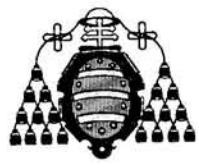
EIGHTH EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY ANALYSIS

(8EWEPA)

Oviedo, Spain
September 24-27, 2003

Program



Universidad de Oviedo

Wednesday, September 24
PRE-CONFERENCE SESSIONS

9:00 – 9:30 **Registration (University of Oviedo – Historic Building – San Francisco Street)**

9:30 - 10:00 **Opening Remarks**
Antonio Alvarez (University of Oviedo)

10:00 – 11:30 **SESSION A-1: Parametric Applications (Chair:** *Carlos Arias***)**

A Cost Study of US Telecommunications
Szabolcs Lorincz
Comment: Peter Schmidt

Productivity and Efficiency Measurement of Railways
Cesar Rivera
Comment: Luis Orea

European Integration and Technical Efficiency: the Role of Public Capital and Education
María Jesús Delgado, Inmaculada Alvarez
Comment: Spiro Stefanou

10:00 – 11:30 **SESSION A-2: Non-Parametric Applications (Chair:** *Mikko Syrjanen***)**

The Law of One Price in DEA
Rolf Färe, Robin Cross
Comment: Kris Kersterns

A Bias Corrected Envelopment Estimator
Luiza Badin, Leopold Simar
Comment: Robin Sickles

Productivity Growth in East Asia Economies' Manufacturing
Hailin Liao
Comment: Hal Fried

11:30 - 12:00 Coffee-Break

12:00 – 13:30 **SESSION B-1: Parametric Applications (Chair:** *Rafael Cuesta***)**

Efficiency Performance in Asian Banking
Kym Brown
Comment: Gary Ferrier

Technology Transfer and National Efficiency: The Role of International Trade
Michael Henry, Richard Kneller, Chris Milner
Comment: Carlos Arias

Railway (De)Regulation: A European Efficiency Comparison
Catherine Vibes, Guido Friebel, Marc Ivaldi,
Comment: Tim Coelli

12:00 - 13:30 **SESSION B-2: Non-Parametric Applications (Chair:** *Valentin Zelenyuk***)**

Efficiency and Rent-Seeking Activities at Public Hospitals: Evidence for Costa Rica
Ariadna Garcia, Juan Cabases, Pablo Arocena
Comment: Knox Lovell

An Analysis of Farm Efficiency in Colombia: A Nonparametric Approach
Maria Gonzalez, Rigoberto Lopez
Comment: Angelo Zago

Aggregation of Farrell Efficiencies with Possible Reallocation of Inputs
Franklin Soriano, Prasada Rao, Tim Coelli
Comment: Shawna Grosskopf

14:00 - 15:30 Lunch

15:30 - 17:00 **INVITED LECTURES: Parametric Applications (Chair:** *Subal Kumbhakar)*

Models for Determining what Determines Efficiency
Peter Schmidt (Michigan State University)

Dynamic Characterization of Efficiency. Conceptual and Modelling Challenges
Spiro Stefanou (Pennsylvania State University)

15:30 - 17:00 **INVITED LECTURES: Non-Parametric Applications (Chair:** *Harold Fried)*

Recent Developments in Primal Productivity Indices: A Practitioners' Perspective
Kris Kerstens (University of Lille)

Reallocation of production between DMUs in DEA models
Peter Bogetoft (Royal Agricultural University, Denmark)

17:00 - 17:30 Coffee-Break

17:30 – 19:30 **SESSION C-1: Parametric Applications (Chair:** *Ana Rodríguez)*

Technical Efficiency for Small Dairy Farms in Southern Chile
Víctor Moreira, Boris Bravo-Ureta, Jorge Vásquez
Comment: Antonio Alvarez

Technical efficiency sow farms: a comparison of methods
Xavier Ezcurra, Margarita Moltó, LluisPla
Comment: Boris Bravo-Ureta

Exact Decomposition of Allocative Inefficiency Using a Quadratic Cost Function
Juan José Díaz, Eduardo Martínez
Comment: Subal Kumbhakar

17:30 – 19:30 **SESSION C-2: Non-Parametric Applications (*Chair*: *Angelo Zago*)**

The Source of Productivity Growth in Dutch Arable Farming: A Perspective from Finance
Guan Zhengfei, Alfons Oude Lansink
Comment: Finn Førsund

DEA Based Bank Branch Productivity Comparison with Bank Methods
Joseph Paradi, Niloofar Tochaie, Mette Asmild
Comment: Peter Bogetoft

On Testing the Equality of Two Distribution Functions of DEA Efficiency Scores
Leopold Simar, Valentin Zelenyuk
Comment: Philippe Vanden Eeckaut

September 25-27
CONFERENCE SESSIONS

THURSDAY 25			
SESSION 1.A ENERGY	*SESSION 1.B* TRANSPORT	*SESSION 1.C* NON-PROFIT ORGANIZATIONS	*SESSION 1.D* EDUCATION I
SESSION 2.A THEORY	*SESSION 2.B* DEA APPLICATIONS I	*SESSION 2.C* SFA APPLICATIONS I	*SESSION 2.D* TFP APPLICATIONS
SESSION 3.A ENVIRONMENTAL EFFICIENCY	*SESSION 3.B* REGULATION AND EFFICIENCY I	*SESSION 3.C* EXPLAINING EFFICIENCY	*SESSION 3.D* PRODUCTIVITY
SESSION 4.A AGRICULTURE I	*SESSION 4.B* BANKS I	*SESSION 4.C* PUBLIC SECTOR	*SESSION 4.D* HEALTH I

FRIDAY 26			
SESSION 5.A AGRICULTURE II	*SESSION 5.B* BANKS II	*SESSION 5.C* REGIONAL EFFICIENCY	*SESSION 5.D* HEALTH II
SESSION 6.A RISK AND EFFICIENCY	*SESSION 6.B* DYNAMIC EFFICIENCY	*SESSION 6.C* EDUCATION II	*SESSION 6.D* BOOTSTRAPPING DEA SCORES
SESSION 7.A STATISTICAL ANALYSIS	*SESSION 7.B* REGULATION AND EFFICIENCY II	*SESSION 7.C* TECHNICAL CHANGE	*SESSION 7.D* DEA APPLICATIONS II
SESSION 8.A ECONOMETRICS I	*SESSION 8.B* DEA ADVANCES I	*SESSION 8.C* INDEX NUMBERS	*SESSION 8.D* DISTANCE FUNCTIONS

SATURDAY 27			
SESSION 9.A MACROECONOMIC ISSUES	*SESSION 9.B* DEA ADVANCES II	*SESSION 9.C* SFA ADVANCES	*SESSION 9.D* ECONOMIES OF SCOPE
SESSION 10.A ECONOMETRICS II	*SESSION 10.B* NON-PARAMETRIC ANALYSIS	*SESSION 10.C* SFA APPLICATIONS II	*SESSION 10.D* MALMQUIST INDEX

Thursday, 25

8:00 – 8:30 **Registration (Príncipe Felipe Conference Palace)**

8:30 - 9:00 **Opening Remarks**
Antonio Alvarez (University of Oviedo)
Mario Díaz (Chancellor of Research)

9:00 - 10:15 **SESSION 1-A: Energy (Chair:** *Finn Førsund***)**

Open Access Transportation, NERC, and Efficiency in Electric Utility Generation
Gerald Granderson

The Relative Performance of Privatized Utilities: Electricity Distribution in Latin America
Martin Rossi

Measuring Productivity when Grids are Merging
Arvid Göran Ek

9:00 - 10:15 **SESSION 1-B: Transport (Chair:** *Kris Kerstens***)**

Measuring Inefficiency in the Norwegian Bus Industry using Multi-Directional Efficiency Analysis
Jens Leth Hougaard, Torben Holvad, Dorte Kronborg, Hans Kurt Kvist

Efficiency Measurement for UK Airports: An Application of Data Envelopment Analysis
Torben Holvad, Anne Graham

Estimation of a Mixture of Input and Output Distance Functions. An Application to Railways
Luis Orea, Subal Kumbhakar, Ana Rodríguez, Mike Tsionas

9:00 - 10:15 **SESSION 1-C: Non-Profit Organizations (Chair:** *Shawna Grosskopf***)**

Measuring Library Efficiency: A Non-Parametric Approach
Margit Sommersguter-Reichmann, Gerhard Reichmann

Measuring Efficiency in the Provision of Communal Services. A Case Study for Italy
Ornella Maietta, Sergio Destefanis

Efficiency in Social Services. Assesing the Performance of Programmes
Javier Salinas, Luis Ayala, Francisco Pedraja

9:00 - 10:15 **SESSION 1-D: Education I (Chair:** *Javier Suárez***)**

Measuring Overeducation with Stochastic Earnings Frontiers and Panel Data
Uwe Jensen

The Efficient Allocation of Student Time: Comparing Stochastic and Non-Stochastic Methods
Peter Dolton, Oscar Marcenaro, Lucía Navarro

Research Efficiency: A Micro-Analysis of Dutch University Research in Economics and Business
Laurens Cherchye, Piet Vandenabeele

10:15 - 10:45 Coffee-Break

10:45 - 12:00 **SESSION 2-A: Theory (Chair:** *Dan Primont*)

A Microeconomic Theory of Price-Induced Technical Progress
Quirino Paris, Michael Caputo

Productivity Indexes for Stochastic Technologies
Robert Chambers

On Graph Efficiency Measurement
Joaquín Millán

10:45 - 12:00 **SESSION 2-B: DEA Applications I (Chair:** *Kostas Triantis*)

The Use of "Performance Radars" as a Predictor of Police Force Efficiency in the UK
Richard Simper, Leigh Drake

A Value Efficiency Approach to Including Environmental Factors in DEA: Helsinki Parishes
Halme Merja

Assessing How ICT Affects Bank Branch Operating Performance
Len Parsons, Jos Lemmink, Rita Walczuch, Alexander Bielowski, Jan Mattsson

10:45 - 12:00 **SESSION 2-C: SFA Applications I (Chair:** *Tim Coelli*)

Productivity Growth in Telecommunications Industry of OECD Countries
Arunava Bhattacharyya

Finance Constraints, Profit-sharing and Technical Efficiency of Italian Firms
Ornella Maietta, Vania Sena

Agglomeration Externalities Within and Between Industries:A Firm Level Cost Function Approach
Ragnar Tveteras, Frank Asche

10:45 - 12:00 **SESSION 2-D: TFP Applications (Chair:** *Kevin Fox*)

Productivity Decomposition in Brazilian Manufacturing 1996-2000
Fernando Garcia, Jorge Pires, Rogério Souza

Local and global Malmquist-type Productivity Change Indices
Mette Asmild, Fai Tam

Sources of Productivity Growth in the Spanish Pharmaceutical Industry
Eduardo González, Fernando Gascón

12:00- 12:30 Coffee-Break

12:30 - 13:30 **Keynote Address (Chair:** *Joseph Paradi*)

Measuring Efficiency at the Household Level
Speaker: *Jean Paul Chavas (University of Maryland)*
Comment: *Kris Kerstens (University of Lille)*

14:00 - 15:30 Lunch

15:45 - 17:00 **SESSION 3-A: Environmental Efficiency (Chair:** *Mette Asmild*)

Agriculture Externalities and Environmental Regulation. Good Practices in Citrus Production
Ernest Reig, Andres Picazo

Environmental Taxation and Frontier Analysis: Insights and Implications of Using DEA
Wendy Chapple

Productivity Growth in US Sub-manufacturing Industries in the Presence of Bad Outputs
Osman Zaim

15:45 - 17:00 **SESSION 3-B: Regulation and Efficiency I (Chair:** *Tom Weyman-Jones*)

Productivity Growth, Technical Change, and Efficiency Change in the Water and Sewerage Industry
David Saal

DEA Based Procurement Design in Natural Resource Management
Kurt Nielsen, Peter Bogetoft

Regulating the Regulators
Michael Pollitt, Preetum Domah

15:45 - 17:00 **SESSION 3-C: Explaining Efficiency (Chair:** *Mike Tsionas*)

Testing the Scaling Property in a Model where Inefficiency Depends on Firm Characteristics
Christine Amsler, Antonio Alvarez, Luis Orea

Introducing Environmental Variables in Nonparametric Frontier Models: a Probabilistic Formulation
Cinzia Daraio, Léopold Simar

A Flexible Time-Varying Specification of the Technical Inefficiency Effects Model
Giannis Karagiannis, Vangelis Tzouvelekas

15:45 - 17:00 **SESSION 3-D: Productivity (Chair:** *Emili Grifell*)

International Benchmarking or Electrical Distribution Utilities
Dag Edvardsen, Finn Førsund

An Integrated Approach to Measuring TFP with Inefficiencies and Scale Economies
Jiro Nemoto, Mika Goto

Soil Quality, Salinity and Productivity: Analysis using Long Term Crop Rotation Trials
Atakelty Hailu, Robert Chambers

17:00 - 17:30 Coffee-Break

17:30 - 18:45 **SESSION 4-A: Agriculture I (Chair:** *Boris Bravo-Ureta*)

Efficiency of the Small Dairy Farm in the USA
Loren Tauer, Ashok Mishra

Testing Tornqvist: Reducing the Agricultural Residual
David Skully

Quota Trading and Profitability in a Fishery: Theoretical Models and Empirics from Denmark
Jesper Andersen, Peter Bogetoft

17:30 - 18:45 **SESSION 4-B: Banks I (Chair:** *Jesús Pastor*)

Productivity Change in European Banking: A Comparison of Parametric and Non-Parametric
Barbara Casu, Claudia Girardone, Philip Molyneux

Is There a Lasting Gap in Bank Efficiency between Western and Eastern European Countries?
Laurent Weill

Two Stage Evaluation of Bank Branch Efficiency Using Data Envelopment Analysis
Joseph Paradi, Stephen Rouatt

17:30 - 18:45 **SESSION 4-C: Public Sector (Chair:** *Diego Prior*)

Activation Efficiency for Cash-help Recipients in Denmark: A DEA Bootstrap Approach
James Weatherall, Tor Beltov

Measuring the Efficiency of Public Services: the Limits of Analysis
Andrew Street, Peter Smith

The Efficiency of Public Employment Services in Switzerland 1998-2001
George Sheldon

17:30 - 18:45 **SESSION 4-D: Health I (Chair:** *Gary Ferrier*)

World Health System Performance Revisited
Knox Lovell, Jeremy Lauer, Christopher Murray, David Evans

Nursing Home Cost Efficiency in New York State: Panel Data Including Quality of Care
Shelton Schmidt, Harold Fried, Suthathip Yaisawarng

Assessing Performance of French Intensive Care Units: A Directional Distance Function Approach at the Patient Level
Hervé Leleu, Benoît Dervaux, Vivian Valdmanis, Etienne Minvielle

21:15 – 22:30 **Welcome reception** (Hotel Reconquista)

Friday, 26

9:00 - 10:15 **SESSION 5-A: Agriculture II (Chair:** *Loren Tauer*)

Decomposition of Productivity Change on Finnish Dairy Farms
Timo Sipiläinen

The Productivity Performance of Irish Dairy Farms: A Multiple Output Distance Function
Carol Newman, Alan Matthews

Productivity Patterns in the U.S. Meat Product Sector
Pinar Celikkol, Spiro Stefanou

9:00 - 10:15 **SESSION 5-B: Banks II (Chair:** *Harold Fried*)

Decomposing the Dividend
Emili Grifell-Tatje, Knox Lovell

Banking Activity and Macro-Economic Performance: An Empirical Study at the Country Level
Jesús Pastor, Ana Lozano

Benchmarking Credit Union Performance: An Interactive Computer Approach
Harold Fried, Peter Bogetoft, Philippe Vanden Eeckaut

9:00 - 10:15 **SESSION 5-C: Regional Efficiency (Chair:** *Federico Perali*)

Network Efficiency in Input-Output Tables: A DEA Application to OECD Countries
Angel Prieto, José Luis Zofio

Public Infrastructure Investment and Efficiency in Italian Regions
Camilla Mastromarco, Ulrich Woitek

Metafrontier Functions for the Study of Interregional Productivity Differences
Prasada Rao, Chris O'Donnell, George Battese

9:00 - 10:15 **SESSION 5-D: Health II (Chair:** *Vivian Valdmanis*)

Effects of Thai National Health Systems Reform on Cost Efficiency of Publicly-Owned Hospitals
Suthathip Yaisawarng, Preecha Asavadachanukorn, Saowaros Yaisawarng

Heterogeneous Production in Efficiency Measurement: Dutch Homes for the Mentally Disabled
Evelien Eggink

The Effect of Strategic and Operational Decisions on Hospital Performance
Gary Ferrier

10:15 - 10:45 Coffee-Break

10:45 - 12:00 **SESSION 6-A: Risk and Efficiency (Chair:** *Robert Chambers*)

An Investigation of Production Risk, Risk Preferences and Technical Efficiency in the Philippines
Renato Villano, GeorgeBattese, Euan Fleming, Chris O'Donnell

Efficiency and Heterogeneous Risk: An Analysis of the Andelusian Deep Water Trawl Fleet
Sean Pascoe, Ines Herrero

Estimation of Risk with Multi-Output Technologies
Alan Wall

10:45 - 12:00 **SESSION 6-B: Dynamic Efficiency Analysis (Chair:** *Spiro Stefanou*)

The Measurement of Dynamic Productive Efficiency: A System Dynamics Approach
Kostas Triantis, Warren Vaneman

Dynamic Efficiency: Is the Public Sector Investing too Little?
Shawna Grosskopf, Kathy Hayes, Lori Taylor

Efficiency and Total Quality Management in Health Care. A Dynamic Frontier Approach
Diego Prior

10:45 - 12:00 **SESSION 6-C: Education II (Chair:** *Emmanuel Thannasoulis*)

Student Achievement and Efficiency in Missouri Schools and the No Child Left Behind Act
Diane Primont, Bruce Domazlicky

Gross State Product Growth and Educational Levels in the US: An Econometric Analysis
Jose Maripani, Boris Bravo-Ureta

Universities as Production Units: The Case of Regional Colleges of Norway
Finn Førsund, Dag Edvardsen

10:45 - 12:00 **SESSION 6-D: Bootstrapping DEA Scores (Chair:** *Paul Wilson*)

Bootstrap Results for a Measure of Market Efficiency
Matthias Staat

On Statistical Analysis of Aggregate Efficiencies
Leopold Simar, Valentin Zelenyuk

Sensitivity analysis of Efficiency and Malmquist Productivity Indices in Spanish Savings Banks
Emili Tortosa-Ausina, Emili Grifell-Tatjé, David Conesa, Carmen Armero

