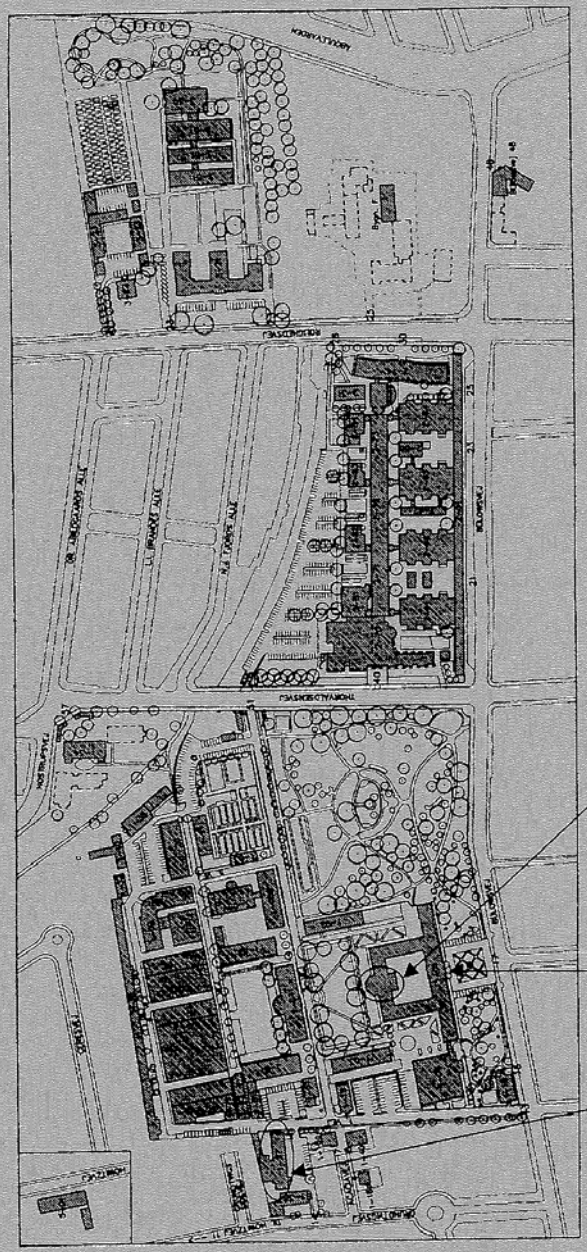
Map of the KVL campus



Fifth European Workshop

on

Efficiency and Productivity Analysis

Copenhagen, October 9-11, 1997

PROGRAM

Scientific Committee:

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Thursday 9/10/97:

13.00 - 14.00	*Registration*
14.00 - 16.00	**Session 1.** *Welcome and opening remarks* *Historical overview*
16.00 - 16.30	*Coffee Break*
16.30 - 17.45	**Session 2.** *New perspectives*

Friday 10/10/97:

9.00 - 10.45	**Session 3. A.** *Theoretical advances in DEA and FDH*	**Session 3. B.** *Theoretical advances in productivity*	**Session 3. C.** *Stochastical Frontiers*
10.45 - 11.15	*Coffee Break*		
11.15 - 13.00	**Session 4. A.** *Statistical foundation*	**Session 4. B.** *DEA vs. MCDM*	**Session 4. C.** *New perspectives in application*
13.00 - 14.00	*Lunch*		
14.00 - 15.30	**Session 5. A.** *Agriculture*	**Session 5. B.** *Banking*	**Session 5. C.** *Malmquist Indexes*
15.30 - 16.30	*Coffee Break* *Software demonstration* *Poster-session*		
16.30 - 18.00	**Session 7. A.** *Bootstrapping*	**Session 7. B.** *DEA applications with MCDM aspects*	**Session 7. C.** *Measurements in non-parametric efficiency*
19.30 -	*Workshop Dinner*		

Saturday 11/10/97:

9.00 - 10.45	**Session 8. A.** *Economic reforms in centrally planned economies 1*	**Session 8. B.** *Incentives and regulation*	**Session 8. C.** *Decomposition*
10.45 - 11.15	*Coffee Break*		
11.15 - 13.00	**Session 9. A.** *Economic reforms in centrally planned economies 2*	**Session 9. B.** *Service and education*	**Session 9. C.** *Sensitivity and computations of efficiency*
13.00 - 14.00	*Lunch*		
14.00 - 16.15	**Session 10. A.** *Agriculture and the environment*	**Session 10. B.** *Health*	

Thursday 9/10/97 - 13.00 - 14.00

Registration

Session 1 - Thursday 9/10/97 - 14.00 - 16.00

Welcome and opening remarks

Peter Bogetoft

Historical overview
Chairman and Discussant: Rolf Färe

I. DEA: WHERE IT CAME FROM! WHERE IT'S GOING?
W. W. Cooper

II. FRONTIER OR NOT FRONTIER? THAT IS THE QUESTION
H. Tulkens

III. WHAT A LONG STRANGE TRIP IT'S BEEN
C. A. Knox Lovell

Thursday 9/10/97 - 16.00 - 16.30

Coffee Break

Session 2 - Thursday 9/10/97 - 16.30 - 17.45

New perspectives
Chairman and Discussant: Finn R. Førsund

I. NONPARAMETRIC TEST OF RETURN TO SCALE
L. Simar
P. W. Wilson

II. A VALUE EFFICIENCY APPROACH TO INCORPORATING PREFERENCE INFORMATION IN DATA ENVELOPMENT ANALYSIS
P. J. Korhonen
M. Halme
T. Joro
S. Salo
J. Wallenius

III. INFORMATION ABOUT SOFTWARE DEMONSTRATION
Philippe Vanden Eeckaut

Session 3 - Friday 10/10/97 - 9.00 - 10.45

A. Theoretical advances in DEA and FDH
Chairman and Discussant: Henry Tulkens

I. FUZZY PAIRWISE DOMINANCE AND IMPLICATIONS FOR TECHNICAL EFFICIENCY PERFORMANCE ASSESSMENT
P. Vanden Eeckaut
K. Triantis

II. STOCHASTIC BOUNDS ON THE SET OF VIRTUAL MULTIPLIERS IN DEA
O. Olsen
N. C. Petersen

III. EFFICIENCY EVALUATIONS BASED ON POTENTIAL (NON-PROPORTIONAL) IMPROVEMENTS
P. Bogetoft
J. L. Hougaard

B. Theoretical advances in productivity
Chairman and Discussant: Rolf Färe

I. COST AND PRODUCTIVITY
C. A. Knox Lovell
E. Grifell-Tatjé

II. PRODUCTIVITY GROWTH, EFFICIENCY AND TECHNICAL CHANGE: A PANEL DATA APPROACH
S. C. Kumbhakar

III. DECOMPOSING TFP GROWTH WITHIN A PROFIT FUNCTION FRAMEWORK
G. Mergos
G. Karagiannis

C. Stochastical Frontiers
Chairman and Discussant: Lars Otto

I. ESTIMATION AND EXPLANATION OF TECHNICAL EFFICIENCY OF CONTAINER TERMINALS: A BAYESIAN STOCHASTIC FRONTIER APPROACH.
J. van den Broeck
C. Coeck
T. Notteboom

II. SPECIFICATION AND ESTIMATIONS OF MULTIPLE- OUTPUT STOCHASTIC RAY FRONTIER PRODUCTION MODELS
M. Löthgreen

III. SEMIPARAMETRIC ERROR COMPONENT DENSITY ESTIMATION TECHNIQUES FOR STOCHASTIC FRONTIER MODELS
W. C. Horrace

Friday 10/10/97 - 10.45 - 11.15

Coffee Break

Session 4 - Friday 10/10/97 - 11.15 - 13.00

A. Statistical foundation
Chairman and Discussant: Léopold Simar

I. FDH EFFICENCY SCORES FROM A STOCHASTIC POINT OF VIEW
B. Park
L. Simar
C. Weiner

II. MONTE-CARLO SIMULTATIONS OF DEA EFFICIENCY MEASURES AND HYPOTHESIS TESTS
S. A. C. Kittelsen

III. MONTE-CARLO EVIDENCE OF DEA+ PERFORMANCE WITH MULTIPLE OUTPUTS
D. Gstach

B. DEA vs. MCDM
Chairman and Discussant: Jørgen Tind

I. SEARCHING THE EFFICIENT FRONTIER IN DEA
P. Korhonen

II. COMPETING OR COMPLEMENTARY APPROACHES
V. Belton
T. Stewart

III. DEA AND MCDM: SOME REMARKS
D. Bouyssou
(presented by P. Korhonen)

C. New perspectives in application
Chairman and Discussant: Emmanuel Thanassoulis

I. CLUSTER ANALYSIS AND DATA ENVELOPMENT ANALYSIS APPLIED TO FACULTY PERFORMANCE EVALUATION
J. Agrell
J. E. Aronson

II. INTERNAL BENCHMARKING FOR MARKETING EFFICIENCY
J. Parsons

III. DEA BASED ANALYSIS OF CORPORATE FAILURE
J. C. Paradi
P. Simak

IV. X-EFFICIENCY LINKED TO BUSINESS STRATEGY, RESSOURCE AND CAPABILITIES AND ENVIRONMENTAL CHARACTERISTIC
A. D. Athanassopoulos
Y. Spanos

Friday 10/10/97 - 13.00 - 14.00

Lunch

Session 5 - Friday 10/10/97 - 14.00 - 15.30

A. Agriculture
Chairman and Discussant: Brian Jacobsen

I. EFFICIENCY IN NEW ZEALAND SHEEP AND CATLE FARMING: PRE AND POST-REFORM
W. E. Johnston
C. J. Morrison

II. DECLINING PRODUCTIVITY IN LDC AGRICULTURE
R. K. Perrin
L. E. Fulginiti

III. DYNAMIC AREA ALLOCATON AND ECONOMIES OF SCALE AND SCOPE
S. Stefanou
A. O. Lansink

B. Banking
Chairman and Discussant: C. A. Knox Lovell

I. BANKING EFFICIENCY AND EUROPEAN INTEGRATION: AN ALTERNATIVE PROFIT FUNCTION APPROACH
L. Weill
M. Dietsch

II. HOW FAST DO BANKS ADJUST ? A DYNAMIC MODEL OF LABOR-USE WITH AN APPLICATION TO SWEDISH BANKS
S. C. Kumbhakar
L. Hjalmarsson
A. Heshmati

III. AGENCY COST, ORGANIZATIONAL FORM, AND EXPENSE PREFERENCE BEHAVIOR: THE CASE OF SPANISH DEPOSITORY INSTITUTIONS
I. Hasan
A. L. Vivas

C. Malmquist Indexes
Chairman and Discussant: Pontus Roos

I. IN SEARCH OF MALMQUIST: A QUEST BEYOND TWO DIMENSIONS
S. C. Ray

II. THE MALMQUIST PRODUCTIVITY INDEX, PRODUCTIVITY AND SCALE
F. R. Førsund

III. A PARAMETRIC STOCHASTIC DISTANCE FUNCTION APPROACH FOR MALMQUIST INDEKS ESTIMATION: THE CASE OF SPANISH INSURANCE COMPANIES
H. Fuentes
E. Grifell-Tatjé
S. Perelman

Session 6 - Friday 10/10/97 - 15.30 - 16.30

Coffee Break

Software demonstration

15.30 – 15.50 : Warwick DEA
15.50 – 16.10 : DEAP
16.10 – 16.30 : EMQ Software

Poster-session

I. A DECOMPOSITION OF AGRICULTURAL PRODUCTION GROWTH: FURTHER EVIDENCE USING NEOCLASSICAL DUALITY
K. Giannakas
G. Karagiannis
K. Mattas
V. Tzouvelekas

II. EFFICIENCY CHANGE AND THE GROWTH IN PRODUCTIVITY: THE ASIAN NIC'S GROWTH EXPERIENCE
C. Chang
Y. Luh

III. ENVIRONMENTAL QUALITY IN THE VON-LIEBIG-PARIS TECHNOLOGI: WITH AN APPLICATION TO MARINE CAGE AQUACULTURES
J. Mistiaen

