Rio de Janeiro)*

Unfeasibility arises frequently when dealing with weight restrictions. This paper proposes a new proceeding to test for feasibility when weight restrictions are imposed to DEA models. The method can be applied to restrictions either to ratio of weights or to input share of virtual input (or output). Then, we propose a method to aid decision maker with searching for changes in order to turn the multipliers problem feasible.

Assesment of Cost Efficiency in Finnish Electricity Distribution
Pekka Korhonen, Mikko Syrjänen (*Helsinki School of Economics*)

When evaluating the reasonableness of electricity distribution pricing in Finland, one of thetasks of the Energy Market Authority is to evaluate the reasonableness of the cost levels of the companies. The objective of this study was to create a suitable DEA-based model for assessing the cost efficiency of the Finnish distribution companies. In more detail, the objective was to select input and output variables and those characterising the operating environments of the different distribution companies based on a thorough analysis of the distribution business. One essential question was to characterise the different types of environmental conditions so that all the units are treated impartially in the evaluation of efficiency. This paper describes the process of analysing and choosing the inputs, outputs and environmental factors to be included in the DEA model, and presents the key findings of the efficiency analysis. The resulting model provides the Energy Market Authority with a tool that is used as a part in the monitoring system

Efficiency and Total factor Productivity in the Ukrainian Agriculture in Transition
Alexej Lissitsa, Martin Odening (*Humboldt-Universität zu Berlin*)

The paper analyzes efficiency and total factor productivity (TFP) change of large agricultural enterprises during their transition to market economics in Ukraine. Efficiency is calculated by Data Envelopment Analysis and productivity change is measured by the Malmquist Productivity Change Index in the period between 1990 and 1999. TFP had on average an almost 6 % yearly decline and dropped 42 %. The main reason for the observed TFP decline is the decrease of technical efficiency which is found to be remarkably negative, but there is a high variation among individual enterprises. The distribution of efficiency scores widens, which indicates that the farms diverge with respect to their economic performance. A regression analysis is conducted where the efficiency scores are related to factors as farm type, farm size, and legal form.

Measuring Technical Efficiency in Sow Farms using DEA
Lluis Plá, Marga Moltó (*Universitat de Lleida)*

The aim in this article is to measure the technical efficiency in sow farms using DEA. DEA is a linear programming based technique for measuring the relative performance among organisational units where the presence of multiple inputs and outputs makes comparisons difficult. This paper introduces the technique and uses real data from around 80 sow farms to exemplify how relative efficiencies can be determined and targets for inefficient farms set. Moreover, the determination of returns to scale is used to discuss scale efficiency.

SATURDAY
POST-CONFERENCE SESSIONS

16:00 - 18:00 SESSION 12-A: *Parametric Applications*

Technical Efficiency in Food Distribution Units
Victoria Vicario, Rafaela Dios *(Universidad de Córdoba)*

The present work collects the results of an investigation carried out with the principal objective of analysing the technical efficiency level in production of a sample of food distribution units at domestic level, over the period 97-99. We have taken as output the sales, which in this case, means production, and as inputs, the capital and the labour. Based on the estimation of the neutral stochastic frontier model, the Cobb-Douglas production technology is confirmed, and we deduced that the mean technical efficiency is about the value 0.8, therefore strategies routed to increase the efficiency can be outlined. From the study of the factors that influence the efficiency, we concluded that the presence on the Internet of the analysed units has a great impact on the said efficiency. Hence, we consider that the possible performances on these units should be aligned to focus on the adoption of new technologies that permit an increase in trade through Internet, in order to improve the technical efficiency of the sector which is the object of the study.

Measurement of Information Technology: Thailand and U.S.
Romesh Diwan, Orachat Leingpeboon (*Rensselaer Polytechnic Institute*)

This paper is a part of a larger study to analyze the impact of information technology (IT) on economic growth in U.S and Thai. Some studies claim that measurement is an explanation of IT productivity paradox. To analyze its contribution, IT can be defined by three features (i) pervasiveness, (ii) falling prices and (iii) continuous innovations. USD of C's "Emerging Digital Economy report (1998)" classifies a set of IT industry for the US for which it provides output and workforce data for the IT sector but not capital data. This paper develops capital data for the US IT sector. It also introduces a new measure of the IT capital for the Thai Economy derived from the globalization thesis and based on imports. It presents both a new method and a new data set. It discusses many conceptual issues in the measurement of US and Thai IT capital.