12:00 - 12:30 Coffee-Break

12:30 - 13:30 **Keynote Address (Chair:** *William Greene*)

Recent Econometric Developments in Efficiency Measurement
Speaker: *Subal Kumbhakar (StateUniversity of New York at Binghamton)*
Comment: *Robin Sickles (Rice University)*

14:00 - 15:30 Lunch

15:45 - 17:00 **SESSION 7-A: Statistical Analysis (Chair:** *Léopold Simar*)

Nonparametric Kernel Measurement of Technical Efficiency
Daniel Henderson

Statistical Inference from DEA Efficiency Estimates: The Case of Food Industries in Germany
Holger Thiele

Two-Stage, Semi-Parametric Models of Production Processes
Léopold Simar, Paul Wilson

15:45 - 17:00 **SESSION 7-B: Regulation and Efficiency II (Chair:** *Sergio Perelman*)

Efficiency and Productivity Analysis for Incentive Regulation
Thomas Weyman-Jones, Julia Boucinha, Celia Godinho, Catarina Inacio

Benchmarking Quality of Service in Incentive Regulation: UK Electric Distribution Utilities
Tooraj Jamasb, Dimitris Giannakis, Michael Pollitt

Collusion, Agent Heterogeneity and Frontier Yardstick Stability
Per Agrell, Peter Bogetoft

15:45 - 17:00 **SESSION 7-C: Technical Change (Chair:** *Lennart Hjalmarsson*)

Embodied and Disembodied Technological Progress in Finnish and Indonesian Paper Mills
Bart Los, Michiel van Dijk, Marcel Timmer

Gauging Change in Technical Efficiency Associated with Technological Change
Robert Weaver, Jarmilla Curtiss

A Unified Approach to Incorporating Technical Change in Modified Production Functions
Federico Perali

15:45 - 17:00 **SESSION 7-D: DEA Applications II (Chair:** *Sverre Kittelsen*)

Large Scale Implementation of DEA: A Case study in Social Services
Alexandra Medina-Borja, Kalyan Pasupathy, Kostas Triantis

A Three-Stage DEA Model in Measuring Efficiency
Cliff Huang, Yung-Lieh Yang, Wann-Jyi Horang, Jun-Yen Lee

DEA and Stochastic Dominance Efficiency Analysis of Investment Portfolios
Timo Kuosmanen

17:00 - 17:30 Coffee-Break

17:30 – 18:45 **SESSION 8-A: Econometrics I (Chair:** *Peter Schmidt*)

Fixed Management and Time-Invariant Technical Efficency in a Random Coefficients Model
Antonio Alvarez, Carlos Arias, William Greene

Estimation of Cost Functions Ignoring Allocative Inefficiency: A Monte Carlo Analysis
Hung-Jen Wang, Subal Kumbhakar

Panel Estimators and the Identification of Firm-Specific Efficiency Levels in Semi-Parametric and Non-Parametric Settings
Robin Sickles

17:30 – 18:45 **SESSION 8-B: DEA Advances I (Chair:** *Peter Bogetoft*)

Negative Data in DEA: A Directional Distance Approach Applied to Banks
Maria Portela, Emmanuel Thanassoulis

DEA with Negative Inputs and/or Outputs Revisited
Ole Olesen, Niels Petersen

DEA and Asymmetric Information: How to Implement Non-linear Pricing in Producer Groups
Angelo Zago, Robert Chambers

17:30 – 18:45 **SESSION 8-C: Index Numbers (Chair:** *Osman Zaim*)

A Method for Transitive and Additive Multilateral Comparisons: A Transitive Bennet Indicator
Kevin Fox

Continuous Time Foundation of Discrete Time Indices of Productivity and Technological Change
Einar Belsom

On the Relation Between Gross-Output and Value-Added Based Productivity Measures
Bert Balk

17:30 – 18:45 **SESSION 8-D: Distance Functions (Chair:** *Rolf Färe*)

Efficiency Measurement with Undesirable Outputs: A Parametric Distance Function Approach
Rafael Cuesta, Knox Lovell, José Luis Zofío

Short- and Long-Run Credit Constraints in French Agriculture: A Directional Distance Function
Stephane Blancard, Jean-Philippe Boussemart, Walter Briec, Kristiaan Kerstens

Directional Duality Theory
Daniel Primont, Rolf Färe

Saturday, 27

9:00 - 10:15 **SESSION 9-A: Macroeconomic Issues (Chair:** *Robert Russell*)

Productivity Differences across OECD Countries in the Presence of Environmental Constraints
Francisco Arcelus, Pablo Arocena

An International Comparison of Productivity Change in Agriculture and the Economy as a Whole
Nuno Moutinho, Fernando Machado, Elvira Silva

Multimodality of Productivity Distributions: An Application to Macroeconomic Convergence
Daniel Henderson, Pelin Kale Attar, Robert Russell

9:00 - 10:15 **SESSION 9-B: DEA Advances II (Chair:** *Joseph Paradi*)

A Simplified Bootstrap for DEA Estimators
Paul Wilson, Leopold Simar, Alois Kneip

A Double Perspective DEA Approach Applied to Assess End Use Household Energy Consumption
Marcos Estellita, Angela Silva

Far out or Alone in the Crowd: Classification of Self-evaluators in DEA
Sverre Kittelsen, Dag Edvardsen, Finn Førsund

9:00 - 10:15 **SESSION 9-C: SFA Advances (Chair:** *George Battese*)

Correcting the Concentration Effect on Technical Efficiency Prediction
Rafaela Dios, José Miguel Martínez

Estimating Multi-output Technologies when Output Random Shock are Non-radial
David Roibás, Carlos Arias

The Gauge Function as a Measure of Profit Efficiency
Glenn Sheriff

9:00 - 10:15 **SESSION 9-D: Efficiency in Multi-Output Technologies (Chair:** *Giannis Karagiannis*)

Non-parametric Economies of Scope in Dutch Horticulture
Alfons Oude Lansink, Spiro Stefanou

Measuring Quality-Quantity Trade-Off in the Regulation of Brazilian "Privatized" Railways
Sergio Perelman, Antonio Estache, Lourdes Trujillo

Economies of Scope in Cargo Handling Services in Spanish Terminals Port
Beatriz Tovar, Sergio Jara, Lourdes Trujillo

10:15 - 10:45 Coffee-Break

10:45 - 12:00 **SESSION 10-A: Econometrics II (Chair:** *William Greene*)

A Comparative Analysis of Alternative Stochastic Frontier Models Applied to Panel Data
Mehdi Farsi, Massimo Filippini, Michael Kuenzle

Fitting an Unknown Production Function for Measuring Efficiency
Daniel Santín

Bayesian Analysis of Input-Oriented Technical Efficiency
Mike Tsionas, Subal Kumbhakar

10:45 - 12:00 **SESSION 10-B: Non-Parametric Analysis (Chair:** *Philippe Vanden Eeckaut*)

Multi-objective Approach as an Alternative to Radial Projection in DEA
Mikko Syrjänen, Pekka Korhonen, Sari Stenfors

Quantitative Peergrouping and Benchmarking Envelopment Approach
Robert Weaver, Taeho Kim

Influence of Optimistic vs. Pessimistic Efficient Frontier on Users' Choices
Pekka Korhonen, Sari Stenfor, Jyrki Wallenius

10:45 - 12:00 **SESSION 10-C: SFA Applications II (Chair:** *Frank Asche*)

An Input Distance Function Approach to the Measurement of Technical and Allocative Efficiency
Tim Coelli, Euan Fleming, Satbir Singh

A Joint Production Efficiency Model of the Water Industry in the United States
Roberto Mosheim

Forward or Backward Causality? Estimating Firm Level Panel Data on R&D and Productivity
Hans Lööf

10:45 - 12:00 **SESSION 10-D: Malmquist Index (Chair:** *Bert Balk*)

Parametric Decomposition of the Input-Oriented Malmquist TFP Index: Greek Fish Farms
Giannis Karagiannis, Christos Pantzios, Vangelis Tzouvelekas

Measuring the Productivity of the Banking System:A Generalized Parametric Malmquist Approach
Meryem Duygun Fethi, Peter Jackson, Thomas Weyman-Jones

A Frontier Approach to Canada-U.S. Productivity Performance
Tarek Harchaoui, Kaïs Dachraoui

12:00 - 12:30 Coffee-Break

12:30 - 13:30 **Keynote Address (Chair:** *Knox Lovell*)

Europe Chasing the American Growth Frontier
Speaker: *Robert Gordon (Northwestern University)*
Comment: *Robert Russell (University of California-Riverside)*

13:30 – 14:00 **Closing ceremony**

14:00 - 15:30 Lunch

15:30 – 19:00 **Workshop trip** (guided visit to Oviedo)

21:00 – ??:00 **Workshop dinner** at Centro Asturiano Country Club

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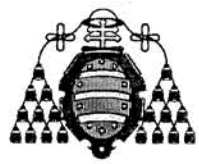
EIGHTH EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY

Oviedo, Spain
September 24-27, 2003

Book of Abstracts



Universidad de Oviedo

Wednesday 24
PRE-CONFERENCE SESSIONS

WEDNESDAY 24	
SESSION A.1 PARAMETRIC APPLICATIONS	*SESSION A.2* NON-PARAMETRIC APPLICATIONS
SESSION B.1 PARAMETRIC APPLICATIONS	*SESSION B.2* NON-PARAMETRIC APPLICATIONS
SESSION C.1 PARAMETRIC APPLICATIONS	*SESSION C.2* NON-PARAMETRIC APPLICATIONS

WEDNESDAY

10:00 - 11:30 SESSION A-1: *Parametric Applications*

A Cost Study of US Telecommunications

Szabolcs Lorincz *(University of Toulouse, France)*

A multiproduct cost model is estimated on a panel of US local exchange carriers from the period 1989-1999. Unlike earlier econometric research on the industry, the model allows specification of cost inefficiency. Results show slight economies of scale and density with moderate cost increments due to allocative inefficiency. Between network access provision and call services, there are anticomplementarities in costs. These findings, joint with cost elasticities' confirmation that the true bottleneck of the technology is network access, point to a related trade-off policy is facing with. Competition in call services might improve performance in this segment, but can interfere with network infrastructure's maintenance/expansion.

Productivity and Efficiency Measurement of Railways

Cesar Rivera (*University of Leeds, UK*)

The purpose of this paper is to estimate and compare the technical efficiency of selected railways in South and North America during the period 1980-1999 following a Stochastic Frontier approach. An input distance function approach is used in order to take into account the multi-output characteristic of the rail industry (passenger and freight services). This approach does not rely on price or financial data, which in many cases are not comparable or just not available, especially during the period of the latest rail reforms (restructuring, privatisation, concessioning, etc.). The results showed that the United States and Canada are the most efficient railways in the region as expected, given partial productivity indicators, following by Brazil, Mexico and Chile.

European Integration and Technical Efficiency: The Role of Public Capital and Education

María Jesús Delgado *(Universidad Rey Juan Carlos, Spain)*

The aim of this paper is to measure and analyze technical efficiency behaviour in the EU-15 from 1980 to 2001, when important progress was made as to european integration, and confirm the existence of effiency convergence among countries. To carry out this analysis, a stochastic frontier model has been used, making it possible to study the role of public investment policy in infrastructures and education. We introduce these two capitals in the function to be estimated and take into consideration allocation criteria in european countries as determinants of technical efficiency. Findings confirm the positive influence of public capital and the investment effort in education on the improvement of efficiency, as well as the existence of a catch-up effect among countries.

WEDNESDAY
10:00 - 11:30 SESSION A-2: *Non-Parametric Applications*

The Law of One Price in DEA

Rolf Färe, Robin Cross *(Oregon State University, USA)*

Frequently, cost and revenue data are available, rather than input and output data. This raises the question of how the cost and revenue-based DEA model coincides with the input and output-based DEA model. A sufficient condition for the two models to coincide is that every firm must face the same price, i.e., the Law of One Price must hold. We address the question, "What are the necessary conditions for the two models to coincide?" We also explore the impact of violations of the Law of One Price by looking at a distribution of prices across decision-making units, using Farrell's original 1957 data set.

A Bias Corrected Envelopment Estimator

Luiza Badin (*Academy of Economic Studies, Bucharest, Romania*)
Leopold Simar (*Universite Catholique de Louvain, Belgium*)

The nonparametric envelopment estimators of production frontiers rely on the assumption that all the observations fall on the same side of the frontier. Therefore, any deviation from the frontier is due only to inefficiency and can be fully controlled by the decision-making units. The Free Disposal Hull (FDH) estimator is the smallest free disposal set covering all the observations. However, by construction, the FDH estimator of the efficient frontier is an inward-biased estimator of its theoretical correspondent. In this paper we consider the univariate extreme values representation of FDH estimator and we propose a bias corrected estimator for the efficient frontier, based on order statistics and closely related to FDH. The estimator is presented in terms of input efficient frontier interpreted as a minimum input function, assuming a one-input, multi-output technology. The observed input-output pairs are realizations of independent random variables and are drawn from a joint distribution whose support is the production possibilities set. In the spirit of Cazals, Florens and Simar (2002), we focus on the lower boundary of the support of a conditional distribution derived from this joint distribution of the input-output pairs.

Productivity Growth in East Asia Economies' Manufacturing

Hailin Liao (*Loughborough University, UK*)

Identifying technical progress and production efficiency in productivity analysis is crucial for understanding potential sources of economic (sustained) growth and international competitiveness. However, debates on the East Asia economic 'miracle' and determinants of sustained growth are never convergent. The main purpose of this study is (1) to use the frontier approach to capture both efficiency change and technological change as components of productivity change, which introduces an additional dimension to the analysis from the policy perspective; (2) to discuss and compare two most commonly used frontier methods to check on the robustness of the empirical measure of TFP growth in eight East Asian economies during 1963-1998. The results are also compared with previous studies.

WEDNESDAY
12:00 - 13:30 SESSION B-1: *Parametric Applications*

Efficiency Performance in Asian Banking

Kym Brown (*Monash University, Australia*)

Using both parametric and non-parametric methodologies this project will measure Asian bank efficiency by incorporating environmental and/or risk factors that allow for the differing bank operating environments within each country. Country specific cultural, bank regulatory and non-performing loan variables will then be analysed to seek an association with average bank efficiency levels. Results will be supplemented by a comparison with univariate ratio analysis. In addition, efficiency outcomes will be incorporated with other macro variables to investigate if or how they affect the level of financial system development i.e. bank-based or capital-market based.

Technology Transfer and National Efficiency in Developing Countries

Michael Henry, Richard Kneller, Chris Milner (*University of Nottingham, UK*)

Productivity differences are viewed as an important explanation of cross-country percapita income differences. The recent literature has put forward two principal explanations for differences in productivity: technology transfer and absorptive capacity. This paper finds evidence that both are important for explaining productivity differences in developing countries and that international trade makes a contribution to both. Developing countries benefit from the R&D investments of developed countries by importing capital goods in which this technology is embodied, while openness to international trade, through greater competitive pressures, also reduces technical inefficiency.

Railway (De)Regulation: a European Efficiency Comparison

Catherine Vibes, Guido Friebel, Marc Ivaldi (*University of Toulouse, France*)

Since the 1980s, many countries have seeked to increase the efficiency of national railroad companies through a range of reforms: separating infrastructure and operations, creating independent regulatory institutions and providing access to the network to third parties. Recently, the European Commission has declared these reforms crucial elements for developing the European railroad industry. We investigate a new panel data set, assembled by the World Bank, and covering most EU countries over a period of 20 years. The goal is to compare the efficiency of national railroad companies, by means of a production frontier model, and to evaluate the effects of reforms on efficiency. Introducing a new way to control for the effect of freight traffic on efficiency of passenger traffic, and using both OLS and controlling for potential endogeneity through LISREL, we find positive, although small effects of reforms.

WEDNESDAY
12:00 - 13:30 SESSION B-2: *Non-Parametric Applications*

Efficiency and Rent-seeking Activities at Public Hospitals: Evidence for Costa Rica

Ariadna García, Juan Cabases, Pablo Arocena (*Public University of Navarra, Spain*)

This paper evaluates the impact of changes in the way of financing public hospitals through introduction of management agreements and hospital decentralization on health workers behaviour within these public hospitals as well as on hospital efficiency. We are using an intertemporal DEA through which we get the efficiency scores for the hospitals (before and after the policy changes) adjusted by quality (we introduce negative outputs such as number of hospital infections, number of readmissions and waiting lists). We are using a directional function approach, calculating direccional technical efficiency of hospitals producing positive and negative outputs. At a second stage we regress these efficiency scores with the absenteeism rates at the hospital, which is a proxy for the rent-seeking behavior of health care workers. We are testing if the introduction of hospital reforms based on more competitive mechanisms is useful to reduce the oportunistic behavior of health care workers and therefore, increase efficiency. We are working with Costarrican public hospitals using panel data with 150 units from 1995-2001.

An Analysis of Farm Efficiency in Colombia: A Nonparametric Approach

María González, Rigoberto López (*University of Connecticut, USA*)

This paper uses Data Envelopment Analysis to measure scale and technical efficiencies of 925 farms in rural Colombia and a Tobit model to identify the effects of land market characteristics on efficiency. Findings indicate that although larger farms are more scale efficient, they are not more technical efficient than small farms. Participation in land markets increases technical efficiency, indicating a positive potential role for market-based land reform. Further results show that intensity of violence in rural areas results in increased scale efficiency, allegedly through consolidation of land ownership.

Aggregation of Farrell Efficiencies with Possible Reallocation of Inputs

Franklin Soriano, Prasada Rao, Tim Coelli *(University of Queensland, Australia)*

We re-assess various firm and industry efficiency measures developed by Färe and Zelenyuk (2003) after relaxing certain basic assumptions. In the aggregation of the Farrell output and input orientated efficiency measures, we relax the assumption that firms face the same output prices. The paper investigates the aggregated overall industry performance measure that allows reallocation of allocatable input endowments across firms in an industry. The study uses microdata from a set of firms in the Australian, textile, clothing, footwear and leather manufacturing industry, which are taken from the Australian Bureau of Statistics confidentialised unit record file (ABS-CURF), to numerically illustrate the effects of the reallocation in the aggregate industry efficiency measures.