IV. PATTERNS OF PRODUCTIVITY CHANGE IN THE NORWEGIAN SALMON FARMING INDUSTRY 1985-93
R. Tveterås
A. Heshmati

V. ENVIRONMENTAL EFFICIENCY WITH MULTIPLE ENVIRONMENTAL DETRIMENTAL VARIABLES; ESTIMATED WITH SFA AND DEA
C. A. Knox Lovell
S. Reinhard
G. Thijssen

VI. A NEW METHOD TO OBTAIN RISK-ADJUSTED EFFICIENCY MEASURES IN BANKING FIRMS: MEASURING THE EFFECT OF DEREGULATION ON SPANISH BANKING SYSTEMS
J. M. Pastor

VII. EFFICIENCY OF SWEDISH BANKING INDUSTRY: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS
A. P. Mlima

VIII. FIRM SPECIFIC TEMPORAL VARIATION IN TECHNICAL EFFICIENCY: RESULTS OF A STOCHASTIC OUTPUT DISTANCE FUNCTION
R. A. Cuesta
L. O. Sanchez

IX. ASSESSING THE COMPARATIVE EFFICIENCY OF DECISION MAKING UNITS UNDER INTER-TEMPORAL INPUT-OUTPUT DEPENDENCE
A. Emrouznejad
E. Thanassoulis

X. QUALITY VS. QUANTITY IN EDUCATION
S. Grosskopf
K. Hayes

XI. TOTAL FACTOR PRODUCTIVITY GROWTH IN THE IRANIAN ELECTRIC POWER INDUSTRY
A. Sharifi

XII EVALUATING THE PERFORMANCE OF A TEST FOR THE SELECTION OF VARIABLES IN DEA BY MONTE CARLO SIMULATIONS
F. Borras
J. T. Pastor
J. L. Ruiz
I. Sirvent

XIII. SENSITIVITY ANALYSIS FOR EXTREME EFFICIENT DMU'S FOR PROPORTIONAL CHANGES IN INPUTS AND OUTPUTS
V. Boljuncic

XIV. COINTEGRATION OF TECHNICAL EFFICIENCY: AN APPLICATION TO THE CONVERGENCE HYPOTHESIS
J. Waechter

XV. COMPARING REFERENCE SELECTIONS IN ALTERNATIVE DEA MODELS
D. Wang

Session 7 - Friday 10/10/97 - 16.30 - 18.00

A. Bootstrapping
Chairman and Discussant: Paul W. Wilson

I. EMPIRICAL TEST OF TRADEOFFS BETWEEN ALTERNATIVE MANUFACTURING PERFORMANCE DIMENSIONS
R. Banker

II. BOOTSTRAP ESTIMATION FOR DEA ASSURANCE REGION EFFICIENCY SCORES
T. Beltov

III. A TWO-LEVEL BOOTSTRAP PROCEDURE TO CAPTURE UNIT SPECIFIC EFFECTS IN DATA ENVELOPMENT ANALYSIS
E. Desli
S. C. Ray

B. DEA applications with MCDM aspects
Chairman and Discussant: Pekka Korhonen

I. MODELS FOR IDENTIFYING TARGET UNITS IN DATA ENVELOPMENT ANALYSIS: COMPARISON AND EXTENSIONS
T. Joro

II. EVALUATION THE EFFICIENCY AND INTENSIFYING THE ACTIVITIES IN A FINNISH LOCAL MARKET CHAIN
A. Siljamäki

III. EFFICIENCY OF TEAM MANAGERS IN NATIONAL HOCKEY LEAGUE
T. Kuosmanen

C. Measurements in non-parametric efficiency
Chairman and Discussant: Philippe Vanden Eeckaut

I. FACETS AND EFFICIENCY MEASUREMENT IN DATA ENVELOPMENT ANALYSIS
P. Pille
J. C. Paradi

II. ASSESSING SLACKS THROUGH A NESTED RADIAL APPROACH IN A FDH TECHNOLOGY
S. Destefanis
A. Pavone

III. THE SHORTEST PATH TO THE EFFICIENT SUBSET
E. G. Fidalgo
A. M. Alvarez

IV. RETURNS TO SCALE AND SCALE ELASTICITY IN DATA ENVELOPMENT ANALYSIS
H. Fukuyama

Friday 10/10/97 - 19.30 –

Workshop Dinner

Session 8 - Saturday 11/10/97 - 9.00 - 10.45

A. Economic reforms in centrally planned economies 1
Chairman and Discussant: Tim J. Coelli

I. PRODUCTIVITY GROWTH, CATCH-UP AND CONVERGENCE IN CHINA'S RFORMING ECONOMY
Y. Wu

II. THE EMERGENCE OF A TWO TIER BANKING SECTOR: A MALMQUIST INDEX APPROACH
J. Piesse
G. Rogowski

III. EXPLORING A REGIONAL EFFICIENCY FRONTIER IN THE FORMER USSR
G. Brock

IV. A DECOMPOSITION OF TOTAL FACTOR PRODUCTIVITY GROWTH: THE CASE OF CHINESE STATE ENTERPRICES DURING THE REFORM PERIOD
Y. Huang
K. P. Kalirajan

B. Incentives and regulation
Chairman and Discussant: Peter Bogetoft

I. PARAMETRIC AND NON-PARAMETRIC APPROACHES TO BENCHMARKING THE REGULATED FIRM
G. Granderson
C. B. Linvill

II. YARDSTICK COMPETITION AND THE REGULATION OF NATURAL MONOPOLIES
G. Ek

III. FIRM PRODUCTIVITY GROWTH AND COMPETITION
M. Dilling-Hansen
T. Eriksson
E. S. Madsen
V. Smith

IV. EVALUATING SOLVENCY AND EFFICIENCY PERFORMANCES IN U.S. PROPERTY-LIABILITY INSURANCE COMPANIES
P. L. Brockett
W. W. Cooper
L. Golden
J. J. Rousseau
Y. Wang

C. Decomposition
Chairman and Discussant: Shawna Grosskopf

I. DISTINGUISHING TECHNICAL AND SCALE EFFICIENCY ON NON-CONVEX AND CONVEX TECHNOLOGIES: AN ILLUSTRATION USING UK RATES DEPARTMENTS
P. Vanden Eeckaut
K. Kerstens

II. THE DECOMPOSITION OF TOTAL FACTOR PRODUCTIVITY GROWTH: A DUAL APPROACH
A. O. Lansink

III. THE COMPONENTS OF TOTAL FACTOR PRODUCTIVITY CHANGE
M. Balk

Saturday 11/10/97 - 10.45 - 11.15

Coffee Break

Session 9. - Saturday 11/10/97 - 11.15 - 13.00

A. Economic reforms in centrally planned economies 2
Chairman and Discussant: Gregory Brock

I. PRODUCTIVITY OF MONGOLIAN GRAIN FARMING: 1976-89
G. E. Battese
T. Bayarsaihan
T. J. Coelli

II. SECTOR LEVEL EFFICIENCY AND PRODUCTIVITY IN HUNGARIAN PRIMARY, SECONDARY AND TERTIARY INDUSTRIES: 1985-91
J. Piesse
C. Thirtle

III. THE MATHEMATICAL PROGRAMMING APPROACH TO TECHNICAL EFFICIENCY OF THE PUBLIC AND PRIVATE IRANIAN TEXTILE INDUSTRY
N. Nafar

B. Service and education
Chairman and Discussant: Jens Leth Hougaard

I. EVALUATING AND ENCHANCING THE PERFORMANCE OF A REGION
H. O. Fried
J. D. Klein

II. SETTING PERFORMANCE TARGETS FOR PUPILS
E. Thanassoulis

III. MARKETING CAPABILITY AND PERFORMANCE OF DAIRY COOPERATIVES IN INDIA
A. I. Ali
M. Bhargava

C. Sensitivity and computations of efficiency
Chairman and Discussant: Lawrence M. Seiford

I. GRAPHHYPERBOLIC EFFICIENCY AND PRODUCTIVITY MEASURES
C. A. Knox Lovell
J. L. Zofio

II. A COMPARISON OF DEA-COST-EFFICIENCY MEASURES
J. T. Pastor
J. M. Pastor

III. CONVEX INPUT AND OUTPUT PROJECTIONS OF NON-CONVEX PRODUCTION POSSIBILITY SETS
P. Bogetoft
J. M. Tama
J. Tind

IV. PERFORMANCE BENCHMARKING IN STOCHASTIC ENVIRONMENTS USING MEAN-VARIANCE DATA ENVELOPMENT ANALYSIS
T. Post

Saturday 11/10/97 - 13.00 - 14.00

Lunch

Session 10 - Saturday 11/10/97 - 14.00 - 16.15

A. Agriculture and the environment
Chairman and Discussant: Catherine J. Morrison

I. DECOMPOSED EFFICIENCY ANALYSIS
IN FARM BUSINESS ADVISORY
M. Lund
J. E. Ørum

II. A MEASUREMENT OF TECHNICAL AND ALLOCATIVE EFFICIENCY
WITH A PANAL DATA OF ITALIAN DAIRY FARMS: EFFECT OF THE
NORMALIZATION OF THE SHADOW PRICE VECTOR
O. W. Maietta

III. PRODUCTIVITY OF THE U.S. AGRICULTURAL SECTOR:
THE CASE OF UNDESIRABLE OURPUTS
E. Ball
R. Färe
S. Grosskopf
R. Nehring

IV. A STOCHACTIC META-FRONTIER APPROACH
TO MEASURING FARM CREDIT UNION EFFICIENCY
C. J. Huang
T. Fu
M. Huang

V. BENCHMARKING WATER UTILITIES' PERFORMANCE USING DATA
ENVELOPMENT ANALYSIS
D. Wood
P. Barrar
D. Kodwani

B. Health
Chairman and Discussant: N. C. Petersen

I. MEASUREMENT OF OUTPUT AND PRODUCTIVITY OF HOSPITAL
SERVICES: A DUSCUSSION OF THE MALMQUIST INDEX APPROACHES
AND WITH AND ILLUSTRATION TO CATARACT SURGERY
P. Roos

II. HAS THE DRG SYSTEM REALLY INFLUENCED HOSPITAL
PRODUCTIVITY GROWTH IN PORTUGAL? AN EMPERICAL ANALYSIS
USING PARAMETRIC AND NON-PARAMETRIC METHODS
C. E. Dismuke
V. Sena

III. COMPARING TEACHING AND NON-TEACHING HOSPITALS:
A FRONTIER APPROACH
S. Grosskopf
D. Margaritis
V. Valdmanis

IV. MEASURING AND ANALYZING HOSPITAL PRODUCTIVITY TRENDS
TAKING IN-TO ACCOUNT CASE-MIX AND QUALITY OF SERVICE:
A MALMQUIST INDEX APPROACH
B. Hollingsworth
N. Maniadakis

V. THE PERFORMANCE OF SURGERY UNITS IN FRENCH HOSPITALS:
EFFICIENCY AND CAPACITY UTILISATION EXPLAINED
B. Dervaux
G. Escano
K. Kerstens
H. Leleu
B. Vincke

The workshop will be held at the

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Fifth European Workshop
on
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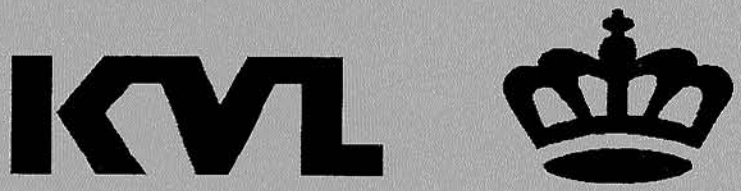
BOOK OF ABSTRACTS



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Léopold SIMAR, Institut de Statistique and CORE, Université Catholique de Louvain, Belgium
Henry TULKENS, CORE, Université Catholique de Louvain, Belgium

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- THE ROYAL VETERINARY AND AGRICULTURAL UNIVERSITY (KVL)

Session 1: Historical overview

I. DEA: WHERE IT CAME FROM! WHERE IT'S GOING! (ORIGINS, GROWTH AND CURRENT DEVELOPMENTS)

William W. Cooper, University of Texas, USA

1. Origins: DEA had its origins in the frustrations of E. Rhodes in his attempts at statistical analyses of President Lyndon Johnson's programs to improve the education of disadvantaged students in U.S. public schools. In one response to the failure of these models and methods he called my attention to an article by M.J. Farrell which I had known about (but forgotten) from earlier personal associations with Farrell as a fellow faculty member at Carnegie-Mellon University. A. Charnes, who was subsequently drawn into this effort, made contact with the earlier work he and I had done in fractional programming. This, in turn, led to both the CCR and BCC ratio forms of DEA which brought into play further new elements such as the treatment of slacks and the duality relations of linear programming which led to interpretations and uses that greatly enhanced Farrell's original formulations

2. Growth and Current Developments: This "applications driven" origin of DEA initiated a course of developments in which new applications, new models, and new methods and concepts vigorously interacted in a great variety of ways. This is now being further augmented by joining DEA with other techniques and disciplines. Examples include joint uses of DEA with (i) statistics (ii) multiple-objective programming (iii) agency theory, (iv) fuzzy sets and (v) redundancy analysis: We see such "joinings" as the onset of yet another phase of developments that will enhance the scope and power of these techniques (and disciplines) as well as DEA.