Cross-Country Output Decomposition: A Stochastic Frontier Approach
Yasmina Limam (*University of Connecticut*)

This paper attempts to measure cross-country TFP differences in a stochastic frontier framework. In addition to measured inputs, the production frontier is assumed to depend on the quality of inputs. I develop a model where the quality of capital depends upon the average age of aggregate capital stocks, while the quality of labor depends on human capital. I estimate a best practice production frontier for a panel of 76 countries, grouped in five geographical regions, Europe and North America, Latin America, Africa, East Asia, and South Asia. The paper seeks to decompose output growth into input growth, quality change, efficiency change, and technological change.

A Comparison of Stochastic Frontiers in Analyzing Technical Efficiency of Farms
Md Abdul Wadud (*University of Rajshahi*)

This paper compares technical efficiency performance of a Cobb-Douglas stochastic frontier and a translog stochastic frontier approach. Farm-specific technical efficiency are estimated using farm-level cross-sectional survey data of rice farmers in Bangladesh in a single estimation technique, which includes both stochastic frontiers and inefficiency effects models, applying the maximum likelihood estimation method. The non-negative technical inefficiency effects are modeled as a function of farm-specific socio-economic factors, irrigation infrastructure and environmental factors. Results imply no variation in technical efficiency estimates obtained from Cobb-Douglas and translog stochastic frontiers. Results also show that rankings of farms along efficiency spectrum are not affected by the choice of functional form of the stochastic frontiers.

SATURDAY
POST-CONFERENCE SESSIONS

16:00 - 18:00 SESSION 12-B: *Non-Parametric Applications*

Formative Evaluation in Primary Health Care – Towards a Critical Realist Use of DEA
Carla Amado (*University of Warwick*)

This presentation will start by discussing some of the issues and difficulties related to performance assessment in primary health care, which need to be addressed to develop a new framework for formative evaluation. Following this, a framework to evaluate the relative performance of Primary Care Trusts in England will be presented. This framework has been developed in collaboration with some of the stakeholders involved in the delivery of primary care in England. I will suggest that DEA can be a useful tool for organisational learning in primary health care. Some of the characteristics of the technique are well suited to answer important questions both in health care policy and health services management. However, an important part of the motivation for this research is that I feel that the technique has not been explored to its full potential, as part of a formative evaluation.

3D-Illustrations of DEA -and FDH- models
Katrin Allen (*University of Aachen*)

Common DEA-illustrations for just 2 input and/or output objects do not always reflect DEA models in a detailed and complete way. Especially, the understanding of the effects of different assumptions on the underlying technology, of the role of the flexible weights in different efficiency measures, or of the relativity of targets and benchmarks is limited or even misleading. For a data set with 12 DMUs, which are described by two inputs and one output, the dual and primal results of 4 different DEA- and FDH-models have been calculated and used to draw 3D-efficiency hulls as well as the projections for the inefficient DMUs. The software MAPLE was used to draw the illustrations. It needs a while to get into the details of 3D-illustrations, and it is time consuming to draw them. But they allow a deeper insight into DEA-models, especially for beginners – and they look beautiful!

Technical Efficiency in the Hospital Sector with Panel Data: Parametric and Nonparametric Techniques
Luigi Siciliani *(University of York)*

The analysis has the purpose to compare different parametric and non-parametric techniques for the estimation of the production frontier and the degree of technical efficiency in the hospital sector with panel data. Non-parametric techniques can very easily manage the multidimensional nature of hospital product. Parametric techniques offer two possible solutions to incorporate in the analysis more than one output. One solution relies on the definition of polar coordinates. The second relies on the homogeneity condition of the Shephard distance function. For each of these specification fixed effect vs. random effect model is estimated. I then compare the results with two non parametric techniques: Data Envelopment Analysis and Free Disposal Hull. Panel data on 40 Italian hospitals for the region Friuli for the years 1995-1999 are used.

Using DEA to Design Contracts under Adverse Selection: An Application to Agricultural Policy
Glenn Sheriff (*University of Maryland*)

A problem faced by policy makers is how to design cost-effective policy mechanisms under conditions of hidden information. Although the theoretical literature has advanced considerably, little has been published concerning how policy makers can use data at their disposal to develop educated guesses regarding the underlying distribution of agent characteristics. This paper helps fill the gap in the literature by applying non-parametric frontier analysis to US agricultural survey data. Results are used to generate an empirical probability density function for farm efficiency levels and a farm profit function that can be used in the design of cost-efficient policies.

7th EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY ANALYSIS

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SEVENTH EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY

Oviedo, Spain
September 25-29, 2001

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