WEDNESDAY
17:30 - 19:30 SESSION C-1: *Parametric Applications*

The Analysis of Technical Efficiency for Small Dairy Farms in Southern Chile

Victor Moreira (*University of Connecticut, USA*)
Boris Bravo-Ureta (*University of Connecticut, Storrs, USA*)
Jorge Vásquez (*Paillaco Farm Management Center, Chile*)

Over the past several years, Chile has been adopting a wide range of economic reforms in an attempt to consolidate a modern free market system that is open to international trade. One such effort has been the introduction of Farm Management Centers (FMCs), which have as a major goal the training of farmers so that they become better managers. Given that FMCs were initiated with the specific goal of improving managerial performance, this paper will formally test this hypothesis. Specifically, we will test the null hypothesis that technical efficiency has been time invariant over a period of years starting with the formation of the Paillaco FMC. If this hypothesis is rejected and technical efficiency is found to increase over time then this finding will be consistent with one of the primary goals of the FMC concept. This paper will use data for dairy farmers that are members of the FMC using an unbalanced panel data set for the period 1996-2002. The stochastic frontier methodology for panel data is used to estimate a production function model where output is the annual milk produced per farm, and the inputs are: total labor, including hired and family labor; number of dairy cows; pasture land; purchased concentrate feed; and other expenses.

Technical Efficiency of Sow Farms: A Comparison of Methods

Xavier Ezcurra, Margarita Moltó, Lluis Pla *(University of Lleida, Spain)*

This paper uses empirical data from 96 Spanish sow farms classified into two groups depending on the final product: weaned piglets or feeder pigs. They were analysed separately. Productive efficiency of sow farms was studied using the constant returns to scale (CRS) and variable returns to scale (VRS). Input-oriented DEA models were calculated. Analysis of returns to scale is used to investigate scale efficiency for sow farms. The results reveal considerable efficiencies in this study. Also efficiency measures are derived using the parametric stochastic efficiency decomposition technique. Results of the parametric model was found not adequate for the distribution of the inefficiency effects. Thus the efficiency measures estimated from the DEA frontier was considered not comparable with the estimated using the parametric approach for these specific data. Firm-specific factors affecting productive inefficiencies from CRS-DEA model are also analysed.

Exact Decomposition of Allocative Inefficiency Using a Quadratic Cost Function

Juan José Díaz, Eduardo Martínez (*Universidad de La Laguna, Spain)*

Parametric decomposition of the evolution of productivity in a model that does not take into account inefficiency is based on Denny et al. (1981). Their proposal has been developed for continuous variations of data. On the contrary, the usual available information on economic variables only allows the calculation of discrete rates of variations. To solve this problem, the translog functional form underlying the index of Törnqvist has been used. More over, the use of quadratic functions in models that do not include inefficiency has required the construction of specific indices of this functional form, adapting for this case the theory of productivity when the available information is expressed in discrete data. The inclusion of inefficiency in the productivity model has been done by Bauer (1990), also proposed for continuous variables. Likewise, the adaptation of discrete variables has been done from the translog functional form and the Törnqvist index. In this paper we propose a theoretical model that adapt the productivity decomposition carried out by Bauer to the case when available information is only the kind of point observations, and the cost function is specified through a quadratic functional form. Thus, we identify the effects upon productivity of allocative and technical inefficiency, of technical change, of returns to scale and of bias related to input aggregation; and all these according to the rates of variation of available discrete data.

WEDNESDAY
17:30 - 19:30 SESSION C-2: *Non-Parametric Applications*

The Source of Productivity Growth in Dutch Arable Farming: A Perspective From Finance

Guan Zhengfei, Alfons Oude Lansink (*Wageningen University, Netherlands*)

Modigliani and Miller (1958) conclude in their seminal paper that the capital structure is irrelevant to firm value under a set of strong assumptions. After MM's study, irrelevance theorem was challenged under more realistic settings. Main arguments include the effects of taxes and bankruptcy cost, information asymmetry and agency problem, free-cash-flow effect and product-market interactions. Related to moral hazards agency problem, over-investment or under-investments also affects firms' performances. In empirical study, the impact of financial arrangement on firm performance is tested across industries and within industries. However, not much attention has been paid to agricultural firms. Unlike other type of business, agriculture has distinctive characteristics, such as family operation, less control over natural production process, risks from weather and disease outbreaks, market fluctuation and subsidization. In this context the financial arrangements may have different impact on agricultural firms. The standard hypothesis in corporate finance theory needs to be investigated. In this study Malmquist productivity index is employed to (1) investigate the impact of financial arrangement on farm performance in production and technological change, (2) analyse the source of productivity growth, taking account of farm characteristics.

DEA Based Bank Branch Productivity Comparison with Bank Methods

Joseph Paradi, Niloofar Tochaie, Mette Asmild (*University of Toronto, USA*)

The subject of this paper is a study of one the big five banks in Canada, but with an interesting difference. The bank has already developed a methodology to measure the most effective staffing allocation across its branches. They use an "efficiency band" which identifies both branches that are over staffed and others which are understaffed. In effect, the most efficient branches (in a DEA sense) are understaffed and are working too hard, so additional staff is required. Overstaffed branches are identified in the usual way. An evaluation or validation of their system as well as some improvements seem essential for the bank. Therefore, the results gained from the proposed solution based on a DEA analysis and the bank's system are being compared to each other. The DEA model proposed monitors the bank branch network efficiency and identifies the best practices of efficient branches, which enables the management to efficiently and effectively manage its human resources across the sales delivery network. When comparing/contrasting the results from both methods, much can be learned. These results yield a practical methodology and computational tool that the bank's executives, managers, and analysts may use to monitor and enhance various aspects of their branch staff allocation, as well as making strategic decisions around the effective redeployment of staff.

On Testing the Equality ofTwo Distribution Functions of DEA Efficiency Scores

Léopold Simar (*Université Catholique de Louvain, Belgium*)
Valentin Zelenyuk (*National University "Kyiv-Mohyla Academy", Ukraine*)

In this study we investigate performance of statistical test of equality of two densities of Farrell-type (technical) efficiencies. We discuss theoretical complications in applying the existing tests that are based on central limit theorem for degenerate U-statistics for the context when the DEA-estimates are used in place of the true but unobserved efficiencies and propose the sub-sampling bootstrap as a way to improve the test performance.

September 25-27
CONFERENCE SESSIONS

THURSDAY 25			
SESSION 1.A ENERGY	*SESSION 1.B* TRANSPORT	*SESSION 1.C* NON-PROFIT ORGANIZATIONS	*SESSION 1.D* EDUCATION I
SESSION 2.A THEORY	*SESSION 2.B* DEA APPLICATIONS I	*SESSION 2.C* SFA APPLICATIONS I	*SESSION 2.D* TFP APPLICATIONS
SESSION 3.A ENVIRONMENTAL EFFICIENCY	*SESSION 3.B* REGULATION AND EFFICIENCY I	*SESSION 3.C* EXPLAINING EFFICIENCY	*SESSION 3.D* PRODUCTIVITY
SESSION 4.A AGRICULTURE I	*SESSION 4.B* BANKS I	*SESSION 4.C* PUBLIC SECTOR	*SESSION 4.D* HEALTH I

FRIDAY 26			
SESSION 5.A AGRICULTURE II	*SESSION 5.B* BANKS II	*SESSION 5.C* REGIONAL EFFICIENCY	*SESSION 5.D* HEALTH II
SESSION 6.A RISK AND EFFICIENCY	*SESSION 6.B* DYNAMIC EFFICIENCY	*SESSION 6.C* EDUCATION II	*SESSION 6.D* BOOTSTRAPPING DEA SCORES
SESSION 7.A STATISTICAL ANALYSIS	*SESSION 7.B* REGULATION AND EFFICIENCY II	*SESSION 7.C* TECHNICAL CHANGE	*SESSION 7.D* DEA APPLICATIONS II
SESSION 8.A ECONOMETRICS I	*SESSION 8.B* DEA ADVANCES I	*SESSION 8.C* INDEX NUMBERS	*SESSION 8.D* DISTANCE FUNCTIONS

SATURDAY 27			
SESSION 9.A MACROECONOMIC ISSUES	*SESSION 9.B* DEA ADVANCES II	*SESSION 9.C* SFA ADVANCES	*SESSION 9.D* ECONOMIES OF SCOPE
SESSION 10.A ECONOMETRICS II	*SESSION 10.B* NON-PARAMETRIC ANALYSIS	*SESSION 10.C* SFA APPLICATIONS II	*SESSION 10.D* MALMQUIST INDEX

THURSDAY
9:00 - 10:15 SESSION 1-A: *Energy*

Open Access Transportation, NERC, and Efficiency in Electric Utility Generation

Gerald Granderson *(Miami University, USA)*

This paper examines the impact of congressional and regulatory policy acts, and membership in the North American Reliability Council (NERC), on efficiency in electricity generation. Congressional and regulatory policy acts led to the creation of non-utilities that could produce and sell electric power. Also, electric utilities are required to provide producers and end-users non-discriminatory access to their transportation facilities. NERC promotes the reliability and security of the bulk electricity system, via establishing standards to ensure the reliability, reviewing the adequacy of existing and planned generation and transmission systems, and reviewing disturbances that occur in the electric system. NERC also gathers information from various power producers, which in is available to its members. The policy acts, information available to electric utilities and, standards established by NERC can also lead to improvements in firm efficiency. The data sample is a panel of 30 U.S. privately owned electric utilities from 1988 to 2001.

The Relative Performance of Privatized Utilities: Electricity Distribution in Latin America

Martin Rossi (*University of Oxford, UK*)

This article analyzes the relative performance of recently privatized Latin American electricity distribution utilities by using a labor requirement function approach. Empirical results show that privatized firms are more efficient in their use of labor and have higher labor productivity growth rates than public or cooperative companies.

Measuring Productivity when Grids are Merging

Arvid Göran Ek *(Swedish Energy Agency, Sweden)*

When following a panel of electricity grids one can get straightforward results using DEA and Malmquist index. But if the panel is successively reduced by mergers the productivity measurement will be biased. First, the number of "competitors" in the bench-mark game DEA is reduced with the tendency to give higher efficiency score. Second, the resources in the pre-merged period is excluded when the grid in question has disappeared as a separate unit. These resources will still be in use in the next period, although with some reductions due to the realization of the merger gain potential. The measure of productivity change in an industry when firms merge will give different results depending on if the firms (observations) are excluded from the panel when they merge into another firm relative to the proposed method of making an ex ante virtual merging which can be used as benchmark for the panel in the next productivity measurement. The proposed method is presented with a simple example explaining the basic idée behind the method. An empirical study is done with data on the electricity distribution grids in Sweden. The grids in Sweden are rapidly merging with regard both to the ownership and internally to the number of price areas within each firm. The panel of observations is therefore successively reduced. The merging process is expected to result in productivity gains but in the same time is the benchmark information reduced due to fewer units to observe.

THURSDAY
9:00 - 10:15 SESSION 1-B: *Transport*

Measuring Inefficiency in the Norwegian Bus Industry using Multi-Directional Efficiency Analysis

Jens Leth Hougaard *(University of Copenhagen, Denmark)*
Torben Holvad *(University of Oxford, UK)*
Dorte Kronborg, Hans Kurt Kvist (*Copenhagen Business School, Denmark)*

This paper deals with methods of measuring and analyzing efficiency in transport industry. The aim of the paper is to introduce and demonstrate the advantages of Multi-directional Efficiency Analysis (MEA) in case of cost data with limited substitution possibilities. For this purpose we reconsider theNorwegian bus data that has previously been analyzed using econometric models and Data Envelopment Analysis; Jørgensen, Pedersen and Solvoll (1995), Jørgensen, Pedersen and Volden (1997) and Odeck and Alkadi (2001). It is shown how, using MEA, it becomes possible to disaggregate inefficiency into different components corresponding to different types of cost generating variables and thereby provide both managers of the bus companies and policy makers with more detailed information on possible improvements of performance.

Efficiency Measurement for UK Airports: An Application of Data Envelopment Analysis

Torben Holvad (*University of Oxford, UK*)
Anne Graham (*University of Westminster, UK*)

This paper aims to examine the efficiency of airports using Data Envelopment Analysis (DEA) technique. The paper involves the analysis of technical efficiency for airports in the United Kingdom. Studies of the performance of UK airports using DEA are lacking. An analysis of efficiency variations for UK airports is of interest as there are significant differences between the airports in terms of ownership structure, company size and market segmentation. A range of different efficiency measures within the non-parametric frontier tradition will be calculated. As such this information will provide a very detailed picture of the differences in performance among the included airports. In addition, to the calculation of efficiency measures emphasis will also be put on possible explanations of the obtained results to determine whether efficiency variations are caused by controllable factors.

Estimation of a Mixture of Input and Output Distance Functions, An Application to Railways

Luis Orea (*Universidad de Oviedo, Spain*)
Subal Kumbhakar (*State University of New York at Binghamton, USA*)
Ana Rodríguez (*Universidad de Oviedo, Spain*)
Mike Tsionas (*Athens University of Economics and Business, Greece*)

In this paper we estimate parametric input and output distance functions as well as a mixture of input and output distance functions. Since estimates of technical inefficiency from the input and output distance functions are not directly comparable, we develop cross-indices that can be used to compute input (output) technical inefficiency from the estimates of output (input) distance function. These cross-indices are especially useful in the mixture model in which both the input and output distance functions are simultaneously estimated. The proposed technique is applied to a panel data on European Railways (1970-1994).

THURSDAY
9:00 - 10:15 SESSION 1-C: *Non-Profit Organizations*

Measuring Library Efficiency: A Non-Parametric Approach

Margit Sommersguter-Reichmann, Gerhard Reichmann (*Graz University, Austria*)

This paper suggests a framework for assessing the technical efficiency of college libraries in Germany. The sample consists of 30 college libraries covering a period from 1998 to 2000. The selection of variables actually used for assessing the relative library efficiency from a set of candidate variables is based upon stepwise DEA proposed by Kittelsen (1993). The results suggest a DEA model based on 2 inputs and 2 outputs. Using the same test statistic with regard to the returns-to-scale specification the results indicate the use of a variable returns-to-scale DEA model. The analysis of efficiency changes over time based on a sequential frontier reveals considerable efficiency differentials across college libraries and across years. To provide some information on the influence of peer libraries several measures are calculated.

Measuring Efficiency in the Provision of Communal Services. A Case Study for Italy

Ornella Maietta (*University of Naples "Federico II", Italy*)
Sergio Destefanis (*University of Salerno, Italy)*

The measurement of efficiency in the provision of communal services has become a very high policy priority in advanced economies. Theoretically, it has long been known that the lack in the non-profit sector of a stakeholder class interested in appropriating the residual from production is a priori likely to increase the chances of opportunistic behaviour from the part of workers and managers, raising the costs of firms in this sector vis-à-vis their for-profit counterparts. Yet, empirical evidence on this matter is at present scarce and far from conclusive. In any case, while the objective function of for-profit firms is almost invariably given by some form of profit maximisation, the objective function of non-profit organisations is less clear-cut and very often multi-dimensional. There is a further issue which closely concerns the measurement of efficiency in the present ambit. The tendering of the provision of communal goods to private organisations raises the issue of the quality of the services provided. In the present work, we undertake to shed some light on these relatively unexplored issues by relying on a data-set about Italian for-profit and non-profit organisations engaged in the provision of communal goods.

Efficiency in Social Services: Assesing the Performance of Programmes

Javier Salinas, Luis Ayala, Francisco Pedraja (*Universidad de Extremadura, Spain*)

This paper is essentially aimed at analysing efficiency differences in the management of Income Support Maesures as well as finding out factors which determine them. In order to meet this objective, the issue is focussed from a two-fold perspective: firstly, the efficiency of social assistance centres is assessed, considering time needed for managing applications as the major output and the different human capital endowment of each centre as the main input. The second part of this analysis deals with efficiency measurement through the various results of each centre related to the achievement of the highest levels of social and economic insertion of those persons participating in such programmes. The data used are the administrative records of the Income Support programmes of the region of Madrid.

THURSDAY
9:00 - 10:15 SESSION 1-D: *Education I*

Measuring Overeducation with Stochastic Earnings Frontiers and Panel Data

Uwe Jensen (*University of Kiel, Germany*)

In this paper, frontiers are applied in labor economics. Employees are called overeducated if the knowledge they have acquired in the education process cannot be fully applied in their present jobs. Overeducation stands for inefficient use of individual and social resources. One yet unsolved problem is how to best measure overeducation. Since the measures in the literature have certain drawbacks this paper proposes a new technique. Based on the human capital model, an earnings frontier describes the transformation of schooling investments (input) to earnings (output). Inefficiency occurs in this production process because the assumptions of human capital theory are not fulfilled in reality, particularly due to information deficits of employers and employees. Therefore, overeducation is measured as income inefficiency, i.e. as ratio between potential income - estimated by a stochastic earnings frontier for given human capital - and actual income. The technique is applied to panel data from the German Socioeconomic Panel.

The Efficient Allocation of Student Time: Comparing Stochastic and Non-Stochastic Methods

Peter Dolton (*University of Newcastle, UK*)
Oscar Marcenaro (*London School of Economics, UK*)
Lucía Navarro (*University of Malaga, Spain*)

Little attention has been devoted to the analysis of the relationship between student study time allocation and student performance. This paper addresses the issue of efficiency in student time use in university study. Specifically, we model the allocation of student time into formal study (lectures and classes) and self study and its relationship to university examination scores using stochastic and non-stochastic methods. More precisely we compare the use of both a stochastic frontier (SF) production function and Data Envelopment Analysis (DEA). These two different methods enable the identification of inefficiency in the pattern of student time use in the process of effective student learning. The stochastic frontier approach allows 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. In contrast, DEA uses a non-parametric approach, requiring few assumptions about the underlying technology. This case study uses unique time budget data and detailed personal records from one university in Spain. The results suggest that formal study time remains a key factor in the educational process.

Research Efficiency: A Micro-Analysis of Dutch University Research in Economics and Business

Laurens Cherchye, Piet Vandenabeele *(Catholic University of Leuven, Belgium)*

We argue that efficiency assessments of academic research should focus on micro-units of research production rather than on conventionally employed (aggregated) macro-units, and show that such a detailed analysis of research performance provides interesting insights. In addition, we propose a non-parametric methodology that is specially tailored for analyzing the productive efficiency of research: it starts from a specification of the managerial objectives of research activities while imposing minimal structure on the (typically unknown) production technology. We illustrate our points by assessing the productive efficiency of research in Economics and Business Management faculties at Dutch universities. Next to measuring productive efficiency, we look for specific patterns in efficiency distributions over universities, years and areas of specialization. In addition, we investigate the impact of external funding and of the size of research programs on academic research efficiency.