II. FRONTIER OR NOT FRONTIER? THAT IS THE QUESTION

Henry Tulkens, Université Catholique de Louvain, Belgium

The speaker request the pleasure of your company for a friendly walk along the path of efficiency analysis from FDH to DEA.

III. WHAT A LONG STRANGE TRIP IT'S BEEN

C. A. Knox Lovell, University of Georgia, USA

In this paper I present a brief history of the development of stochastic frontier analysis, in recognition of its 20th anniversary. I discuss its intellectual antecedents (although we were not fully aware of them at the time), its origins on three continents, its international development during the past two decades, its relationship to nonparametric efficiency analysis, and its potential for future growth as a tool for evaluating the performance of producers and other economic decision-makers.

Session 2: New perspectives

I. NONPARAMETRIC TESTS OF RETURN TO SCALE

Paul W. Wilson, University of Texas at Austin, USA
Leopold Simar, Universite Catholiqué De Louvain, Belgium

This paper discusses various statistics for testing hypotheses regarding returns to scale in the context of non-parametric models of technical efficiency. In addition, the paper presents bootstrap estimation procedures, which yield appropriate critical values for the test statistics. Evidence on the true sizes of the various proposed tests is obtained from Monte Carlo experiments. This paper is an extension of earlier work in Simar and Wilson (1997).

II. A VALUE EFFICIENCY APPROACH TO INCORPORATING PREFERENCE INFORMATION IN DATA ENVELOPMENT ANALYSIS

Pekka J. Korhonen, IIASA, Austria
Merja Halme, Helsinki School of Economics, Finland
Tarja Joro, Helsinki School of Economics, Finland
Seppo Salo, Helsinki School of Economics, Finland
Jyrki Wallenius, Helsinki School of Economics, Finland

We have developed a procedure and the requisite theory for incorporating preference information in a novel way in the efficiency analysis of decision making units (DMU). The efficiency of DMU is defined in the spirit of data envelopment analysis (DEA), complemented with a decision maker's (DM) preference information concerning the desirable structure of inputs and outputs. Our procedure begins by aiding the DM in searching for the most preferred combination of inputs and outputs of DMU (for short, most preferred solution) which are efficient in DEA. Then, assuming that the DM's most preferred solution maximizes his/her underlying (unknown) value function at the moment when the search is terminated, we approximate the indifference contour of the value function at this point with its possible tangent hyperplanes. *Value Efficiency* scores are then calculated for each DMU comparing the inefficient units to units having the same value as the most preferred solution. The resulting *Value Efficiency* scores are optimistic approximations of the true scores. The procedure and the resulting efficiency scores are immediately applicable to solving practical problems.

Keywords: Efficiency Analysis, Data Envelopment Analysis, Multiple

Session 3.A: Theoretical advances in DEA and FDH

I. FUZZY PAIRWISE DOMINANCE AND IMPLICATIONS FOR TECHNICAL EFFICIENCY PERFORMANCE ASSESSMENT

Konstantinos Triantis, Virginia Tech, USA
Philippe Vanden Eeckaut, Universite Catholique de Louvain, Belgium

Classically, the concept of efficiency measurement is based on the definition of a frontier that envelops the observed production plans. The efficiency score itself is based on the distance of an observed production plan from this frontier. The frontier along with the required technical assumptions (such as convexity) needed for its definition may be replaced with the concept of pair-wise dominance. This concept leads to a classification scheme for all production plans instead of a ranking based on efficiency scores. Also, the traditional assumption of deterministic or crisp production plans may be substituted with the weaker assumption of fuzzy production plans as proposed by fuzzy set theory. This paper merges these two concepts and defines a new classification scheme based on fuzzy dominance.

II. STOCHASTIC BOUNDS ON THE SET OF VIRTUAL MULTIPLIERS IN DEA

Ole Olesen, University of Odense, Denmark
N. C. Petersen, University of Odense, Denmark

The talk is concerned with the introduction of probabilistic bounds on the set of virtual multipliers in DEA based upon chance constrained programming. Inherent problematic characteristics of the standard AR-approach are highlighted. The use of smooth as opposed to polyhedral cones is recommended. The suggested approach is applied in an efficiency evaluation of Danish hospitals.

III. EFFICIENCY EVALUATIONS BASED ON POTENTIAL (NON-PROPORTIONAL) IMPROVEMENTS

Peter Bogetoft, Royal Agricultural University,Copenhagen, Denmark
Jens Leth Hougaard, Copenhagen Business School, Denmark

Efficiency evaluations usually involve two issues, namely 1) selection of reference plans and 2) comparison of actual behaviour to reference plans. We provide an axiomatization of the classical Farrell selection used in for example Data Envelopment Analyses, and we argue that this approach ignores important aspect of the technology by stressing proportional variations in inputs (or outputs). We therefore propose an alternative approach where potential improvements are used to guide the selecting of reference plans. An axiomatization of this new approach is provided as well.

IV. FITTING SMOOTH FRONTIERS TO DEA-EFFICIENT UNITS

Chris Tofallis, University of Hertfordshire, UK

Although DEA is widely used to identify efficient organisational units it does not provide a single functional form for the frontier. We show how to fit a mathematical expression, which relates MULTIPLE outputs to multiple inputs for the efficient units. The fitting technique can incorporate constraints, which permit the model to satisfy properties deemed desirable on theoretical grounds. For instance one can ensure there are no slacks in the efficiency scores based on the fitted frontier model.

The technique is a generalisation of constrained regression to the case of multiple dependent variables and so has much broader application. Moreover it can be implemented easily on a spreadsheet.

Session 3B: Theoretical advances in productivity

I. COST AND PRODUCTIVITY

E. Grifell-Tatje, Universitat Autonoma de Barcelona, Spain
C. A. Knox Lovell, University of Georgia, USA

Operating cost or unit cost (operating cost per unit of output produced) varies through time and across producers of a reasonably homogeneous product. It is important for management to be able to attribute cost variation to explanatory factors. Here we develop an analytical model capable of attributing inter-temporal cost variation to a quantity effect and a price effect. We then decompose the quantity effect into a productivity effect and an activity effect. The productivity effect in turn decomposes into a cost efficiency effect and a technical change effect, while the activity effect decomposes into a scale economies effect and an input mix effect. We attribute inter-firm cost variation to the same set of effects, except that the technical change effect is absent in a cross-sectional setting. Finally, we show how the various decompositions can be empirically implemented using linear programming techniques.

II. PRODUCTIVITY GROWTH, EFFICIENCY AND TECHNICAL CHANGE: A PANEL DATA APPROACH

Subal C. Kumbhakar, University of Texas, USA

Until very recently econometric models of productivity growth measurement ignored the contribution of efficiency change to productivity change. Productivity change was allocated to the structure of technology (scale economies) and to shifts in technology (the magnitude and biases of technical change). However, if inefficiency exists, changing over time or not, it makes a contribution to productivity change. Accordingly, it is desirable to incorporate the possibility of efficiency change, both technical and allocative, into an econometric model of productivity change.

Using econometric approaches this paper considers total factor productivity growth measurement and decomposition under three alternative situations. These are: (i) the production function approach, (ii) the cost function approach, and (iii) the profit function approach. Both single and multiple outputs are considered in the cost and profit function approaches. Estimation issues are discussed in each case.

III. DECOMPOSING TFP GROWTH WITHIN A PROFIT FUNCTION FRAMEWORK

George J. Mergos, University of Athens, Greece
Giannis Karagiannis, National Agricultural Research Foundation, Greece

This paper aims to provide an integrated framework for analysing TFP growth using a profit function. Three variants of the framework are presented based on different assumptions about the specification of profit function and the potential sources of TFP growth. In the first, it is assumed that production is efficient, in terms of both technical and allocative efficiency, and TFP growth is decomposed into the effects of technical change and economies of scale. In the second, the contribution of possible technical, allocative, and scale inefficiencies is also considered along with technical change and returns to scale by using a frontier profit function. In the third variant, the effect of capital adjustment (subequilibrium effect) is considered within a temporary equilibrium framework by utilising a restricted (short-run) profit function. Some empirical evidence are provided for the third variant by relying on U.S. agriculture data.

Session 3C: Stochastical frontiers

I. ESTIMATION AND EXPLANATION OF TECHNICAL EFFICIENCY OF CONTAINER TERMINALS: A BAYESIAN STOCHASTIC FRONTIER APPROACH

Julien Van Den Broeck, University of Antwerp, Belgium
Chris Coeck, University of Antwerp, Belgium
Theo Notteboom, University of Antwerp, Belgium

Bayesian Stochastic Frontier models are applied to measure the technical efficiency of container terminals in Europe. Traditional studies on container terminal efficiency tend to focus on partial productivity measures or output/input ratios, they do not enable to assess the overall efficiency of container terminals. Three Bayesian Stochastic Frontier models are estimated in order to give adequate results concerning the individual technical efficiency of the terminals. The data relate to some 36 container terminals of 25 European container ports. In a second phase, some highly productive leading world container ports such as Singapore and Hong Kong are integrated for port benchmarking purposes. Finally, the sources of inefficiency (e.g. type of port, centrality, maritime accessibility) are identified.

II. SPECIFICATION AND ESTIMATION OF MULTIPLE-OUTPUT STOCHASTIC RAY FRONTIER PRODUCTION MODELS

Michael Löthgren, Stockholm School of Economics, Sweden

This paper proposes an approach to specify and estimate primal-based multiple input, multiple-output stochastic production frontier models. A stochastic ray frontier production model is defined as a generalization of the single-output model based on a polar-coordinate representation of the outputs. A possible model extension is to incorporate a technical efficiency effects model to allow estimation of the effects of various explanatory variables on technical efficiency. An empirical application using Swedish health care data reveals a significant positive effect on technical efficiency of an "internal market" reform while the effect on the production frontier is negative. Technical change is found to be positive while technical efficiency has decreased over time.

Key Words: Composed error model, Distance function, Panel data, Stochastic ray frontier model, Technical change, Technical efficiency.

III. SEMIPARAMETRIC ERROR COMPONENT DENSITY ESTIMATION TECHNIQUES FOR STOCHASTIC FRONTIER MODELS.

William C Horrace, University of Arizona, USA

This paper develops several kernel based density estimation techniques for the error components in stochastic production frontier models. We seek to characterize the distributions of the one-sided technical inefficiency component and the systematic noise component under a variety of assumptions on the underlying model. Since residuals from these types of models are convolutions of the error components, density estimation is complicated by a deconvolution problem. Moreover, the one-sidedness of the inefficiency component presents a boundary problem in the estimation. Both of these issues are addressed. While point estimates of the error components are clearly important, density estimates provide a broader view of the nature of the technical inefficiency and allow us to determine if thick-tailed errors are a problem in the data. Some empirical examples are provided.

Session 4A: Statistical foundation

I. FDH EFFICIENCY SCORES FROM A STOCHASTIC POINT OF VIEW

B. Park
Leopold Simar, Universite Catholique De Louvain, Belgium
Christian Weiner, Universite Catholique De Louvain, Belgium

The Free Disposal Hull (FDH) is a non-parametric estimator for the production set. In Productivity Analysis one derives the production frontier and efficiency scores from the FDH. In the literature the method is considered to be deterministic. However, assuming that individuals are drawn independently from a distribution, where the support is the true production set, FDH efficiency scores are random variables. The paper investigates its stochastic properties.