THURSDAY
10:45 - 12:00 SESSION 2-A: *Theory*

A Microeconomic Theory of Price-Induced Technical Progress

Quirino Paris, Michael Caputo (*University of California, Davis, USA*)

Hicks, Griliches, Arrow, Mansfield, Hirsch, McFadden and other distinguished economists have advanced the conjecture that entrepreneurs choose production techniques (at least in part) on the basis of their expected profitability. Since expected profitability depends crucially on expected relative prices, the implementation of this hypothesis requires that expected relative prices enter the production function as shifter parameters of the technological frontier. This paper derives the modified Slutsky matrix that accompanies the price-induced technical progress (PITP) conjecture. It turns out that the test of the PITP hypothesis requires the joint estimation of primal and dual relations of the production and cost system. This objective is realized with a novel estimation approach of the nonlinear errors-in-variables specification that constitutes the primal and dual framework of the cost-minimizing firms under the PITP hypothesis.

Productivity Indexes for Stochastic Technologies

Robert Chambers *(University of Maryland, USA)*

Virtually all existing productivity indexes have been derived under the assumption that producers face a nonstochastic technology and act to maximize profit. Neither of these assumptions appear tenable for most real-world situations. This paper uses the Arrow-Debreu state-space formulation of stochastic technologies, as recently extended by Chambers and Quiggin, to derive productivity indexes for individuals with Krep-Porteus preferences over risky outcomes.

On Graph Efficiency Measurement

Joaquín Millán (*Universidad Politécnica de Madrid, Spain)*

When the economic problem is the simultaneous adjustments on input and output quantities, the reference technology, and the possibility of attaining the reference frontier, is constructed modelling the technology with the graph. A series of efficiency measures that evaluate performance relative to technology described by the graph appear in the literature. The most important of them is the measure constructed using a hyperbolic path to the reference technology: increases in output quantities and decreases in input quantities occur at the same proportion. This paper argues that there is a problem with the current measurement of graph measures because a true efficiency measure must consider the possibility of improvements in both outputs and inputs simultaneously. However, (hyperbolic) graph measures are constructed using only the part belonging to inputs (or outputs) instead of the joint contribution to efficiency. It is paradoxical that the equivalence between input-oriented and graph efficiency measures is recognised, and used for computational purposes, but the fundamental observational equivalence is neglected. As a simple example, the input-oriented and output-oriented efficiency measures are equal under constant returns to scale, but according to common measurement practices the hyperbolic graph efficiency measure, a compound of both input-oriented and output-oriented measures, is the square root of the efficiency computed using any of them! This inconsistency arises in more sophisticated applications of graph efficiency measures. This paper present a unified framework to analyse graph efficiency that results in the equality of graph-efficiency measures to input-oriented or output-oriented measures under the appropriate situations. The implications for common practice are reviewed. The results are valid both in econometric (parametric) and non parametric (DEA) frameworks.

THURSDAY
10:45 - 12:00 SESSION 2-B: *DEA Aplications I*

The Use of "Performance Radars" as a Predictor of Police Force Efficiency in the UK

Richard Simper, Leigh Drake (*Loughborough University, UK*)

Over the last 20 years, governments around the world have implemented strategies and targets to ensure that public services are efficient in the management of resources. In the UK this common agenda has led to the recent 'Police Reform Act 2002' in which consideration was given on how police forces can show 'Value for Money' based on government strategic policy targets. This paper discusses the 'Performance Radar' technique proposed by the Home Office in the United Kingdom as a new public policy objective in order to assess police force performance. We show, utilising an innovative nonparametric modelling strategy, that environmental factors and revenues can have significant effects on whether a police force is deemed to be efficient. Further, the results presents evidence that survey data should not be utilised as a basis to assess police performance.

A Value Efficiency Approach to Including Environmental Factors in DEA: Helsinki Parishes

Halme Merja (*Helsinki School of Economics, Finland*)

In this paper a we propose an approach to incorporate information about environmental variables into Data Envelopment Analysis (DEA). Our special focus is in the environmental factors that affect the allocation of outputs (inputs). As an example we use a case concerning parishes in Helsinki. In that case the environmental factors affecting the decisions are such that cannot be satisfactorily taken into consideration by already known approaches. We use the Value Efficiency procedure in the basic version of which first the best unit called the Most Preferred Solution (MPS) is chosen on the efficient frontier. Then the efficiency of the rest of the units is calculated using that unit as a reference. The resulting scores are less optimistic than the normal DEA efficiency scores. We propose the use of several - preferably existing - units as Most Preferred Solutions. These units are such represent different categories as for environmental circumstances. The rest of the units can be assigned an efficiency score using the MPS in their category as a reference.

Assessing How ICT Affects Bank Branch Operating Efficiency

Leonard Parsons (*Georgia Institute of Technology, USA*)
Jos Lemmink, Rita Walczuch, Alexander Bielowski (*University of Maastricht, Netherlands*)
Jan Mattsson (*Roskilde University, Denmark*)

Our focus is on the extent to which information and communication technology (ICT) affect branch-bank performance. There have been a number of applications of DEA to assessing branch-bank efficiency. Some of these studies have included an ICT variable such as the number of on-line terminals, hours of computer terminal usage, or number of automatic teller machines. One study incorporated of the number of computer terminals as an explanation of efficiency differences. We collected data on the Belgian branches of a multinational financial service provider. In addition to internal operating data and external market data, questionnaires were given to both managers and employees. Questions included ones about work satisfaction, leadership, empowerment, and technology readiness. DEA analysis was performed to benchmark performance of the branches. Differences in the external environments facing branches were adjusted for. Branch efficiency scores were then related to characteristics of individual branches using Tobit analysis.

Impact of Regulatory Changes on Productivity Growth in Telecommunications Industry of OECD Countries: A Heteroskedastic Error Component Model with Unbalanced Panel Data

Arunava Bhattacharyya (*NJ AT&T Laboratories, USA*)

DEA provides a basis for target setting, but the main limitation of the standard DEA models is that they do not take into consideration the decision maker's preferences. This limitation is discussed in many papers that introduce approaches to target setting. However, these papers do not analyse the importance of the value information and the effect of excluding it in practice. Our paper discusses these aspects based on an empirical experiment, where a group of students was free to choose their own target values on the efficient frontier. On the basis of these results we analyse how the radial projections correspond to the preferences of the decision makers. The results show that radial projection is too restrictive for target setting. We propose that in case a DMU has a control over some inputs or outputs, a multiple objective linear programming approach should be used in target setting.

Finance Constraints, Profit-sharing and Technical Efficiency of Italian Firms

Ornella Maietta (*University of Naples "Federico II", Italy*)
Vania Sena (*University of Leeds, UK*)

This paper analyses the mechanisms through which binding finance constraints can induce firms (with profit-sharing schemes) to improve technical efficiency over time in order to guarantee positive profits. This hypothesis is first formalised in a partial equilibrium framework and then is tested on a panel of firms belonging to the Italian manufacturing. Technical efficiency indices are computed by estimating parametric production frontiers. Conventional measures of finance constraints are used to analyse their impact on firms efficiency growth; particularly, the debt-to asset ratio (DAR) e the interest coverage ratio (ICR) are alternatively used to estimated the mean and the variance of the inefficiency component of the error in a one-stage approach. The results support the hypothesis that a restriction in the availability of financial resources can affect positively the growth in efficiency.

Agglomeration Externalities Within and Between Industries: A Firm Level Cost Function Approach

Ragnar Tveteras, Frank Asche *(Stavanger University College, Norway)*

Econometric studies of agglomeration economies have primarily applied aggregate manufacturing data to analyse the existence of external economies of scale, and to what extent internal economies of scale at the industry level are overestimated if the external economies are not accounted for. This paper focuses on regional industrial clusters by estimating cost functions on firm level data. By using firm data we avoid aggregation biases and can test a rich set of hypotheses on how these externalities affect the structure of costs at the firm level. Of particular interest is whether there are inter- or intra-industrial agglomeration externalities or both. We focus on the Norwegian salmon aquaculture industry and two related industries, fisheries and fish processing. Our econometric results suggest that for salmon aquaculture firms, positive agglomeration externalities within the salmon industry dominate spillovers from the related industries.

THURSDAY
10:45 - 12:00 SESSION 2-D: *TFP Applications*

Productivity Decomposition in Brazilian Manufacturing

Fernando García, Jorge Pires, Rogério Souza (*Escola de Economia de São Paulo, Brazil*)

The stochastic production frontier model is applied to Brazilian manufacturing in order to pinpoint the sources of economic growth: accumulation of physical capital, use of labor and total factor productivity (TFP). Following Kumbhakar (2000) and Kim & Han (2001) we decompose the growth of TFP into technical progress, changes in technical efficiency, changes in allocative efficiency, and scale effects. Our main objective is to provide a methodology to be used when only aggregates for groups and subgroups of firms belonging to related activities are available (representative firms). We take each subgroup of activity as an observation in a panel and estimate best practice production frontiers controlling for each of the 23 groups, using 1996 to 2000 data from the Annual Industrial Survey (PIA). Based on such estimates we analyze to what extent labor force skills and R&D investment have influenced the frontier differentials, technical efficiency and technical progress.

Local and Global Malmquist-Type Productivity Change Indices

Mette Asmild, Fai Tam *(University of Toronto, Canada)*

Two different formulations of DEA based Malmquist indices are common in the literature, but their properties and results are quite different. In this paper we suggest 1) A new decomposition of the adjacent index, which considers the global frontier shift as well as local measures for favorability of individual locations, 2) A new formulation of a local Malmquist-type productivity change index, which has the advantage of being transitive without depending on a fixed base period, 3) Global versions of both the adjacent and the base period index. The different indices are illustrated and compared using DEA scores from an empirical data set of North American pulp and paper mills.

Sources of Productivity Growth in the Spanish Pharmaceutical Industry

Eduardo González, Fernando Gascón (*Universidad de Oviedo, Spain*)

The Spanish pharmaceutical industry has suffered an important transformation during the 90s. To survive under the new market conditions labs had to refocus their competitive strategies towards increasing productive efficiency or reinforcing R&D activities. This paper analyzes the evolution of the productive patterns in a sample of 80 pharmaceutical laboratories that operated in Spain from 1994 to 2000. We estimate Malmquist productivity indexes and decompose them into fours sources of productivity change. The results suggest that technical efficiency change and the scale change of the technology explain most of the observed productivity growth observed during the period. The contribution of technical change to productivity growth is negligible, indicating a poor result of the R&D activities at least in the group of small and medium sized labs.

Agriculture Externalities and Environmental Regulation. Good Practices in Citrus Production
Ernest Reig, Andres Picazo (*Universitat de València, Spain*)

This paper aims to analyse the economic effects of constraining farmers' behaviour to a code of good practices in nitrogen fertilisation. Using data envelopment techniques, we calculate unrestricted and environmentally-regulated short run maximum profits, which are used to compute an index of the cost of regulation. We apply this index to a sample of citrus fruit farms in the Region of Valencia (Spain). Our results suggest that the cost of adjusting to the recommended practice is relatively low; the profit loss computed being only about 4 per cent. Furthermore, a graph measure of overall efficiency, following Färe, Grosskopf and Lovell (1994), is also computed. Finally, it seems that the current gap between observed and regulated fertilisation practices could be overcome by improving overall management efficiency.

Environmental Taxation and Frontier Analysis: Insights and Implications of Using DEA
Wendy Chapple (*Nottingham University, UK*)

It has become generally accepted that production processes should take into account principles of sustainability, particularly with the increased regulatory focus on sustainability of production. As a result, there has been significant progression in the modelling of environmental issues into the production process, particularly in the area of policy assessment with regards to shadow costs. In recent years there are been significant shifts in the policy arena, with movement away from traditional command and control frameworks of environmental standard setting towards more innovative policy initiatives ranging from market based systems to voluntary initiatives. To date, much of the empirical and theoretical focus has been on the assessment of regulatory standards with little analysis on other forms of environmental policy, such as market based or voluntary environmental initiatives, which have different costs structures, decision processes, impacts and implications. This paper combines theoretical environmental taxation literature with the productivity methodology to discuss how this approach can provide significant insight into the evaluation of efficiency and efficacy of flexible environmental policy. This paper concludes by discussing the case of the UK landfill tax and its impacts on waste generation in the UK.

Productivity Growth in US Sub-Manufacturing Industries in the Presence of Bad Outputs
Osman Zaim (*Bilkent University, Turkey)*

The last two decades have witnessed major improvements in the measurement of productivity growth. More recently, a large number of studies have been devoted to measuring the effects of environmental regulation on productivity growth. Within a DEA framework two such measures that put due emphasis on the characteristics of production with negative externalities; Malmquist-Luenberger Productivity Index and Cost Malmquist Index, exploit the dual representation of the technology. However, an empirical comparison of these two techniques, has not been done so far. The objective of this study is to provide a comparison of these two approaches, employing data on U.S sub-manufacturing industries. A recently released panel data by Environmental Protection Agency on emissions of environmentaly hazardous substances by two-digit U.S. manufacturing industries provides a valuable means for productivity comparisons across sub-sectors by different techniques.

Productivity Growth, Technical Change, and Efficiency Change in the Water and Sewerage Industry

David Saal, David Parker (*Aston University, UK*)
Tom Weyman-Jones (*Loughborough University, UK*)

After its privatisation in 1989, the water and sewerage industry of England and Wales faced a new RPI + K regulatory price cap, a system which is a variant of the typical RPI-X regulation system. The system was designed to both encourage increased efficiency and also provide funding for the substantial capital investments which were necessitated by the tightening of environmental and drinking water standards after privatisation. Consideration of the RPI+K regime suggests the possibility that the "relaxation" of RPI-X regulation, in order to allow for the industry's massive capital requirements, may have dulled the efficiency incentives normally associated with price cap regulation. Given this hypothesis, this paper will use stochastic frontier techniques to estimate a Malmquist index of productivity growth as well as indices of technical efficiency and technological change for the period 1985-2000. These indices should allow a more careful consideration of how and whether privatisation and the RPI+K system affected productivity growth in the industry.

DEA Based Procurement Design in Natural Resource Management

Kurt Nielsen, Peter Bogetoft (*The Royal Agricultural University, Copenhagen, Denmark*)

This paper discusses the design of multidimensional yardstick based procurement auction. The suggested design combines Data Envelopment Analysis (DEA) based yardstick schemes with the multidimensional score auction. The principal select a single winner to perform a project, characterized by a multidimensional vector. The design is especially useful when there are uncertainties about the underlying common cost structure as well as the principal s valuation function. The design is especially useful in natural resource management. We finish the paper by discussing how the DEA based yardstick auction can be designed to procure multiple contracts select more winners.

Regulating the Regulators

Michael Pollitt, Preetum Domah (*University of Cambridge, UK*)

Efficiency studies of the electricity supply industry (ESI) have focused on the regulated firms. This paper uses stochastic distance function (SFA) to analyze the efficiency of a sample of ESI regulators. This attempt is made possible by data collection using an international postal questionnaire survey of 34 regulators. We translate the measured efficiency scores into efficiency adjustment (or X) factors under UK, Norwegian and Dutch regulators own assumptions about the rate at which regulated companies can reach the efficient frontier. We find substantial variation in efficiency levels between regulators. This conclusion implies that benchmarking can be a potentially important tool to make regulators more accountable to those who actually pay for regulation.

Testing the Scaling Property in a Model where Inefficiency Depends on Firm Characteristics

Christine Amsler (*Michigan State University, USA*)
Antonio Alvarez, Luis Orea (*University of Oviedo, Spain*)

In this paper we consider a modified version of the model introduced by Wang (2000). The proposed model nests other frontier models yet available in the literature and can be estimated by MLE. We show, however, that if some restrictions are satisfied (i.e. the scaling property) it can be estimated by non-linear least squares. This model allows us testing not only the scaling property but also some other interesting hypotheses regarding the distribution of the inefficiency term. The hypotheses are homoskedasticity of both the mean and variance of the pre-truncated normal (these restrictions yield respectively the so-called RSCFG and KGMHLBC models) and the traditional models introduced by Stevenson (1980) and Aigner, Lovell and Schmidt (1977). We apply the model to data on Spanish savings banks. The performed Wald, LR and LM tests rejected scaling and other simplifications.

Introducing Environmental Variables in Nonparametric Frontier Models: a Probabilistic Formulation

Cinzia Daraio (*Scuola Superiore Sant Anna, Italy*)
Léopold Simar (*Université Catholique de Louvain, Belgium*)

This paper proposes a general formulation of a nonparametric frontier model introducing external environmental factors that might influence the production process but are neither inputs nor outputs under the control of the producer. A representation is proposed in terms of a probabilistic model which defines the data generating process. Our approach extends the basic ideas from Cazals, Florens and Simar (2002) to the full multivariate case. We introduce the concepts of conditional e±ciency measure and of conditional e±ciency measure of order-m. Afterwards we suggest a practical wayfor computing the nonparametric estimators. Finally, a simple methodology to investigate the influence of these external factors on the production process is proposed. Numerical illustrations through some simulated examples and through a real data set on Mutual Funds show the usefulness of the approach.

A Flexible Time-Varying Specification of the Technical Inefficiency Effects Model

Giannis Karagiannis (*University of Macedonia, Greece*)
Vangelis Tzouvelekas (*University of Crete, Greece*)

The temporal pattern of technical inefficiency, as initially modeled by Battese and Coelli (1995) and applied in many other studies thereafter, has been very restrictive. Specifically it *a priori* imposes a common pattern upon all firms in the sample which in addition changes in a linearly monotonic fashion during the period under consideration. This in turn implies that in absolute terms the contribution of technical efficiency into productivity changes is invariant across both firms and time. Obviously this is an undesirable implication of the model especially when there is evidence of strong firm heterogeneity and/or a long time span. To overcome these shortcomings, Cornwell, Schmidt and Sickles (1990) flexible specification of the temporal pattern of technical efficiency is incorporated into Battese and Coelli (1995) model. The proposed formulation is estimated using Ball et al. (2001) data set for US and European countries agriculture during the period 1973-1993.

International Benchmarking of Electricity Distribution Utilities

Dag Edvardsen *(The Norwegian Building Research Institute, Norway)*
Finn Førsund *(University of Oslo, Norway)*

Benchmarking by means of applying the DEA model is appearing as an interesting alternative for regulators under the new regimes for electricity distributors. A sample of large electricity distribution utilities from Denmark, Finland, Norway, Sweden and the Netherlands for the year 1997 is studied by assuming a common production frontier for all countries. The peers supporting the benchmark frontier are from all countries. New indices describing cross-country connections at the level of individual peers and their inefficient units as well as between countries are developed, and novel applications of Malmquist productivity indices comparing units from different countries are performed.

An Integrated Approach to Measuring TFP with Inefficiencies and Scale Economies

Jiro Nemoto (*Nagoya University, Japan*)
Mika Goto (*Central Research Institute of Electric Power Indus, Japan*)

This paper proposes an integrated approach to measurement of efficiency and productivity. The index of TFP growth based on the Malmquist input and output indexes enables the decomposition analysis in which the effects of efficiency change, frontier shift and returns to scale on productivity growth are identified. The effects of allocative distortions are further isolated from those of overall efficiency if data on input prices are available. It is easily shown that the index of TFP growth proposed here is reduced to the T`rnqvist index in case that no inefficiencies exist. We illustrate the procedure by an application to the transmission-distribution stage of the Japanese electric utilities. To measure the Malmquist indexes, an input distance function is estimated using the stochastic frontier model with random parameters. Nonparameteric DEA techniques are also employed for comparison.

Soil Quality, Salinity and Productivity: Analysis Using Long Term Crop Rotation Trials from Western Australia

Atakelty Hailu *(University of Western Australia, Australia)*
Robert Chambers *(University of Maryland, USA)*

Australia faces serious challenges from three types of soil degradation - acidity, salinity and sodicity. These degradation problems are primarily induced by human production activities. Economically effective solutions to these challenges will require a sound assessment of the values of alternative approaches to manipulating soil quality. This study uses panel data from long term crop rotation trails in four Western Australian experiment stations to determine the interdependence between production activities and different aspects of soil quality. A Data Envelopment Analysis (DEA) model is used to incorporate initial and end of year soil quality variables into the representation of the underlying production process. Water recharge levels are also included as salinity related undesirable outputs in the model. Distance function values from this environmentally sensitive DEA model are compared to similar values obtained from a model that excludes soil quality variables in the computation of aggregate soil quality index values.

Efficiency of the Small Dairy Farm in the USA

Loren Tauer (*Cornell University, USA*)
Ashok Mishra (*U.S. Department of Agriculture, USA*)

The cost of milk production by farm size was decomposed into frontier and efficiency components with a stochastic cost curve using data on 755 USA dairy farms from the year 2000. The estimated frontier function is much flatter than the average cost curve, and although the frontier cost of production decreases with farm size, that cost reduction is not as pronounced as a cost curve with no efficiency modeled. The higher cost of production of many smaller farms is caused by inefficiency. The 50-cow farm has an average cost of production of $20.95 per cwt. of milk but a frontier cost of production of only $10.05. In contrast, the 1,000-cow herd has an average cost of $10.82 and frontier cost of production of $9.27. The implication is that the efficient 50-cow farm is competitive with the average 1,000-cow farm, but not the efficient 1,000-cow farm

Testing Tornqvist: Reducing the Agricultural Residual

David Skully (*U.S. Department of Agriculture, USA*)

Tornqvist index-based measures of multi-factor productivity growth (MFPG) assume an aggregate translog homothetic CRS technology, competitive long-run equilibrium in factor and product markets, and Hicks-neutral technical change. This paper tests the data underlying the MFPG index for U.S. agriculture and finds that none of the assumptions holds. Accounting for biased technical change, scale economies, and shadow values of quasi-fixed factors yields substantially lower rates of MFPG than uncorrected Tornqvist measures.

Quota Trading and Profitability in Fishery: Theoretical Models and Empirics from Denmark

Jesper Levring Andersen (*Danish Research Institute of Food Economics, Denmark*)
Peter Bogetoft (*The Royal Agricultural University KVL, Denmark*)

Using Data Envelopment Analysis (DEA), we provide a framework to analyse the potential gains from quota trading. We compare the profitability in an incumbent regime with the profitability after a reallocation of production rights. The estimations of profitability depends on several technological and behaviour characteristic, including economies of scale, the ability to change the input and output composition (mix), and the ability to learn best practice (catch-up). We investigate the effects of these characteristics as well as the structural implications of free trade re-allocations. To illustrate the usefulness of our approach, we analyze a dataset from the Danish fishery. We compare the obtainable industry profits under each of eight sets of technological and behavioural characteristics. We show that the aggregate gains but not the structural implications are relatively robust to the invoked characteristics. The reason is that the different means of improving industry profitability – learning, reallocating production rights, and changing catch mixes – are substitutes in the generation of aggregate profit.

THURSDAY
17:30 - 18:45 SESSION 4-B: *Banks I*

Productivity Change in European Banking: A Comparison of Parametric and Non-Parametric

Barbara Casu *(The University of Reading, UK)*
Claudia Girardone *(Middlesex University, UK)*
Philip Molyneux *(University of Wales Bangor, UK)*

This paper compares parametric and non-parametric estimates of productivity change in European banking between 1994 and 2000. Productivity growth has also been further decomposed into technological change, or change in best practice, and efficiency change. Both the parametric and non-parametric approaches consistently identify those systems that have benefited most (and least) from productivity change during the 1990's. The results also suggest that (where found) productivity growth has mainly been brought about by improvements in the performance of best practice banks and there does not appear to have been 'catch-up' by non best-practice institutions. Competing methodologies sometimes identify conflicting findings for the sources of productivity for individual years. However, the two approaches generally do not yield markedly different results in terms of identifying the broad trends in the level and sources of productivity growth in European banking during the 1990's.

Is There a Lasting Gap in Bank Efficiency between Western and Eastern European Countries?

Laurent Weill *(Universite Robert Schuman, France)*

This paper aims to compare the efficiency of banks from Western European countries and Eastern European countries to assess the performance gap between both categories of banks. We measure cost efficiency on a sample of 640 banks from 11 Western European and 6 Eastern European countries with the stochastic frontier approach. We also test the possible influence of environmental variables and risk preferences on the efficiency gap. We conclude the following: (a) there is a gap in bank efficiency between Eastern and Western European countries, (b) this gap is hardly explained by differences in environment or risk preferences, suggesting that the main source of differences is managerial performance, and (c) the efficiency gap was reduced between 1996 and 2000 for 4 among the 6 Eastern European countries.

Two Stage Evaluation of Bank Branch Efficiency Using Data Envelopment Analysis

Joseph Paradi, Stephen Rouatt *(University of Toronto, Canada)*

A new approach of a two stage DEA model is presented for evaluating the efficiency of a bank branch network in multiple dimensions. In the first stage we introduce three different branch performance models – productivity, profitability, and intermediation. In the second stage (the combined model) is used to establish overall efficiency ranking of the branches. The top branches, from the second stage are used as benchmarks for the creation of "templates" for newly opened branches. We then apply this approach to a largest Canadian bank's national retail branch network. From the first stage we provide recommendations for improvements directly to the branch managers. The economic effects of market size and geographical region and their effects on branch performance are also examined. The stage two results are presented to senior management to be used to provide a system-wide ranking of branches.

Activation Efficiency for Cash-help Recipients in Denmark: A DEA Bootstrap Approach

James Weatherall, Tor Beltov (*University of Southern Denmark, Denmark*)

The aim of the paper is to evaluate municipality ability to activate cash-help recipients, which will help individuals gain the necessary skills vital to future regular employment in Denmark. Data Envelopment Analysis (DEA) is used to evaluate the relative productive activation efficiency for a sample of Danish municipalities in 2001. Bootstrapping was performed in order to ensure the robustness of the analysis. The main results indicate that policy practices and individual specific characteristics affect efficiency. Municipalities can improve efficiency levels in the future by emulating the most efficient municipalities or through technological innovation.

Measuring the Efficiency of Public Services: The Limits of Analysis

Andrew Street, Peter Smith (*University of York, UK*)

Increasingly, policy makers are seeking to develop overall measures of the efficiency of public service organisations. To that end, data envelopment analysis (DEA) and stochastic frontier analysis (SFA) have been advocated as tools to indicate organisational efficiency. Although the analytical sophistication of these techniques has reached an advanced stage of development, quite modest changes in model specification can lead to major changes in inferences about efficiency. In this paper we discuss the context within such models are deployed, and their underlying assumptions. Four specific model building issues are discussed: the weights attached to public service outputs; the specification of the statistical model; the treatment of environmental influences on performance; and the treatment of dynamic effects. The paper concludes with recommendations for policy makers and researchers on the development and use of efficiency measurement techniques.

The Efficiency of Public Employment Services in Switzerland 1998-2001

George Sheldon (*University of Basle, Switzerland*)

We present the implementation of a performance measurement system in social services using DEA to evaluate hundreds of organizational units. The system collects operational data from field offices, surveys over 200,000 customers and makes recommendations for improvement in a semi-automated way. It demystifies the limitations for real-life implementation attributed to DEA. Insights from our experience will be shared.

World Health System Performance Revisited

Knox Lovell (*University of Georgia, USA*)
Jeremy Lauer, Christopher Murray, David Evans (*World Health Organization, Switzerland*)

The World Health Organization recently published a health system performance ranking for 191 member countries. The ranking was based on five indicators, with fixed weights common to all countries. We investigate the feasibility and desirability of using mathematical programming techniques that allow weights to vary across countries to reflect their varying circumstances and objectives. By global distribution measures, scores and ranks are found to be not very sensitive to changes in weights, although diffeences can be large for individual countries.

Nursing Home Cost Efficiency in New York State: Panel Data Including Quality of Care

Shelton Schmidt, Harold Fried, Suthathip Yaisawarng (*Union College, USA)*

This research uses panel data on 600 nursing homes in the State of New York from 1995 thorough 2001 to estimate a stochastic cost frontier. Various techniques are applied including the fixed effects model, the random effects model, and the random parameters model. Existing studies of nursing home efficiency have been criticized for ignoring quality of care altogether or for using inadequate proxy measures. In November 2002, however, the Nursing Home Quality Initiative released ten measures of performance and quality for 17,000 nursing homes in the U.S. These recently released quality measures are included in our study.

Assessing Performance of French Intensive Care Units: A Directional Distance Function Approach at the Patient Level

Hervé Leleu, Benoît Dervaux (*Catholic University of Lille, France*)
Vivian Valdmanis (*London School of Hygiene and Tropical Medicine, UK*)
Etienne Minvielle (*Hôpital de Bicêtre, France*)

The aim of this paper is to evaluate technical efficiency of French Intensive Care Units (ICUs) at the patient level. We use a robust approach of a nonparametric frontier estimation (Cazals, Florens and Simar, Journal of Econometrics, 2002) because results may be very sensitive to extreme values. We also derive the medical performance by comparing the number of observed and expected deaths in each ICU. In the model specification, we introduce health outcome measures in the outputs and validated resource utilization indexes in the inputs. We also control for casemix heterogeneity. Data come from a French survey including 15178 patients of 26 ICUs in the region of Paris during the year 2000. Two main results emerge from our analysis. First, the economic efficiency appears positively correlated with the medical performance. Second, the technical inefficiency is strongly concentrated on a few number of patients.

FRIDAY
9:00 - 10:15 SESSION 5-A: *Agriculture II*

Decomposition of Productivity Change on Finnish Dairy Farms

Timo Sipiläinen *(Agrifood Research, Finland)*

The objective of the paper is to examine sources of productivity change on Finnish dairy farms in 1990s. The sources of productivity change are identified through the decomposition of productivity change. A special attention is given in defining the scale effect. In this paper we apply the parametric decomposition of output oriented Malmquist productivity index. The decompositions are calculated in a sample of Finnish dairy farms for 1989-2000. The period is of interest because of the drastic change in agricultural policy when Finland joined the European Union in 1995. The results show that productivity growth has been on average slow but it has speeded up at the end of the research period. The most important source of productivity growth has been technical change. Technical efficiency change does not show any systematic pattern but it varies from year to year. The role of scale effect is minor in productivity change.

The Productivity Performance of Irish Dairy Farms 1984-2000: A Multiple Output Distance Function Approach

Carol Newman, Alan Matthews (*Trinity College Dublin, Ireland)*

The aim of this study is to measure productivity growth on Irish dairy farms over the period 1984-2000. The motivation is to contribute to a better understanding of the competitive position of Irish agriculture in a more market-oriented policy environment. A stochastic multiple output distance function model of the production technology in use on a sample of Irish dairy farms taken from the Irish National Farm Survey between 1984 and 2000 is estimated. Using appropriate population weights a representative index of national total factor productivity growth for the system is produced and decomposed into technical change, efficiency change and changes in scale efficiency. This index is used in assessing the performance of the system over the sample period and in making recommendations as to the best possible course of action in the face of future policy reform affecting the sector over the coming years.

Productivity Patterns in the U.S. Meat Product Sector

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

A panel constructed from the Census Bureau's Longitudinal Research Database is used to measure total factor productivity growth at the plant-level and analyzes the multifactor bias of technical change for each subsector of the U.S. meat products industry from 1972 through 1995. For example, addressing TFP growth decomposition for the meat products subsector by quartile ranks shows that the technical change effect is the dominant element of TFP growth for the first two quartiles, while the scale effect dominates TFP growth for the higher two quartiles. Throughout the time period, technical change is 1) capital-using; 2) material-saving; 3) labor-using; and, 4) energy-saving and becoming energy-suing after 1980. The smaller sized plants are more likely to fluctuate in their productivity rankings; in contrast, large plants are more stable in their productivity rankings. Plant productivity analysis indicate that less than 50% of the plants in the meat industry stay in the same category, indicating considerable movement between productivity rank categories.

FRIDAY
9:00 - 10:15 SESSION 5-B: *Banks II*

Decomposing the Dividend
Emili Grifell-Tatje (*Universitat Autonoma de Barcelona, Spain*)
Knox Lovell (*University of Georgia, USA*)

Most theoretical and empirical research on cooperatives has focused on the comparative statics behavior of optimizing cooperatives. In this paper we dispense with the optimizing assumption, and we focus on the magnitude and sources of observed variation in thedividend that cooperatives are presumed to maximize. We develop an analytical framework that attributes variation in the dividend to layers of mutually exclusive and exhaustive sources, consisting initially of price and quantity variation. Quantity variation is then allocated to variation in labor productivity and variation in input deepening. These two sources ultimately decompose into variation in technology. variation in size, and variation in cost efficiency. We apply our dividend decomposition framework to a 1994-2001panel of 59 Spanish cooperative financial institutions, among which dividend variation has been large and sustained. We also conduct a cross-sectional benchmarking exercise, in which the 2001 performance of all other cooperative financial institutions is compared to that of Caja Laboral Popular, which provides financial services to the Mondragon group of cooperatives.

Banking Activity and Macro-Economic Performance: An Empirical Study at the Country Level
Jesús Pastor (*Universidad de Malaga, Spain)*
Ana Lozano (*Miguel Hernandez University, Spain*)

We study the macroeconomic and the banking efficiency of a set of fifteen OECD countries along a nineteen year period by means of non-parametric methods. We further evaluate the efficiency change an the technical change by means of a specific Malmquist productivity index. We finally revise, in different ways, the possible convergence of the different countries along time (beta and gamma convergence) and find evidence that the countries with a banking oriented financial structure have a better long-run economic behaviour than the countries with a market oriented financial structure.

Benchmarking Credit Union Performance: An Interactive Computer Approach
Harold Fried (*Union College, USA*)
Peter Bogetoft (*Royal Agricultural University, KVL, Denmark*)
Philippe Vanden Eeckaut (*Universite de Lille III, France*)

This article analyzes the effects of the geographic expansion of Spanish savings banks on both cost and revenue efficiency. We perform the study for 1992--2001 data, given this constitutes the period in which most firms have settled their territorial expansion policies. We apply nonparametric techniques, both to measure efficiency and to estimate the relationship between efficiency and territorial expansion. Specifically, we consider nonparametric regression techniques as a mechanism to overcome the problems risen by the inherent statistical dependency of efficiency scores---i.e., that of leading to hypothesis violation in the so-called two-stage (regression) analysis. We find positive and negative links between geographic scope and bank efficiency. Results generally suggest that there may be no particular optimal geographic scope for banking organizations, as some efficient firms, either cost or revenue, have expanded geographically, while other operate efficiently within a single region.

Network Efficiency in Input-Output Tables: A DEA Application to OECD Countries

Angel Prieto (*Instituto de Recursos Naturales y Agrobiología, CSIC, Spain*)
José Luis Zofío (*Universidad Autónoma de Madrid, Spain*)

In this note we undertake a network efficiency analysis within input-output technologies. Input-output tables represent a network where primary inputs and value added components satisfy intermediate and final demand consumption requirements. In this scheme it is possible to optimize resource allocation and intermediate production within the input-output framework using non-parametric DEA techniques. DEA allow us to model the different sub-technologies of alternative production processes, to asses efficient resource allocation among them, and to determine potential output gains if inefficiencies were dealt with. Therefore the proposed model optimizes the underlying multi-lateral technologies that the input-output system comprise. The model is applied to a set of five OECD countries input-output tables.

Public Infrastructure Investment and Efficiency in Italian Regions

Camilla Mastromarco (*University of Lecce and University of Munich, Germany)*
Ulrich Woitek *(University of Munich, Germany)*

Evidence on growth rates in per capita income of Italian regions reveals persistent differences in development patterns between North and South Italy. While Northern regions manage to sustain high growth rates, Southern regions stagnate in low growth "traps". To capture the phenomenon of different long-term growth paths, we model externalities with a threshold effect. The externalities we consider are spillovers from core and non-core public infrastructure investment. Central to the model is the argument that the spillovers from non-core infrastructure depend on the level of core infrastructure. Whenever core infrastructure investment exceeds a threshold, the spillovers from non-core infrastructure are positive. To test the empirical implications of the model we use the stochastic frontier approach which allows to discriminate between the channels through which public infrastructure influences overall productivity. The main results are that the impact of core-infrastructure investment on efficiency is always positive. The impact of non-core infrastructure on efficiency is negative in the South and positive in the North.

Metafrontier Functions for the Study of Interregional Productivity Differences

Prasada Rao, Chris O'Donnell (*University of Queensland, Australia*)
George Battese (*University of New England, Australia*)

The paper develops the concept of metafrontier functions to study regional differences in production technologies. The paper has three components. The first deals with the analytical framework necessary for the definition of metafrontier functions. The second component studies the properties of the metafrontier under the non-parametric approach based on data envelopment analysis (DEA). The third component focuses on the application of metafrontiers within a parametric stochastic frontier framework. An empirical illustration of the metafrontier models is based on US agricultural data for different states. Results from the application of DEA and stochastic frontier metafrontiers are presented and analysed.