II. MONTE CARLO SIMULATIONS OF DEA EFFICIENCY MEASURES AND HYPOTHESIS TESTS

Sverre A. C. Kittelsen, SNF-Oslo Foundation for Research in Economics and Business Administration, Norway

The statistical properties of the efficiency estimates based on Data Envelopment Analysis (DEA) are largely unknown. Recent work by Simar et al. and Banker has shown the consistency of the DEA estimators under specific assumptions, and Banker proposes asymptotic tests of whether two sub-samples have the same efficiency distribution. There are difficulties arising from bias in small samples and lack of independence in nested models. This paper suggest no new tests, but presents results on bias in simulations of nested small sample DEA models, and examines the approximating powers of suggested tests under various specifications of scale and omitted variables.

III. MONTE-CARLO EVIDENCE OF DEA+ PERFORMANCE WITH MULTIPLE OUTPUTS

Dieter Gstach, Vienna University of Economics, Austria

In this paper the small sample properties of two DEA+ estimators in the multiple-output case are investigated via Monte-Carlo analysis. These estimators are the mean inefficiency estimator and the ratio-of-noise-to-total-variability estimator. It is assumed, that observed production relationship deviate randomly from best practice due to inefficiency (like DEA) and noise (unlike DEA), thereby reducing or increasing all outputs of a firm equi-proportionately. Noise, as required by DEA+, is assumed bounded from above.

Best practice in the Monte-Carlo Simulations is modelled as 2-input, 2-output CES-technology. The noise term is parameterized as symmetric Beta-distribution, while inefficiency is supposed to be either exponentially distributed (with 16% average inefficiency) or half-normally distributed (with 20% average inefficiency). Two ratios (20% and 50%) of noise to total error variability are investigated. The simulations are carried out for sample sizes of n=100 and n=500.

In the light of specific deficiencies of DEA+ that became obvious when investigating the single output-case via simulations (forthcoming JPA 1998) and also to cope with the increased dimensionality of the problem, the estimation mechanism was adopted and so results are not strictly comparable to the older study. The benefits of this adoption are markedly better results (both in terms of bias and variability) especially for the noisier settings.

Results show, that the DEA+ estimator for average sample inefficiency has bias and standard deviation < 12% in terms of target values in all settings, compared to a bias between 12% and 76% and variability of up to 14% for the corresponding DEA estimator, whose bias is furthermore increasing with sample size. Mean squared errors (MSE) of the DEA+ estimators thereby never exceed one sixth of the MSE of their DEA counterpart.

The noise contribution estimator of DEA+ performs not as good. Bias across all settings is in a range between 10% and 30% of target values with standard deviations of the same magnitude. Convergence speed has been increased compared to earlier DEA+ estimators but is poor, owing to the fact, that in the critical boundary region the error distribution has very little weight.

Whether inefficiency is modelled as half-normal or as exponential has negligible impact on the results. DEA+ performance furthermore depends critically upon the specification of the involved bootstrapping step.

For applied research with interest in inefficiency scores (rather than noise) therefore the DEA+ estimator is an alternative to related approaches also in the multiple-output case. Other approaches (Sengupta 89, Banker and Maindiratta 92 , Bardan et . al. 94, Kneip and Simar 95 , Brockett and Golany 96, Kumbhakar 96, Löthgren 96, ...) rely on different assumptions and/or the availability of panel data, so the choice for a best suited technique depends upon case specific considerations ultimately.

IV. EMPIRICAL TEST OF TRADEOFFS BETWEEN ALTERNATIVE MANUFACTURING PERFORMANCE DIMENSIONS

Rajiv Banker, University of Texas, USA

This paper employs statistical tests based on the asymptotic properties of the DEA estimator and data collected from 42 manufacturing plants in the U.S. to test whether these plants need to trade off higher performance on any of the four dimensions of cost, quality, on-time delivery and flexibility to improve performance on the other three dimensions.

Session 4B: DEA vs. MCDM

I. SEARCHING THE EFFICIENT FRONTIER IN DEA

Pekka J. Korhonen, IIASA, Austria

In this paper we deal with the problem of searching the efficient frontier in data envelopment analysis (DEA). Our aim is to show that the "free search" approach developed to make a search on the efficient frontier in multiple objective programming can also be used in DEA. This kind of analysis is needed when among others a) a radial projection is not acceptable, b) there are restrictions on some input and output values, or c) a decision maker (DM) would like to find a decision making unit (DMU) with the most preferred input and output values. The search can be applied to CCR/BCC-models, input-oriented/output-oriented/combined models, and to the models with extra constraints. To make a "free search" on the efficient frontier, we recommend the use of Pareto Race (Korhonen and Wallenius [1988]) for this purpose. In Pareto Race, the DM may simply control the search with some function keys. The information is displayed to the DM in the bar graphs and in numerical form. The search can be terminated at any time the DM wishes. A numerical example is used to illustrate the approach.

Keywords: Data Envelopment Analysis, Multiple Objective Programming, Efficient Frontier, Free Search, Pareto Race

II. DEA FOR OPTION GENERATION AND PRE-SCREENING IN MCDA

Theo Stewart, University of Cape Town, South Africa and Technical University Delft, The Netherlands (visiting)

At early stages of the multiple criteria decision making process, the emphasis is on the generation of options and on the screening of the options to select a shortlist for more detailed evaluation (value judgements). In many cases, options (which we shall refer to as ``policy scenarios" to emphasise that options may not be comprehensively described at this stage) are defined by combinations of actions or interventions which may be seen as ``inputs". Results of any combination of actions may then be viewed as outputs". Initial option generation and screening needs to be based on

these inputs and outputs, and should impose a minimum of value judgement. This suggests the use of Data Envelopment Analysis (DEA) to identify and eliminate inefficient alternatives. In this paper we develop this concept and apply it to a numerical example which arose in a real world application. It appeared that the standard DEA approach provided rather little help in screening alternatives when the options were carefully designed. A Monte Carlo variation of DEA suggested previously by the author did, however, provide considerably more insight.

III. COMPETING OR COMPLEMENTARY APPROACHES

Valerie Belton, University of Strathclyde, U.K.
Theo Stewart, University of Cape Town, South Africa

A number of authors have highlighted the similarities of the DEA and MCDA models, commenting principally from a theoretical perspective on the mathematical structure and methods for solution. Given these similarities it is possible that the two approaches could be viewed as competing.

In this paper we will comment on these approaches from an applied perspective, focusing on the problematique - the nature of problems tackled and process of analysis - and we will argue that rather than the two approaches being viewed as competing there are many ways in which they can be used complementarily and that each can learn important lessons from the other.

A "typical" application of DEA is an ex-post evaluation of the performance of many similar units, such as branches of a bank or university departments, for purposes of monitoring and control. The analysis is based on measurement data which is perceived to have an objective basis. The analysis identifies those units which are efficient in comparison with the others and for inefficient units suggests target performance levels which would render it efficient. In contrast, MCDA is proffered as an approach which seeks to model values, an approach which seeks to manage rather than eliminate subjectivity. Many applications of MCDA are prospective in nature and the emphasis is on the detailed evaluation of relatively few options or strategies for the future, with a view to identifying an agreed way forward.

In this paper we explore the differences and similarities between MCDA and DEA as applied in practice, with a view to highlighting ways in which one can inform and potentially enhance the other. In particular, we will focus on the following aspects:

Retrospective vs. prospective evaluation
The distinctions in use are blurred both in interpretation and in reported application. We will explore these overlaps and interactions in greater detail.

Subjectivity vs. Objectivity
The greater emphasis of MCDA on attention to value judgements is apparent throughout the process: in the specification of criteria, which are derived from a problem structuring process involving key stakeholders: in the definition of value-based criteria against which the performance of alternatives are assessed: in the elicitation of inter-criteria information reflecting the perceived importance of different factors. In contrast, guidelines for identifying factors to be included in a DEA analysis, such as they exist, are based on statistical measures rather than value judgements. Analyses are based on objective measurement data. Furthermore, the rationale of DEA, which seeks to present each unit in its best possible light, is one which, at least initially, shuns subjective judgements about the importance of different factors contributing to the measurement of performance.

We will explore some ways of incorporating subjectivity in DEA. In particular, drawing on the extensive debate in the MCDA field, we will examine the use and interpretation of weights in DEA.

On the other hand we will look at how MCDA can draw on the more objective approach of DEA. Two possible ways of doing so are the use of DEA to identify potentially optimal solutions in MCDA and the use of DEA to screen alternatives for MCDA.

Model structure
DEA tends to focus on the evaluation of large sets of alternatives using relatively few factors - differentiating between inputs and outputs. In contrast, many MCDA analyses are concerned with evaluation of a few alternatives, using a detailed hierarchy of criteria. We consider the extent to which these typical structures are constraints on the type of problem which might be addressed.

Benchmarks
The identification of targets for inefficient units is an integral part of DEA. We look at how MCDA can be integrated with DEA to explore the definition of the most appropriate target and how the notion of targets might be used to promote thinking creatively about "new" alternatives.

IV. DEA AND MCDM: SOME REMARKS

Denis Bouyssou, ESSEC, France

The formal similarities between Multiple Criteria Decision Making (MCDM) and Data Envelopment Analysis (DEA) have been noted by several authors.

In particular it can be shown that the notions of "efficiency" in MCDM and DEA have much in common. In view of these similarities it has been argued that DEA could be considered and used as an MCDM tool.

The purpose of this presentation is to make some remarks on the interest and validity of various methods that have been proposed to apply DEA techniques to MCDM problems. Using simple examples we show that they raise serious difficulties.

Keywords: MCDM, DEA, Efficiency, Convex Efficiency.

Session 4C: New perspectives in application

I. CLUSTER ANALYSIS AND DATA ENVELOPMENT ANALYSIS APPLIED TO FACULTY PERFORMANCE EVALUATION

Per J. Agrell, University of Georgia, USA and Linköping Institute of Technology, Sweden
Jay E. Aronson, University of Georgia, USA

This work extends the usefulness of efficiency analysis, e.g., Data envelopment Analysis, by incorporating optimal clustering techniques to differentiate natural groupings in decision making units. After an initial estimation of the efficient frontier, clustering i applied to identify justifiable ranks, role models and groups to be used in the management of incentives, promotion, reviews and allocation of funds. A faculty performance model is used to assess the efficiency of individual faculty members in terms of the outputs of research, reaching and service, in relation to the salary input. Actual rank and identified rank (cluster) are compared, and conclusions are made regarding the relative inter- and intra-group efficiency of the faculty. Implemented in a ready-to use spreadsheet with underlying modules, the approach gives academic departments a versatile and objective tool for their internal or external performance assessments. The empirical results furthermore inspire an interesting view of the organization of higher education, promotion and the assignment of tasks.

Keywords: Data envelopment analysis, cluster analysis performance evaluation.

II. INTERNAL BENCHMARKING FOR MARKETING EFFICIENCY

Leonard J. Parsons, Georgia Institute of Technology, USA

Benchmarking is the search for the best practices that will lead to superior performance of an organization. These best practices may be found within the organization, in the industry, or outside the industry. The benchmarking of these best practices has two aspects: the practices themselves, i.e., the methods that are used, and the metrics, i.e., the quantified effect of these practices. Benchmark metrics permit identification of the benchmark gap: how much, where, when; while benchmark practices suggest how to close the gap: improved knowledge, improved practices, improved processes.

How do you identify which practice should be designated the best? One way is to look for situations in which the benchmark metric is significantly better, and then examine the practices that caused the exceptional achievement. This means that an operation under investigation first must be quantified. An operation can be broken down into inputs, a work process with repeatable practices, and outputs. Then a metric can be constructed based on the analysis of outputs in relation to inputs. The benchmark metric will be based on the best performance among comparable operations.

Further [perhaps qualitative] investigation of the practices underlying the best performing operation should yield insight into the sources of success, which may come from process practices, management practices, or operational structure.

The traditional technique for addressing performance has been ordinary least squares regression. However, regression gives an average relationship. What is needed in benchmarking then are ways to establish best performance. Recent methodological advances such as data envelopment analysis (DEA) and frontier production functions, provide such information.

A traditional example of external benchmarking using OLS regression is the PIMS (Profit Impact of Market Strategy) Program. It initially compared a business unit's performance to *normal* industry performance for businesses with the same strategic characteristics, "par." More recently, however, each business's profitability is compared to what it would be if it performed as well as the *better* performers among other PIMS businesses with similar strategic characteristics. The Program found that most businesses actually perform far below their potential—typically attaining only about 40 percent of their potential (when measured over a five year period.)