Effects of Thai National Health Systems Reform on Cost Efficiency of Publicly-Owned Hospitals

Suthathip Yaisawarng *(Union College, Schenectady, USA)*
Preecha Asavadachanukorn, Saowaros Yaisawarng (*Chulalongkorn University, Thailand*)

This paper assesses effects on cost efficiency of Thai National Health Systems Reform, in particular, the Universal Health Care Coverage (the 30-baht scheme). Our sample consists of regional and general publicly owned hospitals, covering the period before the implementation of the 30-baht program (2000-2001) and the period in which the program is fully implemented (2002). For each sample period, we estimate a stochastic cost frontier and compute efficiency scores for each hospital in the sample. The cost frontier includes input prices, output quantities, fixed input, and a set of control variables. We also estimate the cost frontier for the pooled sample with the 30-baht program dummy. Efficiency scores are compared across sample periods to identify the overall impacts of the program.

Heterogeneous Production in Efficiency Measurement: The Case of Dutch Homes for the Mentally Disabled

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

The production of many public sector firms is very heterogeneous. This paper deals with different ways to model production heterogeneity in cost function analysis. The idea is that there are several main categories of production. Each category consists of various subgroups corresponding to different costs, according to some distinguishing characteristics. Including all subgroups as production indicators into a cost function is not feasible. In earlier work we solved this by using a hedonic index , a weighted index of services, instead of separate service indicators. This means that a number of restrictions is imposed on the parameters in the model. This paper looks into the effects these restrictions have on the outcomes measured in terms of marginal costs and other characteristics such as the scale effect. This is done by comparing various models. The empirical analyses are conducted on a panel data set of Dutch homes for the mentally disabled.

The Effect of Strategic and Operational Decisions on Hospital Performance

Gary Ferrier, Lewis Epley (*University of Arkansas, USA*)

The past 10 years has witnessed a surging business interest in developing and managing supply chains--the networks that procure materials, transform those materials into products, and deliver the products to customers. A supply chain lies between the extremes of a fully vertically integrated entity and a group of wholly independent firms that interact in the marketplace. Cooper and Ellram, (The International Journal of Logistics Management, 1993) liken a supply chain to a well-functioning relay team--working together, the links in the supply chain enhance performance and value. This paper examines the effect of supply chain management practices on hospital performance. A variety of both the strategic and operational factors associated with supply chains are identified and measured for a sample of US hospitals. After measuring hospital performance using DEA and the Malmquist index, the effect of these factors on performance are analyzed. The supply chain factors identified include whether a hospital is part of a system (i.e., a legal entity that owns other health care facilities), whether a hospital is part of a network (i.e., works with other providers such as physicians or insurers), whether a hospital is part of a group purchasing arrangement, whether the hospital is internally or contract managed, whether a hospital contracts directly with employers to provide services, the proactiveness of a hospital with regard to meeting community needs for health care services, the self-assessment tools used by the hospital, the variety of services offered by the hospital, the types of arrangements hospitals have with physicians, among others.

FRIDAY
10:45 - 12:00 SESSION 6-A: *Risk and Efficiency*

An Investigation of Production Risk, Risk Preferences and Technical Efficiency in the Philippines

Renato Villano, George Battese, Euan Fleming (*University of New England, Australia*)
Chris O'Donnell (*University of Queensland, Australia*)

The study of risk and technical efficiency is an important topic in agricultural development. Risk plays a vital role in farmers decisions on input allocations and therefore output supply. This paper seeks to provide empirical evidence on the estimation of production risk, risk preferences and technical inefficiency. An 8-year panel data set of 46 rice farmers from a representative rainfed lowland environment in Central Luzon, Philippines is used. Production risk is first analysed by using the Just and Pope (1978 , 1979) framework. This examines the marginal effects of inputs on production risk, independent of the effects of inputs on mean output. The stochastic frontier framework is used to estimate technical efficiencies of rice farmers. These two frameworks are reconciled and extended in order to accommodate the risk preferences of farmers. The risk preference function and the model developed by Kumbhakar (2002) is used. This model allows us to examine production risk, by taking into account technical inefficiency and attitudes of farmers. Finally, the results and its implications are discussed.

Efficiency and Heterogeneous Risk: An Analysis of the Andelusian Deep Water Trawl Fleet

Sean Pascoe (*University of Portsmouth, UK*)
Inés Herrero (*Universidad Pablo de Olavide, Spain)*

A recent study of efficiency of the Andelusian deep water trawl fishery raised the issue of whether fishers aimed at maxising revenue (in liu of information to allow assessment of profit maximisation) or maximising catch. Using efficiency analysis, the study concluded that most fishers clearly attempted to maximise revenue, but some fishers appeared to maximise catch. This was interpreted as possibly a revenue risk aversion strategy rather than an objective of catch maximisation per se. In this study, this intepretation will be re-examined using the approach proposed by Kumbhaker (2002) for incoporating heterogeneous risk into the technical efficiency model.

Estimation of Risk with Multi-Output Technologies

Alan Wall (*Universidad de Oviedo, Spain*)

While there is a large literature on the empirical modelling of production risk in a single-output setting, far less attention has been given to this issue when there are multiple outputs. We examine the methods traditionally used to model multi-output production and find that they effectively impose strong restrictions on the nature of production risk, particularly in the case of the econometric distance functions estimated in the literature to date. Relaxing these restrictions permits the modelling of a variety of producer responses to risk which cannot be adequately captured by existing methodologies and the strengths and weaknesses some possible solutions are discussed.

FRIDAY
10:45 - 12:00 SESSION 6-B: *Dynamic Efficiency Analysis*

The Measurement of Dynamic Productive Efficiency: A System Dynamics Approach

Kostas Triantis, Warren Vaneman (*Virginia Tech, USA*)

Traditionally, the study of productive efficiency has concentrated on system efficiency in a steady state. *Dynamic productive efficiency* is a measure of a system's ability to convert inputs to outputs at a specific time *t*, during a transient period. Dynamic productive efficiency is distinguished from productive efficiency by: (i) the element of time and (ii) a disturbance are introduced that cause the system to seek a new equilibrium. The study of systems during their transient periods is important because these states are the most disruptive. In order to measure dynamic productive efficiency, Vaneman and Triantis (2003) related dynamic production axioms to the fundamental system dynamic behaviors (Forrester (1961), Sterman (2000)). With this stage being set, a System Dynamics optimization model is developed and used to measure and evaluate dynamic productive efficiency. Finally the efficiency results obtained by Kopp (1981) using constrained optimization procedures are replicated using the SD optimization model.

Dynamic Efficiency: Is the Public Sector Investing too Little?

Shawna Grosskopf *(Oregon State University, USA)*
Kathy Hayes *(Southern Methodist University, USA)*
Lori Taylor (*Federal Reserve Bank of Dallas, USA)*

There is a fairly extensive literature on the impact of public capital on technology and productivity (TFP) in the United States. This paper contributes to this literature in a variety of ways. First, we have refined the standard data on public and private capital to better reflect year-to-year variations, and to generate new estimates of private and public capital in the high-tech manufacturing industry. Second we use a dynamic production model developed by Fare and Grosskopf (1996) to measure dynamic efficiency. As a byproduct of the model, we solve for optimal investment paths, which we then can compare to realized investment. We apply this to U.S. data on the manufacturing sector as well as the subset of high-tech manufacturing industries over the 1978-1999 period using state level data. Earlier work (Grosskopf, Hayes and Taylor, 2002) suggests that high tech manufacturing is more productive than manufacturing as a whole and that state and local policy can explain variations in performance.

Efficiency and Total Quality Management in Health Care Organizations. A Dynamic Frontier Approach

Diego Prior (*Universitat Autònoma de Barcelona, Spain*)

This paper focuses on hospital performance using Data Envelopment Analysis (DEA) and the Malmquist productivity index. We quantify the movements in productivity following two approaches: 1) a traditional approach, considering only output and input variables, and 2) a more comprehensive approach including the movements in quality and restricting some achievements if quality is reduced. Provided that the indicator for quality (nosocomial infections) is equivalent to a bad output, we explore characteristics and compare results of the different technological ways to the consideration of the quality (good or bad attributes and strong or weak disposability technological assumptions). After discussing the effects of the existent possibilities, the paper presents the better formulation in order to preserve TQM postulates. The decomposition in the Malmquist productivity index shows an improvement in productivity and a positive technical change, especially when quality is introduced.

Student Achievement and Efficiency in Missouri Schools and the No Child Left Behind Act

Diane Primont, Bruce Domazlicky *(Southeast Missouri State University, USA)*

The 2001 No Child Left Behind Act (NCLBA) requires that schools1 make "annual yearly progress" in raising student achievement, or, face possible sanctions. The NCLBA places added emphasis on test scores, such as scores from the Missouri Assessment Program (MAP), to evaluate the performance of schools. In this paper, we investigate school performance in Missouri by measuring the efficiency with which schools provide their education services using a two-stage DEA approach. We compare our results to the schools that the Missouri Department of Elementary and Secondary Education has designated as "deficient" as a result of low performance on the MAP tests. Finally, we simulate the effects of sanctions under the NCLBA on the performance of failing schools.

Gross State Product Growth and Educational Levels in the United States of America: An Econometric Analysis

Jose Maripani, Boris Bravo-Ureta (*University of Connecticut, USA*)

The objective of this paper is to examine the link between education and the growth of GSP across individual states within the USA. The model used is a production function in the Solow (1956) tradition. Education is incorporated following suggestions from Psacharopoulos and Arriagada (1986), Landau (1986), and Evans, Green and Murinde (2002) who argue that enrollment and expenditures in education are appropriate variables to measure the effect of human capital on economic growth. The data set includes annual observations for the 51 States for the period 1982 to 2000 and other selected years in order to incorporate several lagged variables. The main data sources are the Bureau of Economic Analysis for Regional Accounts Data and the U.S. Department of Education and National Center for Education Statistics. The initial econometric results reveal that investments in education and physical capital have a positive and significant effect on growth. On the other hand, enrollment rates in primary, secondary and higher education do not appear to have a discernable impact on economic growth.

Universities as Production Units: The Case of Regional Colleges of Norway

Finn Førsund *(University of Oslo, Norway)*
Dag Edvardsen *(The Norwegian Building Research Institute, Norway)*

A university is a producer of services, the main types being education, research and dissemination of knowledge in society at large, employing labour, capital and materials as resources. Three output and four input variables are constructed, short- and long education, research publications and forms of artistic expressions, and faculty and non-faculty man-years, area of buildings and other expenses. The basic unit is a department. There are about 100 departments in total within the sector of regional universities in Norway, ranging from units giving training for specific professions, and general arts and sciences departments. For the panel covering 1994-1999 productivity development is measured, assuming a stationary frontier technology. New indices describing cross-group and cross-period connections are developed, and novel applications of Malmquist productivity indices comparing units from different groups are performed. The departments may be classified according to the taxonomy efficient expansion, inefficient expansion, and positive or negative adjustment capability.

Bootstrap Results for a Measure of "Market Efficiency"

Matthias Staat (*University of Mannheim, Germany*)

Bootstrap Results for a Measure of "Market Efficiency" The method by Simar and Wilson (1988) is used to bootstrap DEA scores for several datasets on computers and computer parts. The average efficiency score of products has been interpreted as a measure of market efficiency. I also calculate scores using standard DEA and explore how market efficiency is affected by the bias of the DEA estimator. The results indicate that the standard scores reflect the relative differences in average efficiency reasonably well. However, an inspection of the mean square error (MSE) of the results reveals that there are many cases for which the bootstrap results have a higher MSE than the standard DEA results. For some datasets, the bootstrap cannot "improve" on the original results. For the cases for which the bootstrap results pass the MSE criterion they are considerably lower than the standard DEA results. This implies that market efficiency has been overestimated in previous studies.

On Statistical Analysis of Aggregate Efficiencies

Leopold Simar (*Universite Catholique de Louvain, Belgium*)
Valentin Zelenyuk (*National University "Kyiv-Mohyla Academy", Ukraine*)

In this study, we merge and elaborate on results of two recent directions in research on efficiency analysis—the Aggregation and the Smooth Bootstrap—applied, as an example, to one of the most popular point-estimators of individual efficiency: the Data Envelopment Analysis (DEA) estimator. In particular, we present a method of statistical analysis (bias correction, confidence intervals, various hypotheses tests, etc) for aggregate efficiency estimates, whose form and weights of aggregation are derived using (neo-classical) economic theory arguments. A natural context of application of our methods would be a study of efficiency of a particular economic system (e.g., an industry) as a whole, or a comparison of efficiencies of distinct groups within such a system (e.g., private vs. public or regulated vs. non-regulated firms, etc), often encountered in the literature.

Sensitivity Analysis of Efficiency and Malmquist Productivity Indices: An Application to Spanish Savings Banks

Emili Tortosa-Ausina (*Universitat Jaume I, Spain*)
Emili Grifell-Tatjé (*Universitat Autònoma de Barcelona, Spain)*
David Conesa, Carmen Armero (*University of València, Spain)*

Hypothesis testing and statistical precision in the context of nonparametric efficiency and productivity measurement have been investigated since the early 1990s. Recent contributions focus on this matter through the use of resampling methods—i.e., bootstrapping techniques. However, empirical evidence is still practically non-existent. This gap is more noticeable in the case of banking efficiency studies, where the literature is immense. In this paper, we explore productivity growth and productive efficiency for Spanish savings banks over the (initial) post-deregulation period 1992--1998 using Data Envelopment Analysis (DEA) and bootstrapping techniques. Results show that productivity growth has occurred, mainly due to improvement in production possibilities, and that mean efficiency has remained fairly constant over time. The bootstrap analysis yields further evidence, as for many firms productivity growth, or decline, is not statistically significant. With regard to efficiency measurement, the bootstrap reveals that the disparities in the original efficiency scores of some firms are lessened to a great extent.

Nonparametric Kernel Measurement of Technical Efficiency stimating

Daniel Henderson (*State University of New York at Binghamton, USA*)

This paper uses nonparametric kernel methods in order to estimate production (or cost) frontiers as well as to estimate technical efficiency. A random effects nonparametric estimator is proposed (the first of its kind), its structure defined and properties stated. Monte carlo exercises show that it outperforms DEA methods and performs almost as well as the parametric model in estimating both the frontier and inefficiency when the true technology is linear. In constrast, when the technology becomes more nonlinear, the nonparametric estimator outperforms both models. The techniques are then applied to estimate the technical efficiency of 17 OECD economies.

Statistical Inference from DEA Efficiency Estimates: The Case of Food Industries in Germany

Holger Thiele *(Federal Dairy Research Centre, Germany)*

The technical efficiency results are often more useful if inference on the determinants of technical efficiency of firms is possible. The stochastic frontier analysis offers a model for simultaneous estimation of variables which influence the individual efficiency scores, namely the Battese and Coelli (1995) approach. Its vast use in the applied literature indicates the potential usefulness of such models. For DEA, however, the literature is less unique regarding the proper inference procedure from efficiency estimates. The proposed methods include, amongst others, tests for differences in grouped means, parametric as well as non-parametric; OLS regression; and limited dependent variable techniques. The latter methods are often applied in the literature but fail to deal with non-normality and the restricted range of the efficiency scores. In this paper, several techniques for drawing inference from efficiency estimates are compared in a systematic manner by utilising Monte Carlo experimentation. The methods show distinct differences in bias and precision. The empirical dimension of the problem is illustrated for a set of 35 firms in the German dairy industry in period of 2000. The observed firms cover 60% of the sectors total sales. An output-oriented DEA is conducted. The environmental variables which are used to explain variations in the efficiency estimates include the diversification, the export orientation, the region of a firm among others.

Two-Stage, Semi-Parametric Models of Production Proceses

Léopold Simar (*Universite Catholique de Louvain, Belgium*)
Paul Wilson (*University of Texas at Austin, USA*)

A plethora of papers have used multi-stage estimation procedures where nonparametric estimates of productive efficiency are obtained in the first stage and then regressed on environmental variables in a subsequent stage in attempts to account for exogenous factors that might affect firms performance. None of these papers have described a coherent data-generating process (DGP). Moreover, conventional approaches to inference employed in these papers are invalid due to complicated, unknown serial correlation among the estimated efficiencies. We first describe a DGP wherein firms efficiencies are influenced by environmental variables. We then propose a single and a double bootstrap procedure; both permit valid inference, and the double bootstrap procedure improves statistical efficiency in the second-stage regression. We examine the statistical performance of our estimators using Monte Carlo experiments.

Efficiency and Productivity Analysis for Incentive Regulation
Thomas Weyman-Jones (*Loughborough University, United Kingdom)*
Julia Boucinha, Celia Godinho, Catarina Inacio (*EDP, Portugal*)

Regulators use models such as non-parametric DEA, and parametric SFA for implementing yardstick competition, while principal agent incentive regulation theory provides the analytical support for using a benchmarking approach. We show that stochastic frontier analysis fits well with agency models of risk averse managers. However, theoretical predictions about the behaviour of regulated firms, subject to high powered incentive contracts, may be different from the assumptions about the independence of errors required for implementing stochastic frontiers. When data problems cause the rejection of composed error models, non-stochastic methods, e.g. COLS, which are based on point estimators of the efficient costs, may be used instead so that efficiency targets are dominated by outliers. An alternative is to use interval estimators of benchmark costs, so that high residual variance in small samples is used to offset the harshness of the efficiency target.

Benchmarking Quality of Service in Incentive Regulation: UK Electric Distribution Utilities
Tooraj Jamasb, Dimitris Giannakis, Michael Pollitt (*University of Cambridge, United Kingdom*)

Following the path of sector reforms, a number of regulators around the world have adopted incentive regulation based on price and revenue cap models for the regulation of the natural monopoly networks and facilities. The experience with the incentive models has generally been positive and the models have resulted in significant cost savings. At the same time, security and reliability of supply are generally treated separately and through setting standards of service and penalty and reward schemes to these. However, concern about the economic efficiency aspect of the existing schemes has recently led some regulators to seek more innovative approaches. This paper analyses the development of efficiency and productivity incorporating both cost and quality of service in 14 Great Britain electric distribution utilities under revenue cap regulation and quality standards 1990 using Malmquist index with separate quality components. The paper examines and compares the results of benchmarking models with average and frontier-based benchmarking models of service quality using DEA and regression based techniques. We offer some conclusions on the scope for the use of such benchmarking within the regulatory process.

Collusion, Agent Heterogeneity and Frontier Yardstick Stability
Per Agrell (*Université catholique de Louvain, Belgium*)
Peter Bogetoft (*Royal Agricultural University, Denmark*)

A fundamental problem attached to the implementation of frontier based performance evaluation systems, or yardstick regulation regimes, is how to assure repeated truthful revelation of data. The threat of collusive behavior among evaluated agents limits the evaluator's possibilities to increase the dimensionality of the model and, thus, its informational value. Weight restrictions, separating regimes, artifical observations and ad hoc data discrimi-nation have been proposed to address this problem. In this paper, we critically examine the stability of frontier yardsticks under various collusive behavior among the agents. In particular, we stress the strategic value of maintaining agent hetereogeneity prior to and during the evaluation period. The heterogeneity enriches the frontier performance assessment, but more importantly, increases the cost of collusion and risk of opportunistic reporting. Anticipating the worst case scenario, the regulator may also allocate the weighting task to the agents, collectively, which give some leveraging results. We present a dynamic framework for model development and implementation under which the efficient agents contribute to model re-finement in exchange for industry rents.

Embodied and Disembodied Technological Progress in Finnish and Indonesian Paper Mills

Bart Los (*University of Groningen, The Netherlands*)
Michiel van Dijk (*Eindhoven University of Technology, The Netherlands*)
Marcel Timmer (*University of Groningen, The Netherlands*)

Plant-level data for about 50 Indonesian paper mills (see van Dijk, 2003) and a similar number of Finnish mills will be used to obtain indications of the impact on industry-wide productivity of three sources of growth: (1) process innovation by Finnish productivity leaders who managed to increase labor productivity for given qualities (in terms of "speed") of machinery and to install machinery of increasing speed, (2) embodied technological change, through scrapping of low-speed machinery and investment in higher-speed machinery by both Finnish and Indonesian mills (plants), and (3) catch-up towards productivity leaders through disembodied technology spillovers and learning-by-doing for a given quality of core-machinery. The dataset broadly covers the period 1975-1997. The results of the above-described decomposition of productivity growth will be linked to several additional plant-level variables, such as the age of the mills, the ownership structures of the mills and the presence or absence of foreign engineers at Indonesian mills.

Gauging Change in Technical Efficieny Associated with Technological Change

Robert Weaver (*Penn State University, USA*)
Jarmilla Curtiss (*Institute of Agricultural Development, Germany*)

A general problem in the economics of innovation is the assessment of change in inefficiency associated with a new technology. If technical inefficiency is viewed as a result of persistent management error that reflects intrinsic characteristics of a technology, then a change from one technology to another may involve a change in that inherent technical inefficiency. The problem of measurement is complicated by a difference in the state of learning associated with the old vs. new technologies. This paper defines inherent technical inefficiency as persistent. A production process that produces joint private and public goods is presented. The paper uses a stochastic frontier approach to evaluate the extent of difference between the frontiers associated with an old and new technology. Estimates of change in technical efficiency are presented. For an application, the paper analyzes the efficiency of soybean production with respect to grain output and environmental impact and compares two technologies ~ a new technology using genetically modified (GM) herbicide resistant varieties versus the old, herbicide-based, nonGM technology. A shift to GM technology has been argued by physical scientists to result in changes in private good input and output flows, as well as changes in environmental effects. Results indicate that while physical science predicts little to no productivity change between the two technologies, a measurable difference in technical efficiency is apparent.

A Unified Approach to Incorporating Technical Change in Modified Production Functions

Federico Perali (*University of Verona, Italy*)

The paper extends the theory of demand functions modified by demographic factors to the theory of production. It provides a unified approach to incorporating technical change or other exogenous factors in the production structure useful to lend theoretical plausibility to the shadow price approach to the estimation of economic efficiency. The concept of technology modified Slutsky equation is introduced showing the interaction of technical change and/or other factors with both prices and teh scale of productions. Shadow prices are interpreted as quality signals. Issues related to economic and econometric identification are discussed along with the implications for the measurement of allocative efficiency. The conclusive part of the paper present an application to the Italian banking sectorthe shadow price approach is modelled as an extension of the price scaling modifying technique commonly used in demand analysis.

Large Scale Implementation of DEA: A Case Study in Social Services

Alexandra Medina-Borja, Kalyan Pasupathy, Kostas Triantis (*Virginia Tech, USA*)

In 2000, Switzerland introduced a set of financial incentives to encourage public employment offices to improve their placement efforts. The success of a placement office is measured by its ability to lower the duration of unemployment, to reduce long-term unemployment and to prevent repeat unemployment, conditional on the size and composition of the stock of unemployed the office has to place. The incentive scheme assigns fixed weights to the individual goals. Our study employs Malmquist indices calculated with DEA to investigate the extent to which measures aimed at improving the placement efficiency of public employment offices in Switzerland have been effective. The DEA model employed allows the inclusion of both bad and good outputs as well as the weights of the incentive scheme. The results indicate that the absolute placement efficiency (total factor productivity) of the employment offices increased after the introduction of the incentive scheme, although the relative placement efficiency (catch-up) of the offices, which single cross-section studies measure, declined.

A Three-Stage DEA Model in Measuring Efficiency

Cliff Huang (*Vanderbilt, USA*)
Yung-Lieh Yang, Wann-Jyi Horng, Jun-Yen Lee (*Ling Tung College, Taiwan*)

The objective of this paper is methodological and aims to extend the traditional DEA efficiency measures by the model of three-stage DEA. We are used the three-stage DEA model to assess the technical efficiency based on the adjustment of stochastic noises and environmental variables. On the first stage, the technical efficiency and input slacks were obtained by the traditional DEA. On the second stage, from the first stage as above, we used the variables of input slacks to regress against a set of environmental variables. This stage is seemly stochastic frontier analysis. The original input variables would be adjusted by the stochastic noise and the exogenous environmental variables from the results of regression. On the third stage, the adjusted input variables instead of original input variables are used to measure the technical efficiency by the traditional DEA. The proposed three-stage DEA model is applied to the IC industry in Taiwan. In this paper, the adjusted technical efficiency will be provided and compared to the technical efficiency of the first-stage DEA model.

DEA and Stochastic Dominance Efficiency Analysis of Investment Portfolios

Timo Kuosmanen (*Wageningen University, Netherlands*)

This paper links the DEA approach to mutual fund performance analysis with the new Stochastic Dominance (SD) approach to portfolio analysis by Kuosmanen (2001). The SD approach views mutual funds as Decision Making Units (DMUs), and rates of return in different states of nature (or periods of time) take the role of inputs and outputs. The key difference is that the SD method can freely mix outputs, because the investor is indifferent between states of nature. This strong symmetry property makes the SD efficiency criteria more stringent than the usual DEA efficiency criteria. Besides restructuring and illustrating existing results, we utilize these linkages to decompose measures of SD portfolio efficiency using DEA frontiers to components of transaction efficiency and diversification efficiency, in the spirit of Farrell. The new approach is applied to return data of 57 US based growth equity funds to examine difference in portfolio efficiency between environmentally responsible mutual funds and traditional equity funds.

Fixed Management and Time-Invariant Technical Efficency in a Random Coefficients Model

Antonio Alvarez (*Universidad de Oviedo, Spain*)
Carlos Arias (*Universidad de León, Spain*)
William Greene (*Stern School of Business, NYU, USA*)

The justification for estimating models with time-invariant technical efficiency is usually based on the assumption that management is fixed over time. We show that in a simple translog production model fixed management, treated as an unobservable input, leads to time-varying technical efficiency. The existence of an unobservable input introduces a great deal of difficulty in the estimation of the production function. In fact, it precludes modeling management as a fixed effect. However, under reasonable assumptions, the model can be rewritten as a random coefficients model whose estimation is feasible.

Pitfalls in the Estimation of Cost Functions Ignoring Allocative Inefficiency: A Monte Carlo Analysis

Hung-Jen Wang (*Academia Sinica, Taiwan*)
Subal Kumbhakar (*State University of New York – Binghamton, USA*)

Econometric estimation of cost frontiers are quite common in the efficiency literature. Since both technical and allocative inefficiencies increase cost, it is widely believed in the stochastic frontier (SF) literature that a one-sided error term in the cost function will capture the cost of overall (technical plus allocative) inefficiency. In this paper, we show, in terms of a detailed Monte Carlo simulation, that failure to model the allocative inefficiency component properly (hoping that the one-sided error term will capture the overall cost inefficiency) biases estimates of (i) the cost function parameters, (ii) returns to scale (RTS), (iii) input price elasticities, and (iv) cost-inefficiency.

Panel Estimators and the Identification of Firm-Specific Efficiency Levels in Semi-Parametric and Non-Parametric Settings

Robin Sickles (*Rice University, USA*)

This paper attempts to reconcile competing approaches to modeling efficiency in panel studies by proposing a set of semiparametric estimators whose construction endows certain optimality properties on the derived efficiency scores. We impose structure on the class of semiparametric efficient estimators (SPE) by utilizing a linear in logs (or geometric mean in inputs) parameterization of technology. For this relatively simple technology structure we ask how well will the robust procedures identify and estimate the efficiency scores of particular firms at a point in time and over time. We discuss the set of existing and newly proposed SPE estimators for the panel model. They are the fixed effects stochastic frontier, the random effects stochastic frontier, the Hausman-Taylor random effects stochastic frontier, and the random and fixed effects stochastic frontier with an AR(1) error.

FRIDAY
17:30 - 18:45 SESSION 8-B: *DEA Advances I*

Negative Data in DEA: A Directional Distance Approach Applied to Banks

Maria Portela (*Universidade Católica Portuguesa, Portugal*)
Emmanuel Thanassoulis (*Aston University, UK*)

This paper is drawn from the use of Data Envelopment Analysis (DEA) in helping a Portuguese bank to manage the performance of its branches. The bank wanted to set targets for the branches on such variables as growth in number of clients, growth in funds deposited and so on. Such variables can take positive and negative values but traditional DEA models, with some specialised exceptions, have hitherto been restricted to non-negative data. We report on the development of two models to handle unrestricted data in a DEA framework and illustrate the use of these models on data from the bank concerned. The main advantage of our method is that it is able to provide efficiency scores similar in meaning to radial efficiencies traditionally used in DEA, while at the same time negative data is used without the need to subjectively transform it. Finally our approach yields targets that are, in general, easier to achieve than those resulting from the additive model.

DEA with Negative Inputs and/or Outputs Revisited

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

Negative input and output data in DEA has been discussed for the past ten years. Recently, a decomposition of (negative) interval scale data has been suggested. How well this approach provides a solution is analyzed. We discuss the problem of how to address negative data entries on both the input and the output side. Use of facial information from the cone or convex hull of the data for formulating alternatives to translation of data are explored.

DEA and Asymmetric Information: How to Implement Non-linear Pricing in Producer Groups

Angelo Zago (*Universita di Verona, Italy*)
Robert Chambers (*University of Maryland, USA*)

This paper shows how to design an optimal payment system for a group of producers using DEA. It first shows that it is possible to implement the first best through higher prices for better quality commodities even with asymmetric information. It considers the heterogeneity among producers and designs a non-linear pricing schemes for members, after taking into account the quality characteristics and market demand for the commodity. When implementing the scheme with experimental data on grapes production, it uses climatic and soil conditions data "to level the playing field", that is to remunerate the performance of producers taking into account also the conditions they cannot modify but under which they produce the commodity. It uses the pricing scheme with a specific dataset for market, weather, and soil quality conditions to show the impact on the choices and payments received by a group of farmers involved in grapes production in Italy.

A Method for Transitive and Additive Multilateral Comparisons: A Transitive Bennet Indicator
Kevin Fox (*University of New South Wales, Australia*)

It is shown how the Bennet indicator (or "index") can be made transitive. This is useful for making consistent (profit, cost, price, quantity) comparisons between firms when there are more than two firms and/or more than two periods.

Continuous Time Foundation of Discrete Time Indice of Productivity and Technological Change
Einar Belsom (*Norwegian University of Science and Technology, Norway*)

Discrete time indices are defined to have a continuous time foundation and are called CTF indices if they are equal to the corresponding continuous time measure whenever it is independent of path. I show that certain Malmquist TFP type indices are CTF indices of productivity, while the input or output oriented Malmquist indices are not. The technological change parts of the oriented Malmquist indices are, however, CTF indices of technological change. I provide a CTF index of the scale effect contributing to productivity change, and offer a decomposition of productivity into technological change, scale effect and efficiency change.

On the Relation Between Gross-Output and Value-Added Based Productivity Measures
Bert Balk (*Statistics Netherlands, Netherlands*)

In this paper I reconsider the relation between a gross-output and a value-added based total factor productivity (TFP) index. It appears that, without requiring any micro-economic theory, a Domar-type relationship between both indexes can be derived. Moreover, gross-output and value-added based TFP indicators appear to coincide. In the Divisia index framework and maintaining the classical assumptions (profit maximization and a production technology which exhibits globally constant returns to scale), it appears that both TFP indexes measure technological change. In establishing this result, no separability assumptions are involved. Their growth-rates differ by the Domar factor. Both indexes are path-dependent. Path-independency of the gross-output based TFP index requires that the technology exhibits Hicks input neutrality, whereas path-independency of the value-added based TFP index requires Hicks value added neutrality.

Efficiency Measurement with Undesirable Outputs: A Parametric Distance Function Approach

Rafael Cuesta (*Universidad de Oviedo*)
Knox Lovell (*University of Georgia, USA*)
José Luis Zofío (*Universidad Autónoma de Madrid, Spain*)

We use a parametric hyperbolic distance function to estimate technical efficiency when some outputs are undesirable. This family of distance functions was introduced by Cuesta and Zofío (2003) and they allow to estimate graph efficiency in a parametric way. In this paper we apply their approach to accommodate undesirable outputs. As a result, we can estimate the parametric counterpart of the efficiency measure by Färe et al. (1989). In other words, we estimate the maximum equiproportionate expansion of desirable outputs and reduction of undesirable outputs for a given amount of inputs. The parametric environmental efficiency model is applied to a panel of fourteen OECD countries whose national income and CO2 emissions are asymmetrically treated.

Short- and Long-Run Credit Constraints in French Agriculture: A Directional Distance Function

Stephane Blancard (*University of La Réunion, France*)
Jean-Philippe Boussemart, Kristiaan Kerstens (*University of Lille III, France*)
Walter Briec (*University of Perpignan, France*)

This empirical application investigates the eventual presence of credit constraints using a panel of French farmers. This is the first European application using a direct modelling approach based upon axiomatic production theory. The credit constrained profit maximisation model proposed by Färe, Grosskopf and Lee (1990) is extended in three ways. First, we rephrase the model in terms of directional distance functions to allow for duality with the profit function. Second, we model the presence of credit constraints in the short-run and investment constraints in the long-run using short- respectively long-run profit functions. Third, we lag the expenditure constraint one year to account for the separation between planning and production in agriculture.

Directional Duality Theory

Daniel Primont (*Southern Illinois University at Carbondale, USA*)
Rolf Färe (*Oregon State University, USA*)

Shephard introduced radial distance functions as representations of a firms technology. A systematic exposition of Shephard s work can be found in Färe and Primont (1995). More recently, a series of articles and a book by Luenberger have provided some new technology representations, the benefit and the shortage functions. Exploiting theses results, Chambers, Chung, and Färe (1995) introduced directional distance functions; these can be thought of as additive alternatives to the corresponding radial concepts. In this paper, the radial approach is further extended by introducing and characterizing indirect directional distance functions; these are directional versions of their radial counterparts. This, in turn, leads to a new set of duality results that will be of use in applied work.

SATURDAY
9:00 - 10:15 SESSION 9-A: *Macroeconomic Issues*

Productivity Differences across OECD Countries in the Presence of Environmental Constraints

Francisco Arcelus (*University of New Brunswick, Canada*)
Pablo Arocena (*Universidad Pública de Navarra, Spain*)

When modeling the tradeoff between a good/acceptable output and a bad/unacceptable output within an environmental setting, an important unresolved issue at hand is the determination of how to compute the value of such a tradeoff. Measuring difficulties arise primarily from the absence of a well-developed and widely acceptable methodology to establish a pricing mechanism with which to assign value to the tradeoff. As a result, it is difficult to assess the worth of a given good-output/bad-output production allocation decision, in the absence of an acceptable monetary measure. It is the purpose of this paper to develop such a model by exploring the economic properties of these output types, developing the production process that gives rise to the asymmetric treatment of the outputs and exploring various ways of computing the tradeoff.

An International Comparison of Productivity Change in Agriculture and the Economy as a Whole: A Stochastic Production Frontier Finite Mixture Model Approach

Nuno Moutinho (*Universidade do Porto, Portugal*)
Fernando Machado (*Universidade Católica Portuguesa, Portugal*)
Elvira Silva (*Faculdade de Economia do Porto, Portugal*)

Using a stochastic production frontier finite mixture model, labor productivity change is decomposed into catch-up, technological change and factor accumulation effects and stochastic shocks. This decomposition is investigated separately in the agriculture sector and the economy as a whole using a balanced panel data set of 45 countries in different development stages during the time period 1967-1992. The impact of labor productivity change components on the evolution of the cross-country counterfactual distribution of labor productivity is also analyzed. For the overall economy, the empirical results indicate that growth and the twin-peak distribution of labor productivity are driven by capital deepening. However, the results for the agriculture sector suggest that labor productivity distribution is brought by total factor productivity changes rather than factor accumulation. Furthermore, the agriculture sector exhibits reductions in capital per worker as well as stronger catch-up and technological change effects.

Multimodality of Productivity Distributions: An Application to Macroeconomic Convergence

Daniel Henderson (*State University of New York at Binghamton, USA*)
Robert Russell, Pelin Kale Attar (*University of California, Riverside, USA*)

This paper uses nonparametric kernel methods in order to estimate production (or cost) frontiers as well as to estimate technical efficiency. A random effects nonparametric estimator is proposed (the first of its kind), its structure defined and properties stated. Monte carlo exercises show that it outperforms DEA methods and performs almost as well as the parametric model in estimating both the frontier and inefficiency when the true technology is linear. In constrast, when the technology becomes more nonlinear, the nonparametric estimator outperforms both models. The techniques are then applied to estimate the technical efficiency of 17 OECD economies.

SATURDAY
9:00 - 10:15 SESSION 9-B: *Dea Advances II*

A Simplified Bootstrap for DEA Estimators

Paul Wilson (*University of Texas at Austin, USA*)
Leopold Simar (*Universite Catholique de Louvain, Belgium*)
Alois Kneip (*Johannes Gutenberg-Universitaet Mainz, Germany*)

It is now well-known that naive bootstrap resamling leads to inconsistent inference in the case of DEA estimators. This paper introduces a simple, tractable bootstrap that (i) allows for heterogeneity in the inefficiency process, and unlike previous methods, (ii) does not require multivariate kernel smoothing, and (iii) avoids the need for solutions of intermediate linear programs. For a sample of size n, bootstrap pseudo-samples of size m<n are drawn from the empirical distribution of the (x,y)-pairs. This sub-sampling approach provides consistent inference, and iterating this bootstrap (i.e., nesting a bootstrap within the original bootstrap) provides a method for choosing m.