The purpose of this presentation is to review recent internal benchmarking applications of the marketing function. There are two main areas of marketing where data on comparable decision making units are available: (1) in chains, which have multiple retail outlets and (2) in organizations which have their own sales force. Being able to distinguish factors under the store manager's or sales person's control from environmental factors, such as market potential, not under their control is crucial. Most of the marketing studies use DEA, although a few use frontier production functions. Retailing chain studies include three national retailers, a business specialty store, a telecommunication boutique, a quick service restaurant, a department store, a financial institution, and a bank. Sales force studies include an insurance company, a building products company, an agricultural chemicals company, an advertising to business company, a business equipment maker, and a chemical production equipment manufacturer.

III. DEA BASED ANALYSIS OF CORPORATE FAILURE

Joseph C. Paradi, University of Toronto, Canada
Paul Simak, University of Toronto, Canada

The increasing number of corporate bankruptcies in the 1990s have reemphasized the need for research in the area of identifying early warning indicators of corporate distress. The traditional methods used for this purpose have a number of known problems and shortcomings associated with them and there is a continuing need to explore other methods of analyzing financial data. The multidimensional nature of corporate performance makes it a very attractive application area for Data Envelopment Analysis. The goal of this work was to validate the hypothesis that DEA can be used as a tool for predicting future corporate distress. Specific production models were developed, using the same variables as the industry standard ratio based processes use, using the power of DEA to predict the future financial viability of firms based on their historical financial data. The DEA results compared very favorably to those of the popular "Z score" model, and in most cases, the model accurately selected companies which showed signs of financial distress as early as 3 years prior to failure. The efficacy of the model's ability to predict bankruptcies was also tested in an investment portfolio program where the potential problem firms were sold short. This has also shown exciting possibilities for future research.

IV. X-EFFICIENCY LINKED TO BUSINESS STRATEGY, RESOURCES AND CAPABILITIES AND ENVIRONMENTAL CHARACTERISTICS

Antreas D. Athanassopoulos, Athens University of Economics and Business, Greece
Yiannis Spano, Athens University of Economics and Business, Greece

In this paper we develop a synergistic framework between two different schools of thought concerning the antecedents of firm performance. The first corresponds to the micro-analytic assessment of the relative efficiency and is based on the use of input-output technologies upon which production or cost functions are obtained empirically. This body of knowledge proceeds into the assessment of performance by addressing the question of fitness of empirical data on the parametric or non-parametric forms. An ultimate objective of this being the quantification of inefficiency and thus the

assessment of lack of fitness between resources and outcomes. The second school of thought, often met in strategic management literature, corresponds to the perceptual assessment of business performance based on the management of individual firms and using as a point of reference their main competitors. In that respect fitness is considered between perceived strategies and alternative types of performance indices. In any case performance per se is not at question but indeed the extent to which selected strategies explain the observed outcomes.

Previous research has lead into inconclusive evidence as to whether firm performance should be assessed solely on the basis of hard evidence or whether the perceptual information of management should be gauged. Furthermore, the dimensionality of the performance construct is another source of debate since irrespective on the type of measurement sought, the description of the multidimensional nature of performance needs to be addressed.

In this research we consider firm performance from the two alternative stand points and also we propose an integrated framework whereby the x-efficiency is used as the dependent variable of a causal structural equation modeling framework. The basic premise of their research is that the performance at the firm level should anticipate the differential strategy, life cycle, internal resources and capabilities, capacity utilization, technology levels as antecedents of firm performance. Performance is operationalised along side the dimensions of sales, growth and market power all expressed in perceptual and objective ways. Empirical results are provided from a sample of 150 Greek manufacturing firms.

Session 5A: Agriculture

I. EFFICIENCY IN NEW ZEALAND SHEEP AND CATTLE FARMING: PRE AND POST REFORM

Warren E. Johnston
Catherine J. Morrison, University of California, USA

In this study we consider the impacts of deregulation and technical change on the efficiency of farms in New Zealand agricultural sector. We focus on the impact of dramatic regulatory changes in this sector during the 1980s, using unbalanced panel data for 32 farms in a homogenous region of New Zealand for 1969-1991. The farms produce wool, lamb, mutton, beef and deer. Inputs include land, labour, capital, and a detailed group of materials and service inputs. A distance-function representing the multiple output and input technology is used for the analysis. Our preferred specification is a flexible (translog) technology, incorporating non-neutral regulatory impacts and non-constant return to scale. We also model the determinants of the deviations from technical efficiency in a one-step model, including a regulatory variable, a time term, and a debt/equity ratio. A stochastic production frontier approach based on maximum likelihood techniques is used for estimation. We find evidence of regulatory-induced changes in output composition – towards beef and deer and away from wool and especially lamb. This appears to have motivated investment in complementary capital, land and beef/deer livestock inputs. Firms that were more flexible in their adaptation towards these new mixes adjusted to regulatory changes with less upheaval. Technical inefficiency, however, does not seem to have a driving factor, and seems primarily linked with debt/equity levels rather than regulatory effects.

II. DECLINING PRODUCTIVITY IN LDC AGRICULTURE?

Lilyan E. Fulginiti, University of Nebraska-Lincoln, USA
Richard K. Perrin, University of Nebraska-Lincoln, USA

This paper examines changes in agricultural productivity in 18 developing countries over the period 1961-1985. We use a non-parametric, output-based Malmquist index and a parametric variable coefficient Cobb-Douglas production function to examine whether our estimates confirm results from other studies that have indicated declining agricultural productivity in LDC's. The results confirm previous findings, indicating that at least half of these countries have experienced productivity declines in agriculture.

Key Words: agricultural productivity, regression, non-parametric, Malmquist, parametric, variable coefficients.

III. DYNAMIC AREA ALLOCATION AND ECONOMIES OF SCALE AND SCOPE

Spiro Stefanou, Pennsylvania State University, USA
Alfons Oude Lansink, Wageningen Agricultural University, The Netherlands

This paper incorporates the area allocation in an adjustment cost framework by simultaneously determining the levels of input demand and output supply. Dynamic measures of economies of scale and scope are derived from output-specific areas. An application to a rotating sample of Dutch cash crop reveals farmers have a strong incentive for specialisation, but that large adjustment costs for area allocation resulting in small adjustments towards the optimal level prevent them from doing so.

Session 5B: Banking

I. BANKING EFFICIENCY AND EUROPEAN INTEGRATION: AN ALTERNATIVE PROFIT FUNCTION APPROACH

Michel Dietsch, Université Robert Schuman, Strasbourg, France
Laurent Weill, Université Robert Schuman, Strasbourg, France

Since the beginning of the process of economic integration the banking industry in Europe has faced important changes in its competitive environment. These changes were mainly the consequence of the liberalisation of capital movements and the second banking directives of 1989. Before the mid-eighties, banking markets were national oligopolies with varying degrees of competition. Legal barriers to entry and control of interest rates prevented from perfect price competition.

Competition imperfections were consequently responsible for technical inefficiencies (due to the overuse of inputs for a level of output like banking overcapacities) and allocative inefficiencies (due to a failing mix of inputs or outputs in reference with prices, like cross subsidies on the input and output sides. Integration of national banking markets is supposed to reduce all these inefficiencies by increasing competition thanks to the removal of legal national and cross-border barriers to entry. Indeed, banks are induced to minimize costs, so they must reduce excess capacity and eliminate the sub-optimal combinations of production factors and outputs. However one can assess that the market structure of the European retail banking markets will likely be an imperfect competition one in the next future. The main reason is that natural barriers to entry and exit in banking markets are still present. They are the result of the existence of large sunk costs (branch and ATM networks, expenses in information gathering), and of the product differentiation due to reputation effects, customers long-term relationships and switching costs in these markets.

The main purpose of this paper is to compare the profit efficiency of European banks, in order to verify this proposition. Comparative studies of efficiency of European banks still remain very scarce in economic literature. Moreover, all the existing studies only analyze the production or cost efficiency of banks (Dietsch and Lozano Vivas (1996), Pastor and al: (1994), Allen and Rai (1996)). However, a cost efficiency approach seems to be insufficient to take account for all the inefficiencies of banks. Indeed, production efficiency only cares about technical inefficiencies and so forget allocative inefficiencies, while cost efficiency only accounts for the input inefficiencies. On the contrary, a profit approach takes into account inefficiencies on the output side as well as those on the input side. With a profit frontier, bank managers the same amount of attention for the increase of revenues than for the reduction of costs. This seems then to be the perfect efficiency concept because evidence suggests inefficiencies on the output side are as large than those on the input side (Berger, Hancock and Humphrey (1993)).

There are two types of profit efficiency frontiers in the literature. The standard profit function, first applied in banking by Berger, Hancock and Humphrey (1993), makes the assumption that output prices are given, so that each bank can sell as much as output as it wishes without having to lower the prices. This assumption may give incorrect estimates of efficiency for firms on markets, which are not perfectly competitive. Indeed, Berger and Mester (1997) underline the act that there is an understatement of the standard profit function for banks under efficient scale since these banks might have to lower prices to increase output, so these banks can not earn the maximum potential profit as measured.

Humphrey and Pulley (1997) developed the alternative profit function to resolve this problem. Instead of taking output prices as given, this function takes output quantities as given. So, alternative profit efficiency incorporate differences across banks in market power and their abilities to exploit it.

Thus, we consider the alternative profit efficiency as the best one in order to study the efficiency of European banks. The reason is because of the imperfect competition structure of banking markets. The alternative profit efficiency frontier takes into account input and output inefficiencies as well as differences across banks in market power and their abilities to exploit it. We think that this approach should give information on the potential efficiency gains in banking markets in relation with the completion of the Single Banking Market.

We also estimate the evolution of the profit efficiency of European banks from 1990 to 1995 in order to check the conventional wisdom about the micro-economic benefits of European integration on efficiency.

We use the distribution- free approach (Berger (1993)) in order to estimate an alternative profit function model and a variant of the distribution-free approach for the study of the evolution of the profit efficiency. Our panel includes about 2000 banks from all countries of the European Union between 1990 and 1995 (data from database "Bankscope" edited by BVD-IBCA).

II. LABOR PRODUCTIVITY AND LABOR-USE EFFICIENCY: A DYNAMIC ADJUSTMENT MODEL WITH AN APPLICATION TO SWEDISH BANKS

Subal C. Kumbhakar, University of Texas at Austin, USA
Lennart Hjalmarsson, Göteborg University, Sweden
Almas Heshmati, Göteborg University, Sweden

The literature of productivity growth is quite extensive. Similar is the case with measurement of productive efficiency. However, there are not many studies, which focus on both productivity growth and efficiency change. The present paper uses an econometric model, which addresses both productivity growth and efficiency change in a multi-output framework. Since the notion of productivity change is related to time, and the concept of efficiency is essentially micro, we use panel data to address the productivity and efficiency change issues. Our focus, in this paper is on labor productivity growth and labor-use efficiency in 156 Swedish banks during the period 1984-1995. To examine labor productivity we consider the labor requirement function, and define labor productivity growth in terms of a shift in the production possibility frontier, given labor. Thus, it is essentially the same as technical change, adapted to the labor requirement function instead of the production possibility frontier. Labor-use efficiency is modeled via an adaptive expectation type model where the adjustment parameter (which is both bank and time varying) plays a major role. By relating the adjustment parameter to bank-specific variables, we allow the individual banks to control the speed of adjustment in attaining their target level of employment.

Key words: Labor-use, efficiency, dynamics adjustment, multi-output, banks.

III. AGENCY COST, ORGANIZATIONAL FORM, AND EXPENSE PREFERENCE BEHAVIOR: THE CASE OF SPANISH DEPOSITORY INSTITUTIONS

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In recent decades, a number of papers [Williamson (1963), Leibenstein (1966), Leibenstein (1975)] in the literature argued against the traditional neo-classical assumption that firm management is primarily driven by the profit maximization goals especially in an environment where there is a separation of ownership and control of firms; less competitive and inefficient markets; and high degree of regulatory structure. These papers in general suggested that managers might pursue strategy of maximization of personal utility by favoring excessive allocation of resources in salaries, larger staff, unnecessary perks, privileges, and office settings. Among others, Edward (1977), Hannan (1979), Hannan and Mavinga (1980), Verbrugge and Goldstein (1981), Verbrugge and Jahera (1981) found consistent evidence of such expense preference behavior in the U.S. depository industries, Awhand Primeaux (1985) in electrical utility industry, and Field (1988) in the mutual life insurance companies.

The findings above are however not conclusive as Rhoades (1980), Smirlock and Marshall (1983), Blair and Placone (1988), Mester (1989), and Stansell and Hollas (1990) provided evidence inconsistent with expense preference behavior among the U.S. banks and thrift institutions. Using, thrift data, the later two papers argued to some extent that the supporting evidence of expense preference behavior in previous papers were flawed from inappropriate estimation approach and once corrected no such evidence is found. The popularity of using thrift data is not surprising as the industry provides a good opportunity to compare institutions with both mutual and stock forms of organizations. Unlike the stock institutions, the mutual form of organizations do not have direct monitoring or profit making pressure from stock holders (owners), and therefore their managers may have different goals and strategies. This paper attempts to provide additional evidence in the existing debate on expense preference in the banking industry and contribute in the literature in a number of ways. First, the paper uses data from the Spanish depository industry, which contains both mutual and stock types of institutions. To our knowledge, this is the first attempt to inquire such issues in any European banking industry. Second, the paper introduces a stochastic frontier analysis in estimating the best practice expense preference behavior and finding the role of organizational forms in determining the variability of expense efficiency. Third, unlike other papers on this topic, the paper would provide estimates, which test, for a different production technology for both mutual and stock institutions [Mester (1993)]. Such evidence should give us a clear picture whether expense preference is motivated by a lack of monitoring structure or a necessity of running a different types of institutions. Fourth, unlike most studies in the literature, we provide a cross-sectional pooled time series data (1986-1995) that can capture the changes in managerial discretion on expense preference over time. This is even more interesting in the Spanish depository industry given its changes in regulatory environment during our sample period. We would focus on finding the changes in behavior due to changes in the competitive scenarios in both input and output markets of the industry.

Session 5C: Malmquist indexes

I. IN SEARCH OF MALMQUIST: A QUEST BEYOND TWO DIMENSIONS

Subhash C. Ray, University of Connecticut, USA

Geometric exposition of the correspondence between the Malmquist productivity index measured by the ratio of distance functions and the ratio of average productivities is typically restricted to the single-input, single-output case. This paper extends the previous work by Fare, Grosskopf, Lindgren, and Roos (1992) and Ray and Desli (1996) to single-output, multiple-input technologies. When input bundles vary only in scale but not in mix, the Malmquist index corresponds to the ratio of ray average productivities. When two input vectors lie on different rays through the origin, one can use a CRS-distance function to obtain a projection of an input bundle on to a point on a different ray. Such trans-ray projection permits subsequent measurement of the ratio of ray average productivities, which is what is measured by the Malmquist productivity index. Even in the multiple-output, multiple-input case, one can use the distance function to reduce it to essentially a single-input single-output productivity comparison.

II. THE MALMQUIST PRODUCTIVITY INDEX, PRODUCTIVITY AND SCALE

Finn R. Førsund, University of Oslo, Norway

The Malmquist productivity index calculated for inefficient observations and relative to a VRS frontier technology does not correspond to the standard notion of a total factor productivity (TFP) index. It is shown that the Malmquist index can be decomposed into one part showing a TFP-type change, and one part showing scale efficiency change. This decomposition is based on the relevant technically optimal scale points as reference points. Further, it is shown how a Malmquist total factor productivity index can be expressed as the product of the two oriented Malmquist productivity indexes, a TFP- type term and a scale efficiency term.

III. A PARAMETRIC STOCHASTIC DISTANCE FUNCTION APPROACH FOR MALMQUIST INDEX ESTIMATION: THE CASE OF SPANISH INSURANCE COMPANIES

Hugo Fuentes, Universitat de Barcelona, Spain
Emili Grifell-Tatje, Universitat Autonoma de Barcelona, Spain
Sergio Perelman, CREPP - University of Liege, Belgium

The Spanish insurance industry was submitted last decade to a deregulatory process like other service activities within the European Union. In this paper we estimate Malmquist indexes of productivity for several samples composed by multi-branches and specialized firms operating in the life, non-life and health insurance markets. The panel data covers the period 1987-1994 and includes near all the existing firms. For each sample we estimate a stochastic parametric distance function that allows for technological improvements over time. The main results confirm those obtained for insurance activities in other European countries. On the one hand, productivity change and technological progress are extremely weak and, on the other hand, technical efficiency is highly widespread among firms.

Session 6: Posters

I. A DECOMPOSITION OF AGRICULTURAL PRODUCTION GROWTH: FURTHER EVIDENCE USING NEOCLASSICAL DUALITY

Giannis Karagiannis, National Agricultural Research Foundation, Greece
Vangelis Tzouvelekas, The University of Wales, UK
Konstantinos Mattas, Aristotle University of Thessaloniki, Greece
Konstantinos Giannakas, University of Saskatchewan, Canada

In recent years particularly emphasis in efficiency studies was directed in the decomposition production growth in agriculture. This present paper attempts to investigate the relative contribution of technical and allocative efficiency, technological change and increased input use to the output growth of the Greek olive-oil sector using panel data, by combining recent developments of production frontier methodology and improving the existing analytical framework. A strongly separable translog production frontier is used to decompose output growth of 125 Greek olive-growing observed during 1987-1993. The results suggests that scale economies and allocative efficiency, which were neglected in previous studies of this type, have significant part to play in explaining agricultural production growth.

II. AN ANALYSIS OF TECHNICAL EFFICIENCY FOR LONGLINE FISHERY IN HAWAII

Khem R. Sharma, University of Hawaii at Manoa, USA
PingSun Leung, University of Hawaii at Manoa, USA

This paper examines the level and determinants of technical efficiency for a sample of Hawaii-based longline fishing vessels operating in 1993. The data on per-trip costs and revenues, fishing targets, vessel ownership, and experience and education level of fishermen are analyzed using a translog stochastic frontier production function, including a model for vessel-specific technical inefficiencies. In addition to technical efficiency, input elasticities and returns to scale are also estimated. The technical inefficiency effects are found to be highly significant in explaining the levels and variation of vessel revenues. The mean technical efficiency for the sample vessels is estimated to be 86%. Despite their higher revenues, vessels targeting swordfish and tuna are significantly less efficient compared with mixed vessels. Owner-operated vessels are significantly more efficient than those operated by hired captains. Both longline experience and education level of fishermen have a strong positive impact on technical efficiency.

III. EFFICIENCY CHANGE AND THE GROWTH IN PRODUCTIVITY: THE ASIAN NICS' GROWTH EXPERIENCE

Ching-Cheng Chang, National Taiwan University, Taiwan
Yir-Hueih Luh, National Tsing Hua University, Taiwan

The ASEAN has shown an outstanding economic performance over the past two decades, It i6 recognized as the fastest growing region in the world besides China and the East Asian Newly Industrialized economies (NIEs) This paper focuses on identifying the sources of productivity growth a sample of ten Asian countries including China, Japan, the NIEs and ASEAN countries. In this paper, we calculate productivity growth and its components using distance function-based Malmquist productivity indexes and linear programming methods following Pare, Grosskopf, Norris and Zhang (1994). The growth in productivity can be decomposed into changes in efficiency (the catching-up effect) and technical progress (the innovation effect). This further decomposition is important for facilitating a multilateral comparison that may help explain and characterize the differences and similarities in growth patterns for the Asian countries The data of our analysis comes from the Penn World Tables (Mark 5) over the 1965-1990 period. Real gross domestic product is used as the output measure whereas unemployment and capital are two aggregate input proxies. Since this method constructs a best practice frontier from the sample countries, the results allow us not only to compare the pattern of productivity growth and its components but also to identify which countries arc shifting the frontier over time (i.e" the "innovators").

Key Words : Malmquist index, productivity growth catching up, innovation

IV. ENVIRONMENTAL QUALITY IN THE VON LIEBIG-PARIS TECHNOLOGY: WITH AN APPLICATION TO MARINE CAGE AQUACULTURE

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There exists a well established literature arguing that the von Liebig Hypothesis, also known as the "law of the minimum", best describes the characteristics of nutrient-response models in agriculture(Ackello-Ogutu, Paris, and Williams; Paris and Knapp; Paris). The "law" is centered around the two essential features typifying of crop response functions:

(i) non-substitution between nutrients, and (ii) a yield plateau. This literature culminates with a paper by Paris which elucidates the essential features of the "law of the minimum", tests a number of functional production function specifications against experimental crop response data, and derives cost functions dual to von Liebig production functions. Chambers and Lichtenberg recently generalized both primal and dual representations of the von Liebig-Paris (vLP) technology. Hitherto, applications of the vLP technology are restricted to realm of nutrient-response models in agriculture and deal exclusively with inputs that can be endogenously determined. The aim of this paper is twofold: (i) to characterize the vLP technology further by introducing environmental quality as an exogenously determined input affecting production, and (ii) to suggest another practical application - the case of marine cage aquaculture.

In many production processes environmental quality variables enter as exogenously determined inputs, at least in the short-run, but critically affect the production process. In this paper the vLP technology is adapted to incorporate environmental quality which is treated analogously to factor augmenting technical change. Such environmental quality changes, in the vLP technology, determines both the effectiveness of inputs and the yield plateau. Both primal and dual measures of environmental quality change are developed. Dual measures are relatively less data intensive. The environmental quality augmented von Liebig-Paris approach enables a more accurate comparison and aggregation, both inter-temporally and inter-spatially, of production processes that are influenced by exogenous environmental variables.

V. PATTERNS OF PRODUCTIVITY CHANGE IN THE NORWEGIAN SALMON FARMING INDUSTRY 1985-93

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Almas Heshmati, Göteborg University, Sweden

In this paper we investigate the patterns of technical change and TFP growth in Norwegian salmon farming using several competing primal model specifications. Norwegian salmon agriculture is a young industry, but also the largest producer and technology leader on the world market. The combination of being a technology leader and at the same time an outsider on its most important export market, the European Union, may have put the industry in a vulnerable position on the trade political arena. Decreasing prices on the EU market have lead to a series of antidumping charges and measures, although the foundation for these actions are subject to debate. Norwegian producers are currently facing a 14 % antidumping tariff on the EU market. The plaintiffs argue that lower prices on Norwegian salmon than its competitors is due to subsidies and uncontrolled expansion of the Norwegian industry, while the Norwegian industry claims that productivity increases explain the falling prices. In this paper we try to shed some light on the patterns of productivity change in the Norwegian industry, which may provide a partial explanation of the price decline in previous years. Since this is an infant industry, we are particularly concerned about the development of the cross-sectional distribution of technical efficiency over time, since diffusion effects and learning effects may have lead to a greater productivity increase for the least productive farms.

We estimate several competing models of technical change, such as the traditional time trend model, the general index (GI) model, the Cornwell-Schmidt-Sickles model and the Stevenson model, on an unbalanced data set of Norwegian salmon farms. To control for heterogeneity observations are grouped into a number of homogeneous cohorts on the basis of common key characteristics such as fish species, region and licensed pen volume. The production functions are estimated with fixed cohort-specific effects. We find that the mean rate of TFP growth varies considerably across the models, from -1.7 per cent in one of the GI model specifications to +2.1 per cent in the time trend model.

By implementing interaction terms between between firm-specific effects and technical change parameters in some model specifications we can analyse the development in the firm distribution of productivity over time. This enables us to analyse how important a narrowing of the productivity gap between the least productive and the most productive farms through diffusion and learning effects have been for the average productivity change of the industry.

Keywords: Technical change, TFP, salmon farming, unbalanced panel.

VI. ENVIRONMENTAL EFFICIENCY WITH MULTIPLE ENVIRONMENTALLY DETRIMENTAL VARIABLES; ESTIMATED WITH SFA AND DEA.

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C. A. Knox Lovell, University of Georgia, USA
Geert Thijssen, Wageningen Agricultural University The Netherlands

The objective of this paper is to estimate a comprehensive environmental efficiency measure of Dutch dairy farms. This environmental efficiency is based on the nitrogen surplus, phosphate surplus and the total (direct and indirect) energy use of an unbalanced panel of dairy farms.