A Double Perspective DEA Approach Applied to Assess End Use Household Energy Consumption

Marcos Estellita, Angela Silva (*Federal University of Rio de Janeiro, Brazil*)

Double Perspective DEA (DP-DEA) was first applied to estimate the value range of real estate units, employing both classic DEA models with Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS).The method uses, as an objective measure of the observed units efficiency, two simultaneous perspectives: the maximization of outputs and the minimization of inputs, in such a way that inputs under one perspective are the outputs under the other and vice-versa. In this work, DP-DEA is integrated with Conditional Demand Analysis, a technique that breakes household energy consumption into its constituents due to each appliance use.

Far out or Alone in the Crowd: Classification of Self-evaluators in DEA

Sverre Kittelsen (*Frisch Center, Norway*)
Dag Edvardsen (*The Norwegian Building Research Institute, Norway*)
Finn Førsund (*University of Oslo, Norway*)

The units found strongly efficient in DEA studies on efficiency can be divided into self-evaluators and active peers, depending on whether the peers are referencing any inefficient units or not. The paper subdivides the self-evaluators into interior and exterior ones. The exterior self-evaluators are efficient by default. These units should therefore be removed in a two-stage analysis of efficiency. A method for classifying self-evaluators based on the additive DEA model is developed. The application to municipal nursing- and home care services of Norway shows significant effects of removing exterior self-evaluators from the data when doing a two-stage analysis.

Correcting the Concentration Effect on Technical Efficiency Prediction

Rafaela Dios (*University of Cordoba, Spain*)
José Miguel Martínez (*University of Murcia, Spain*)

In efficiency analysis by means of stocastics frontier production function, the composite error variable includes the inefficiency component. For this reason, individual prediction cannot be made directly from an estimation of the error in the model. In order to solve this problem, Jondrow et al (1982), and Battese and Coelli (1989) have separatly developed two different procedures, based on the expectation operator of the conditional distributions. Although the two predictors are different, they both suffer from a concentration effect with respect to the distribution of the theoretical efficiency. In a previous work (Dios et al, 2002) we conducted research into the behaviour of these two predictors and concluded from this that the value of the gamma parameter has a great influence on the afore-mentioned effect, producing a truncation of the distribution that coud reach over 50%, so that the extreme values of the efficiency can never be estimated by the considered predictors. In this work we propose a method that spread out the predicted efficiencies in order to minimise the above mentioned concentration effect. The Monte Carlo results demonstrate that the corrected predictions have a better behaviour than the predictors themselves.

Estimating Multi-output Technologies when Output Random Shock are Non-radial

David Roibás (*Universidad de Oviedo, Spain*)
Carlos Arias (*Universidad de León, Spain*)

Distance functions provide a primal representation of multi-output technologies. The econometric estimation of an output oriented distance function requires that all outputs are affected in the same proportion by the random disturbance. It is not difficult to see that the assumption of random disturbances affecting in the same proportion all outputs in the production process can be highly unrealistic. We avoid the assumption of proportional effects of random disturbances in outputs representing the technology by a multi-output production function with technical efficiency affecting all outputs. In this setting, the problem of output endogeneity can be tackled using instrumental variables. We explore the properties of this approach using Monte Carlo simulation.

The Gauge Function as a Measure of Profit Efficiency

Glenn Sheriff (*Columbia University, USA*)

Reliance on radial input or output-based technical efficiency measures has unnecessarily hindered stochastic profit frontier estimation for cross-sectional data. We discuss an alternative radial efficiency measure based on McFadden's gauge function. The gauge function provides a complete functional representation of the production possibility set for commonly specified technologies, and is dual to the restricted profit function. Unlike measures based on output or input distance functions, profit efficiency calculated using a gauge-based measure of technical efficiency is independent of prices, even for non-homogeneous technologies. In addition, the gauge efficiency measure does not enter netput profit share equations. These results simplify econometric estimation of profit frontiers and profit efficiency, allowing the use of econometric techniques similar to those used for estimating stochastic production and cost frontier.

SATURDAY
9:00 - 10:15 SESSION 9-D: *Economies of Scope*

Non-parametric Economies of Scope in Dutch Horticulture

Alfons Oude Lansink (*Wageningen University, The Netherlands*)
Spiro Stefanou (*Pennsylvania State University, USA*)

Measuring economies of scope allows for an assessment of the benefits from output diversification or specialisation for firms in a sector. Therefore, measuring economies of scope provides a tool for explaining and predicting trends towards specialisation or diversification within sectors like agriculture and horticulture. Previous authors have developed static and dynamic measures of scale and scope in a parametric context. However, non-parametric measures of scale and scope have rarely been developed. This paper contributes to the literature by developing nonparametric measures of scope and scale and to decompose the economies of scope into pure economies of scope, allocative efficiency, scale efficiency, congestion efficiency and pure technical efficiency. Data on horticultural firms, covering the period 1990-1995, were obtained from the Agricultural Economics research Institute. Firms stay in the sample to a maximum of 6 years, so the panel is incomplet. Three outputs (vegetables, flowers and potplants) and five inputs, i.e. energy, materials, services, structures, installations and labour are distinguished. Results show that allocative and congestion efficiency are the major source of scope inefficiency in Dutch horticulture.

Measuring Quality-Quantity Trade-Off in the Regulation of Brazilian "Privatized" Railways

Sergio Perelman (*Université de Liège, Belgium*)
Antonio Estache (*World Bank, USA*)
Lourdes Trujillo (*Universidad de Las Palmas de Gran Canaria, Spain*)

Railways restructuring and privatization have become a mainstream policy option in many developing countries reforming their transport sector. To address the residual monopoly power and to minimize the risks of abuses for specific goods and services they are regulated by an independent regulator. In that context, one of the main practical yet often underestimated issue is the fact that quality needs to be monitored quite closely. This paper looks at an interesting experience in addressing this issue. Brazil's concession contracts signed between 1997 and 1999, indeed, offered an innovative solution to ensure a close monitoring of the quantity-quality trade-off in a price cap regulatory regime. The main challenge for the regulators is to develop a general quality adjusted efficiency measure which can be used in regulatory processes. To contribute to the ongoing policy debate, we compare in this paper several alternative approaches using DEA and Malmquist index of productivity change and data on 7 Brazilian railways operators. The Malmquist productivity index proposed by Färe, Grosskopf and Roos (1993) appears to be the best adapted. It takes simultaneously into account the evolution of quantity and quality delivered by the operator and has the property to be decomposable into quantity and quality productivity changes that constitute the main information needed in the price-cap regulation process.

A Distance Function for Cargo Handling Services in Spanish Terminals Port

Beatriz Tovar, Lourdes Trujillo (*Universidad de Las Palmas de Gran Canaria, Spain*)
Sergio Jara (*Universidad de Chile, Chile*)

Cargo handling in ports is a multioutput activity, as freight can arrive in many forms like containers, bulk, rolling stock, or non-containerised general cargo. Each type of movement involves the use of both common and specialised inputs. In this paper the operation of cargo handling firms in ports is analysed by means of the estimation of a distance function, using monthly data on three firms located at the Las Palmas port in Spain. Both size and traffic mix is first shown to be sufficiently diverse as to allow for a reliable estimation of a distance function for analyzing efficiency in this multi-output sector.

A Comparative Analysis of Alternative Stochastic Frontier Models Applied to Panel Data
Mehdi Farsi, Massimo Filippini, Michael Kuenzle (*Federal Institute of Technology, Switzerland*)

This paper studies a number of recently developed stochastic cost frontier models that distinguish between unobserved heterogeneity and inefficiency variation among firms. Our main focus is on the models that incorporate firms' fixed or random effects in a stochastic frontier model. These methods are applied to a panel data of 36 Swiss nursing homes operating from 1993 to 2001. A comparison of the results sheds some light on the heterogeneity problem. When the latent heterogeneity is correlated with some of the explanatory variables, the random effects model is biased but the fixed effects model has a poor performance in inefficiency estimation. Theoretically, by introducing firms' fixed effects in a stochastic frontier model, one should be able to get around the inconsistency problem while keeping the inefficiency estimates intact. However, our results suggest that in certain conditions the problem can only be avoided if such correlations are included in the specification.

Fitting an Unknown Production Function for Measuring Efficiency
Daniel Santin (*Universidad Complutense, Spain*)

The aim of this paper is to show how artificial neural networks (ANNs) are a valid alternative to traditional techniques for fitting production functions and measuring technical efficiency. It main comparative advantages are in contexts where the production function is smooth, completely unknown, contains non-linear relationships among the variables and the quantity of noise and inefficiency in data is moderate. In this work I estimate a production function that fulfils all microeconomics requirements. However this function is different of typical ones, such as the Cobb Douglas or translog. The objective is to fit this production function with DEA, stochastic frontiers, ordinary least squares and ANNs and to verify which of them obtains better estimations of efficiency. A Monte-Carlo experiment is carried out for this purpose. In this case, the ANNs algorithm can detect, better than traditional tools, the underlying structure of the production function from observed data.

Bayesian Analysis of Input-Oriented Technical Efficiency
Mike Tsionas (*Athens University of Economics and Business, Greece*)
Subal Kumbhakar (*State University of New York at Binghamton, USA*)

This paper deals with Bayesian estimation of input-oriented (IO) technical efficiency from using a stochastic production frontier approach. Although the IO technical efficiency is commonly used in theoretical discussions, it is never estimated in practice using a production function. To emphasize the point that estimated efficiency, returns to scale, etc., might differ depending on whether the IO or OO model is used, we compare results from the IO and OO models. Both cross-sectional and panel data approaches are used. We provide inferences for parameters and efficiency using Bayesian methods organized around Markov Chain Monte Carlo techniques, especially the Gibbs sampler with data augmentation.

Multi-objective Approach as an Alternative to Radial Projection in DEA

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

DEA provides a basis for target setting, but the main limitation of the standard DEA models is that they do not take into consideration the decision maker's preferences. This limitation is discussed in many papers that introduce approaches to target setting. However, these papers do not analyse the importance of the value information and the effect of excluding it in practice. Our paper discusses these aspects based on an empirical experiment, where a group of students was free to choose their own target values on the efficient frontier. On the basis of these results we analyse how the radial projections correspond to the preferences of the decision makers. The results show that radial projection is too restrictive for target setting. We propose that in case a DMU has a control over some inputs or outputs, a multiple objective linear programming approach should be used in target setting.

Quantitative Peergrouping and Benchmarking: An Envelopment Approach

Robert Weaver (*University of Connecticut, USA*)
Taeho Kim (*Korea Institute for Industrial Economics, Korea*)

This paper reconsiders the problem of quantitatively identifying benchmark firms. DEA-based approach of findings a "virtual peer" is reviewed, and a new approach two step approach for identifying observable peers is presented. The approach consists of two stages: peergrouping through a nonparametric distance measure and DEA-based benchmark identification. The peergrouping process classifies firms into subgroups based on characteristics and the pattern of nonradial technical efficiency across variable inputs in DEA. DEA-based benchmarking determines benchmarks for each peergroup using DEA scores and similarity analysis. The criterion for identification of benchmarks is drawn from technical efficiency estimates extending past work by Horsky and Nelson (1996), Golany and Thore (1997), Ray and Desli (1997), and Smith (1997) by using similarity analysis. An application is presented based on a recent survey of farm production operations in the U.S.

Influence of Optimistic vs. Pessimistic Efficient Frontier on Users' Choices

Pekka Korhonen, Sari Stenfor, Jyrki Wallenius (*Helsinki School of Economics, Finland*)

In this paper we have experimentally investigated the influence of an 'optimistic'/'pessimistic' efficient frontier on subjects' choices and attitudes towards the frontier, and their feelings in general. Each subject is regarded as an independent decision making unit. Our experiment was run with 201 freshman and sophomore students at the Helsinki School of Economics. The subjects evaluated a time-allocation task between five different 'activities' (outputs) (credit units, free time, grades, professional work, and income) for the next academic year. The results of our experiment indicate that the 'optimism' or 'pessimism' of efficient frontier did have a statistically significant influence on the subjects' choice concerning the target values of the activities (outputs)., in part consciously, in part unconsciously. In addition, a measurable influence on subjects' negative feelings (irritation, distress, disappointment) could be detected. No influence concerning subjects' positive attitude towards the efficient frontier could be found (satisfaction with the model, confidence in the model, etc.). Furthermore, the importance attached to the output values by the subjects could not be used to predict how subjects changed the target values of the outputs as a result of the efficient frontier they used. Our observations imply that the realism of an efficiency frontier has What are the implications of the results for modelers? The model does matter. It does have a several conscious and sub-conscious influences on a decision maker s choices and feelings.

SATURDAY
10:45 - 12:00 SESSION 10-C: *SFA Applications II*

An Input Distance Function Approach to the Measurement of Technical and Allocative Efficiency

Tim Coelli (*University of Queensland, Australia*)
Euan Fleming (*University of New England, Australia*)
Satbir Singh (*Beribagh, Sahranpur, UP, India*)

In this paper we describe how one can measure technical and allocative efficiency relative to a stochastic input distance function. This method avoids many of the problems that can afflict the cost and/or production frontier approaches, such as non-optimising behaviour, limited price variation, regressor endogeneity, and the single output restriction. The method is illustrated using survey data on private and cooperative Indian dairy processing plants. Our empirical results indicate that the private firms are not more cost-efficient than the cooperative firms, and also show that the introduction of reforms to encourage the entrance of new private sector firms did not have the expected positive effect upon cost efficiency in this industry.

A Joint Production Efficiency Model of the Water Industry in the United States

Roberto Mosheim (*University of Puerto Rico at Mayaguez, USA*)

The importance of enhancing knowledge about the performance of water supply systems cannot be overemphasized given the many significant issues facing the water industry today. Two of these aspects are modeled explicitly in the study proposed here: organizational type and water quality. The results should be interesting not only from an academic but also from a policy perspective given that in the United States in the year 2000 there were 91 regulated contaminants, and future regulation will increase that number and lead to a myriad of treatment technique regulations. This study analyzes the costs of private (investor-owned and cooperative) and public water utilities operating in the United States. Two outputs (water production and residual chemicals in the distributed water), four inputs (capital, labor, energy and materials), and eight characteristics internal and external to the firm are distinguished. Capital is considered fixed. The bulk of the data that is used here came from the 1996 American Water Works Association (AWWA) survey of its members. The dataset contains information on the 898 utilities that responded to the survey. The methodology to be employed is the inefficiency effects model by Battese and Coelli (1995).

Forward or Backward Causality? Estimating Firm Level Panel Data on R&D and Productivity

Hans Lööf (*Royal Institute of Technoogy, Sweden*)

This paper uses firm level panel data on innovation observations and economic variables to investigate a number of theoretical and methodological issues raised over the past decades. In order to improve the analysis and to explore different hypothesis on the causality between physical capital, financial capital, knowledge capital, human capital and firm performance two alternative approaches are utilized. The first follows a cross-section of Swedish firms observed in the second Community Innovation (CIS) survey (1996) back to 1992 and forward to 2000. The CIS innovation data is merged with extensive register data based on annual accounts and educational statistics. In the second approach a dynamic model is estimated using an extensive panel of Swedish firms participating in an innovation survey (1998). The firms are observed between during a nine-year period.

Parametric Decomposition of the Input-Oriented Malmquist TFP Index: Greek Fish Farms

Giannis Karagiannis (*University of Macedonia , Greece*)
Christos Pantzios (*University of Patras, Greece*)
Vangelis Tzouvelekas (*University of Crete, Greece*)

The paper specifies the Malmquist productivity index in an input-based analytical framework using the stochastic frontier approach, and a trans logarithmic form of the input-distance function. By extending results of existing studies, we form an input-oriented Malmquist productivity index which allows for technical efficiency change; scale efficiency change; an input-mix effect; and, technical change. The last component is further decomposed into neutral, output-induced and input-induced shifts of the technology frontier over time. Operational expressions for all the aforementioned components are derived using a discrete changes-approach which is consistent with the usual discrete-form data. An empirical application of the suggested framework is carried out on a panel dataset of Greek seabass and seabream producing farms.

Measuring the Productivity of the Banking System:A Generalized Parametric Malmquist Approach

Meryem Duygun Fethi, Peter Jackson (*University of Leicester, United Kingdom*)
Thomas Weyman-Jones (*Loughborough University, United Kingdom*)

A recent development in the analysis of productivity decomposition is the generalised parametric Malmquist index estimated from a time shifting output distance function, Orea (2002). This Malmquist index can be decomposed into efficiency change, technical change and returns to scale effects. Consequently it is a proper index of total factor productivity. Estimation proceeds by specifying a composed error model of the translog approximation to the output distance function. The inefficiency component of the error is time dependent, and the distance function shifts with time, so that efficiency change and technical change components of the Malmquist index can be calculated. The returns to scale effect is calculated by using the Fare and Primont (1995) measure of scale elasticity based on the input elasticities of the output distance function. We use this index and its components to evaluate the productivity of the banking system in a transition economy during a period of financial upheaval.

A Frontier Approach to Canada-U.S. Productivity Performance

Tarek Harchaoui, Kaïs Dachraoui (*Statistics Canada, Canada*)

Much of the recent Canadian productivity debate has focused on the Canada-U.S. productivity growth gap but fewer efforts have been directed to tracing and quantifying its sources. This paper fills this gap by exploiting the frontier approach to productivity measurement. Using a nonparametric programming method, we construct a North American frontier for the business sector and for the manufacturing sector based on data from the two countries. Each sector or industry is compared to that frontier. How much closer a particular sector or industry of any country gets to the North American frontier is known as technical efficiency and results from catching up to best-practice production technology; how much the North American frontier shifts at each sector s or industry s observed input mix is known as technical change and results from the type of innovation that brings best-practice technology into the country. The combined effect of these two changes yields a frontier version of multifactor productivity growth that is derived from the Malmquist index of multifactor productivity growth. The paper concludes that, whether at the level of the aggregated business sector or at the manufacturing sector level, Canada s productivity problem during the 1988-2000 period,is mostly ascribed to the deterioration of its technical efficiency-or the extent to which firms are using production technology that places them behind the leaders. The results also suggest that Canada s productivity surge in the 1995-2000 period was mainly due to a recovery in its technical efficiency. We also find that, over the 1981-1997 period, the dispersion of the distribution of technical efficiency across North American manufacturing industries increased drastically.

EIGHTH EUROPEAN WORKSHOP ON EFFICIENCY AND PRODUCTIVITY ANALYSIS

Oviedo, Spain
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