In our previous paper (Reinhard, Lovell and Thijssen, 1997) we defined environmental efficiency as the ratio of minimum feasible to observed use of an environmentally detrimental input, conditional on observed levels of the desirable output and the remaining inputs. In this paper we expand this method to fit multiple environmentally detrimental inputs. A comparison of two major methods for the calculation of efficiency, namely the parametric approach (Stochastic Frontier Approach; SFA and Fixed Effects Model; FE) and the non-parametric approach (Data Envelopment Analysis; DEA), shows the strengths and weaknesses of these methods for estimating environmental efficiency. First, the one environmentally detrimental input case is estimated, using the three distinguished methods, separately for nitrogen surplus, phosphate surplus and total energy respectively. We start with the translog specification and tests whether the data allow simplified translog specifications. Secondly, we estimate the three bad input model and

analyze the differences with the one bad input models. The technical efficiency results (mean, minimum and maximum) do not differ largely between the distinguished methods. The environmental efficiency scores differ a lot and depend on the concavity of the production frontier. In our context, DEA has the advantage that it can impose the necessary concavity. SFA and FE have the advantages that they are stochastic and allow testing of hypothesis, but their usefulness for the estimation of environmental efficiency depends on the concavity results.

VII. A NEW METHOD TO OBTAIN RISK-ADJUSTED EFFICIENCY MEASURES IN BANKING FIRMS: MEASURING THE EFFECT OF DEREGULATION ON SPANISH BANKING SYSTEM

Jose M. Pastor, Universitat de Valencia, Spain

Traditional efficiency measures neglect bank risk and, even when risk is accounted for, do not differentiate between the portion subject to managerial control ("internal") versus the portion that is exogenous and is part of a changing environment ("external"). This paper proposes a new sequential DEA procedure which decomposes a major indicator of bank risk-provision for loan losses (PLL) into internal and external components. Our decomposition is contrasted with three alternative approaches. Besides, using the portion of PLL due to internal components and a wide set of environmental variables, the CRS efficiency measure is decompose in four parts: risk and environment adjusted efficiency measure, scale efficiency, environment effect and risk effect. This method is applied to the analysis of Spanish banking system in order to test whether the deregulation process imposed by the Single Market Program of the European Community has affected banks conduct in terms of efficiency and risk.

VIII. EFFICIENCY OF SWEDISH BANKING INDUSTRY: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS

Aziz Ponary Mlima, Göthenburg University, Sweden

This paper seek to investigate the efficiency of the Swedish banking industry. The analysis is based on the deterministic non parametric (DEA) approach to efficiency measurement. A DEA model with variable returns to scale is applied to establish the frontier for the best practice. The results shows that there is a considerable variation in efficiency scores of different banks with different size and characteristics. The results provided by this study are of value to the bank managers and policy makers working within the industry for improving efficiency and for better policy prescription to individual banks and the entire banking industry .

IX. PRODUCTIVITY IMPACT OF BANK MERGERS: POTENTIAL VERSUS ACTUAL PRODUCTIVITY GAINS IN BRANCH NETWORKS

H. David Sherman, Northeastern University, Boston, USA

Commercial bank mergers and acquisitions continue to generate larger banks with greater geographical presence and the promise of economies due to size. Studies of these mergers suggest that there are economies of scale emanating from consolidated management and centralized information systems. Other studies suggest that bank consolidations generate inefficiencies which offset savings from synergies, and are costly to customers.

This paper investigates the productivity gains achieved from bank branch network mergers. Closing of branches in the same geographic area represents one widely acknowledged economy. Offsetting this are customer defections to competing banks arising from these mergers and reported difficulties managing larger branch networks distributed over more states and countries.

One bank with a 200 branch network resulting from the merger of five banks is analyzed to consider the question: Has the bank achieved productivity gains from the larger network that exceed the gains the five banks could have achieved independently?

Findings: Management can demonstrate real economies achieved from these mergers. However, potential productivity gains among these branches substantially exceed the gains already achieved from the merger. The five branch systems continues to maintain operating differences more than three years after they merged and systematic differences in their operating efficiencies are identified. The potential benefits of managing the branch network with unified procedures and systems is estimated using data envelopment analysis.

Implications: The study suggests that this bank's operating productivity could have been improved beyond the levels achieved from the branch mergers. While this result cannot be generalized, evidence that several other major bank mergers have not benefited from branch network productivity gains is presented. If this is common, it suggests that investors, managers and board members should expect and seek greater productivity gains from branch consolidations than have been achieved.

Topic: Bank branch productivity, bank mergers and acquisitions, efficiency, data envelopment analysis

X. FIRM SPECIFIC TEMPORAL VARIATION IN TECHNICAL EFFICIENCY RESULTS OF A STOCHASTIC OUTPUT DISTANCE FUNCTION

Rafael Alvarez Cuesta, Universidad de Oviedo, Spain
Luis Orea Sanchez, Universidad de Oviedo, Spain

The aim of this paper is testing the temporal variation of technical efficiency of the Spanish Savings Banks during the period 1985-1994. Furthermore, a stochastic output distance function (Shephard, 1970) estimated by maximum likelihood is employed to accomodate multiple output technology. The distance function presents the advantage that it does not need information about prices, so it can accomodate the multiproduct nature of the financial sector only using the quantities as data. To model the temporal variation of efficiency is an extension of Battese and Coelli (1992) model allowing for firm-specific patterns of temporal change.

KEY WORDS: Time-varying Technical Efficiency, Stochastic Distance functions, Panel Data.

XI. ASSESSING THE COMPARATIVE EFFICIENCY OF DECISION MAKING UNITS UNDER INTER - TEMPORAL INPUT - OUTPUT DEPENDENCE

Emmanuel Thanassoulis, University of Warwick, U. K
Ali Emrouznejad, University of Warwick, U.K.

In this paper we propose a method for assessing the comparative efficiencies of units operating production processes where input output levels are inter - temporally dependent. One cause of inter temporal links between input and output levels is capital stock which influences output levels over many production periods. Such units cannot be assessed by standard DEA which assumes input - output correspondences are contemporaneous. The method developed in the paper overcomes the problem of inter - temporal input - output dependence by using input - output paths' mapped out by operating units over time as the basis of assessing them. The paper begins with a discussion of the causes of inter - temporally dependent input and output levels. Then, it defines a Production Possibility Set (PPS) on data paths rather than DMUs. We illustrate the proposed assessment method using a data set.

Key words: Data Envelopment Analysis, Dynamic Efficiency, Performance Measurement.

XII. QUALITY VS QUANTITY IN EDUCATION

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In a recent paper, Färe et al (1997) showed how to compute productivity when quality of outputs and inputs is also of interest. They applied their approach to Swedish primary and secondary schools operating in 1992-94 and found that including quality characteristics did affect productivity. since the quality characteristics and outputs are not marketed in

the public education context, it is not clear that increases in these will actually increase constituent welfare. Increasing costly quality attributes that do not enhance constituent welfare would in fact be welfare reducing in this case.

In order to account for consumer preferences, particularly in the absence of explicit market prices, Färe, Grosskopf and Roos (199) showed how to adapt the underlying model to include a utility target. Unfortunately, we do not have information that could be used to capture consumer preferences and then compute the relative shadow values of quality and quantity characteristics consistent with technology and the simulated preferences.

We demonstrate our technique using the Swedish education data used in Färe et al.

XIII. TOTAL FACTOR PRODUCTIVITY GROWTH IN THE IRANIAN ELECTRIC POWER INDUSTRY

Alimorad Sharifi, University of Göteborg, Sweden

This paper is concerned with the estimation of Total Factor Productivity growth and economies of scale for the Iranian electric utilities within the period 1980-1993. In this study 12 electric utilities have been considered which produce electricity by using steam turbine, gas turbine and diesel power plants. To estimate economies of scale, rate of technical change and total factor productivity growth the econometric functional form such as translog cost function is used. In order to design a model which captures both time-series and cross-section data, pane data model like Fixed Effect model is estimated. The translog cost function accommodates Firm-specific variability through one-way error component model. For the formulation of technical change, time trend model is used. The optimal procedure is to jointly estimate the cost function and the cost share equations as a multivariate regression system. Including the cost share equations in the estimation procedure has the effect of adding many additional degrees of freedom without adding any unrestricted regression coefficients. This will result in more efficient parameter estimates than would be obtained by applying OLS to the cost function alone. So the model is estimated using the iterative seemingly unrelated regression (ITSUR). The input elasticities, economies of scale and total factor productivity are analyzed. The results show that the Iranian electricity industry has been exercising Increasing Returns to Scale (IRS) within the period 1980-93, technical change has increased from 9% in 1980 to 18% in 1993 and total factor productivity has also increasing trend with the average of 14% for the whole period.

Keywords: Iranian electricity industry, Panel data Analysis, Fixed Effect model, Translog Cost Function, Scale Economies (SCE), Total Factor Productivity (TFP), Technical change.

XIV. EVALUATING THE PERFORMANCE OF A TEST FOR THE SELECTION OF VARIABLES IN DEA BY MONTE CARLO SIMULATIONS

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J. L. Ruiz, Universidad Miguel Hernández, Elche, Spain
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F. Borras

In this paper we experimentally evaluate the performance of the statistical test for the selection of variables developed by Pastor et al. (1995). The difficulties with the statistical analysis in DEA (see, for example, Banker (1996) and Simar (1996)) has suggested the need for this study. The experiment has been designed varying the specifications of four factors: production technology (we have considered 14 different one output multiple input technologies described in terms of Cobb-Douglas type production frontiers), two inefficiency distributions (exponential and half-normal), two median inefficiency levels (low and high) and three sample sizes (50, 100 and 200). Obviously, we have two main objectives: first, comparing estimated and true sizes of the test; and second, analyzing its power. Some of the obtained results are: the performance of the test is better sample size increases, the power is higher as the role of the variable being analyzed (within the production technology) is larger and, finally, the behavior of the test is independent of the shape of the underlying inefficiency distribution. We eventually compare the performance of our test to that of the test which Banker has proposed to deal with the same problem.

XV. SENSITIVITY ANALYSIS FOR EXTREME EFFICIENT DMU'S FOR PROPORTIONAL CHANGES OF INPUTS AND OUTPUTS

Valter Boljuncic, Ekonomije i Turizma, Croatia

Sensitivity analysis in DEA, as in LP is a topic of great interest. We will consider sensitivity analysis in CCR model, and for extreme efficient DMUs. If DMU is extreme efficient, then it is also robust, i.e. we can increase its inputs and decrease its outputs, of course to some limits, and it will still remains efficient. The idea of the work is to find sufficient, and if possible necessary conditions on the changes of inputs and outputs and that the observed DMU remains efficient. In this work we use proportional increase of inputs and proportional decrease of outputs. WE use modified CCT model, and for every input and output we obtain point of projection. We discus if the obtained m+s points are efficient or not, where nonefficient points lead us to unfeasibility of programs. The result in the paper is for the case where is no unfeasibility encountered, and where the obtained hyperplane, i.e. hyperplane which goes through the obtained points, is not dominated with some (inefficient) DMU from reference set. We show that the obtained hyperplane is not dominated if and only if it goes through the origin. With these premises we show that the observed DMU can have changes of inputs and outputs that do not move it from the half-space generated with obtained hyperplane, and limited with the projected points, so that it will remain efficient. Case with unfeasibility and dominance is not solved, but present topic for further research.

XVI. COINTEGRATION OF TECHNICAL EFFICIENCY: AN APPLICATION TO THE CONVERGENCE HYPOTESIS

Jens Uwe Waechter, University of Georgia, USA

Many recent papers dealing with the convergence hypothesis regress the time average growth rates of a cross-section of countries on a number of different variables, among them the initial level of per-capita income. A negative coefficient on this variable is then interpreted as an indication of the convergence of the economies under consideration. Generally, this output growth is not decomposed into input growth, technical change and change in technical efficiency. It has been shown that this negative coefficient does not necessarily imply a convergence of the cross-sectional income distribution and, furthermore, that the findings of such approaches are artifacts of the econometric methods employed. This paper investigates the question whether or not efficiency estimates of selected countries display a long-run relationship. Estimation of efficiency scores requires the construction of the frontier or reference technology. The shortfall of an economy from the relevant frontier indicates inefficiency and a change in efficiency "catching up" towards best practice. This convergence in productivity is not accounted for in the growth regression. Estimation proceeds in three stages. Following Alam and Sickles (1995), time-varying efficiency scores are computed for a sample of OECD countries using both econometric and programming. Then, it is tested whether the non-stationary efficiency scores are cointegrated. Failure to reject the cointegration null can be interpreted as support for the convergence hypothesis.

XVII. COMPARING REFERENCE SELECTIONS IN ALTERNATIVE DEA MODELS

D. Wang, The Royal Veterinary and Agricultural University, Copenhagen, Denmark

This paper is devoted to compare reference selections of the alternative DEA models in the efficiency measurement. These models include the oriented CCR model of Charnes, Cooper and Rhodes (1978), the oriented BCC model of Banker, Charnes and Cooper (1984), the additive DEA model of Charnes et al. (1985), the weighted additive DEA models of Pastor (1994) and Lovell and Pastor (1995), and the ideal-plan DEA model of Bogetoft and Hougaard (1996). I focus on the mathematical properties of these models and other aspects, such as the possible biases concerning the reference selections and the ability of detection substitution and scale properties in production theory. To evaluate the competing DEA models, I use data on the efficiency of Danish Agricultural advisory service. A correlation analysis between the models is carried out.

Contents: 1.Introduction; 2. The alternative DEA models; 3. A general comparison; 4. Empirical analysis; 5. Conclusions and references

Session 7A: Bootstrapping

I. BOOTSTRAPPING RELATIVE EFFICIENCY STANDARD ERRORS IN PANEL STOCHASTIC FRONTIERS

Anthony Postert, University of Houston, USA
Robin C. Sickles, Rice University, Houston, USA
Leopold Simar, Universite Catholique De Louvain, Belgium

Bootstrapping has become a powerful technique for estimating sampling distributions of statistics since its introduction by Efron (1979). The original approaches have been expanded to bootstrap samples that exhibit heteroscedasticity or serial dependence. We propose a new bootstrapping procedure for heteroscedastic and dependently distributed data. Our procedure can be used in time series regressions and is robust to both heteroscedasticity and serial dependence. We consider theoretical issues in regard to the asymptotic distribution of our estimator and its rate of convergence as well as carry out Monte Carlo experiments to compare ours with other bootstrapping procedures. Stochastic Frontier Models are often estimated with little regard for the correlation pattern of the composed error. Our bootstrapping technique can be used to test the whether or not the efficiency scores for firms are significantly different, regardless of the correlation of the composed error.

II. BOOTSTRAP ESTIMATION FOR DEA ASSURANCE REGION EFFICIENCY SCORES

Tor Beltov, Odense Universitet, Denmark

The Paper is analyzing situations where Nonparametric Efficiency Scores are estimated with different assurance region parameters. It is shown that the impact of changes in the assurance region parameters do not, monotonously, influence the calculated bootstrap parameters. Based on a Monte Carlo study some conclusions are presented.

III. A TWO-LEVEL BOOTSTRAP PROCEDURE TO CAPTURE UNIT SPECIFIC EFFECTS IN DATA ENVELOPMENT ANALYSIS

Subhash C. Ray, University of Connecticut , USA
Evangelia Desli, University of Connecticut, USA

One major complaint about Data Envelopment Analysis (DEA) is that it is non-statistical and the efficiency score obtained for an individual Decision Making Unit (DMU) is a point estimate without any confidence interval around it. In recent years, researchers have resorted to bootstrapping (e.g., Simar (1992, 1996), Simar and Wilson (1995) among others) in order to generate empirical distributions of efficiency scores from repeated applications of DEA after resampling. The essential procedure is to pool the efficiency measures obtained from the actual data and to randomly sample with replacement from this pool to construct pseudo data on inputs (or outputs) for the DMUs. These artificial data on inputs (outputs) are associated with actual output (input) data for another round of DEA. The new set of DEA scores constitute the next pool from which another random sample is drawn. Repeating this procedure for a large number of times generates large enough samples of efficiency scores for each DMU. One can then look at the mean and the variance of each of these distributions.

While this procedure is quite appealing and is gaining wide acceptance, in a sense, it goes to the other extreme by assuming that all DMUs have the same probability of getting an efficiency score from any specified interval within the (0-1) range. This reduces efficiency to a purely random variable and there would be little point in talking about the efficiency of on one DMU vis-a-vis another. In reality, however, some DMUs are more like to be rated at a higher efficiency level than other DMUs. There usually are systematic factors that contribute to differences in efficiency. For example, in an inter-country analysis of manufacturing production it is not sensible to conceptualize a data generating process where

Germany and Ethiopia have the same probability of getting efficiency scores in excess of 0.975. The existing bootstrapping procedures do not consider the possibility that the distributions of efficiency conditional on unit specific factors may differ across DMUs. One could argue in favor of including these factors within the scope of the DEA model itself so that the remaining variation in efficiency can be justifiably attributed to purely random factors. However, inclusion of these factors as non-discretionary inputs within the DEA model automatically extends the disposability property (strong or weak) to such variables. This is not a realistic assumption in many situations. This is one reason why researchers often regress DEA efficiency scores on a number of explanatory variables to adjust for environmental factors. They do not include these factors in the DEA model itself.

In this paper we propose a two level bootstrap procedure which empirically generates the conditional distribution of efficiency for each individual DMU. The principal innovation in this study is that instead of resampling directly from the pooled DEA scores, we first regress these scores on a set of explanatory variables not included at the DEA stage. The residuals from this regression are pooled and a random sample with replacement is drawn from this pool. The predicted value from the fitted regression model is adjusted by the residuals drawn to create a pseudo-data set of efficiency scores for the DMUs. These pseudo efficiency scores incorporate the systematic effects of unit specific factors along with the contribution of the randomly drawn residual. These pseudo efficiency scores are used to create a new data set for the next round of DEA. The newly obtained efficiency scores are fed into the regression analysis to estimate a new model with a new set of residuals.

The paper also includes an empirical application using data from Connecticut public schools.

Session 7B: DEA applications with MCDM aspects

I. MODELS FOR IDENTIFYING TARGET UNITS IN DATA ENVELOPMENT ANALYSIS: COMPARISON AND EXTENSION

Tarja Joro, Helsinki School of Economics & Business Administration, Finland

Besides of the efficiency scores, Data Envelopment Analysis also provides the inefficient DMUs with information on reference units. Reference units are obtained by projecting the inefficient surface. The production theoretical background for this is, that the DMU preserves its current input-output mix while improving its activities towards efficiency. However, it is possible that from the managerial point of view some other solution on the efficient surface might be more preferable target, i.e. there exists an input-output mix that is more suitable for the inefficient unit than the one it currently uses. The purpose of this paper is to present a dynamic and interactive way to provide targets for inefficient Decision Making Units in Data Envelopment Analysis using Multiple Objective Linear Programming Models.

II. EVALUATION THE EFFICIENCY AND INTENSIFYING THE ACTIVITIES IN A FINNISH LOCAL MARKET CHAIN

Aapo Siljamäki, Helsinki School of Economics, Finland

In this real life application we operate in interaction with Decision Maker in measuring efficiency and mixing resources. DM is an essential part of the solution method. DM is giving his/hers affection to the importance of the goals. In this application we have measured the efficiency of one Finnish hypermarket chain

III. EFFICIENCY OF TEAM MANAGERS IN NATIONAL HOCKEY LEAGUE

Timo Kuosmanen, Helsinki School of Economics and Business Administration, Finland

In this paper cost efficiency analysis is extended to team sports, namely North American National Hockey League (NHL). Theoretical framework formulated in this study is applicable to any other professional team sport, too. Team managers are taken as decision making units that maximize the league points of the team, constrained by the funds available for compiling the team. Actual data of player compensation and league points for the season 1996 - 1997 is analyzed using data envelopment analysis (DEA) -technique. As a result we get efficiency score for each team. based on these efficiency scores we can speculate which team would have won the Stanley Cup if all the teams were efficient. Furthermore, the relative contribution of managerial skills to team success is estimated.

Session 7C: Measurement in non-parametric efficiency

I. FACETS AND EFFICIENCY MEASUREMENT IN DATA ENVELOPMENT ANALYSIS

Peter Pille, University of Toronto, Canada
Joseph C. Paradi, University of Toronto, Canada

We present an algorithm to determine all the facets of the DEA frontier. This enables the projection of inefficient units to the closest point on the efficiency frontier. We discuss the issue of facets dimensionality. The proportion of full dimensional facets will affect the degree of freedom to move along the frontier, and also the meaningfulness of projecting to a nearby point on the frontier. We introduce an efficiency measure for inefficient units, relative to the

closest point on the frontier. This efficiency measure can be used with any projection to the frontier, including the traditional input or output oriented radial projections. With radial projections, slack is accounted for in the measure, and the measure collapses to the traditional radial measures when there is no slack.

II. ASSESSING SLACKS THROUGH A NESTED RADIAL APPROACH IN A FDH TECHNOLOGY

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Sergio Destefanis, Université degli Studi di Salerno, Italy

After having argued that usual radial efficiency measures are not appropriate within an FDH technology, we show in this paper that, for a multi-input multi-output FDH technology, it is possible to obtain various efficiency measures (also allowing for the existence of slacks, such as the asymmetric Färe, Russell, Zieschang) through a nested radial procedure.

If for instance, the case of input-inefficiency is considered, it can be shown that the input vector (of order m) of an inefficient DMU can be decomposed in m radial projections on m subspaces. This decomposition procedure follows a hierarchically ordered (or nested) sequence from the space of dimension m (which allows the greatest possible radial reduction associated with the disappearance of slack in at least one input) to a space of dimension one. At every step of the procedure, Debreu-Farrell measures are obtained which correspond to the amount of slack in a given input that is cancelled by a radial contraction in the relevant subspace. For all inputs we compute the product of these Debreu-Farrell measures, obtaining the total input contraction required to bring an inefficient DMU on the efficient subset.

Considering an FDH technology and various assumptions on the structure of relative input prices, it is shown that (a) through this nested procedure it is possible to obtain a measure of technical efficiency satisfying the four properties indicated in Russell (1988); (b) some commonly used nonradial measures (asymmetric Färe, Russell, Zieschang) can be generated through this nested procedure; and © the true value of (radial and nonradial) inefficiency always falls in an interval bounded by the asymmetric Färe and the radial Debreu-Farrell measures.

The above described procedure is then applied to a sample of Italian manufacturing firms.

III. THE SHORTEST PATH TO THE EFFICIENT SUBSET

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Antonio M. Alvarez, Universidad de Oviedo, Spain

Efficiency improvements can be thought of as movements towards the production frontier. In a multidimensional context, such movements can be undertaken in many different directions or paths. The design of management programs must consider the various options (paths) available and their associated costs, in order to select the least costly alternative. We argue that the firm should follow the path to the efficient subset that minimizes the distance between the actual productive process and the reference point on the efficient subset. The objective of this paper is to develop a framework capable of identifying the shortest path to the efficient subset of the production frontier. For this purpose, we introduce the concept of input-specific distance as a modified version of the single-factor efficiency measure, introduced by Kopp (1981). The input-specific distance measure computes the length of the movement that is required to reach the efficient subset when the distance to the isoquant is measured along a unique input. We show that, under the assumption of convexity, the smallest input-specific distance determines the shortest path to the efficient subset. The model is applied to a sample of Spanish dairy farms, finding labor and feedstuffs as the inputs that (on average) lead more directly to the efficient subset. Thus, the main effort should be placed in investigating the efficient use of these two inputs

IV. RETURNS TO SCALE AND SCALE ELASTICITY IN DATA ENVELOPMENT ANALYSIS

Hirofumi Fukuyama, Fukuoka University, Japan

The aim of this paper is to unify and extend the existing results on the determination of returns to scale and on the computation of the scale elasticity and then to present mathematical characterisations of the scale elasticity within a data envelopment analysis framework.

Session 8A: Economic reform in centrally planned economies 1

I. PRODUCTIVITY GROWTH, CATCH-UP AND CONVERGENCE IN CHINA'S REFORMING ECONOMY

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Since the initiative of economic reform in the late 1970s, the Chinese economy has sustained a continuously high rate of annual growth. This seemingly miraculous growth has attracted the attention of many economists in the world. In particular, major efforts have been made to understand the role of efficiency and productivity in economic growth in the post-reform mainland Chinese economy. However, most previous studies have focused only on the industrial or agricultural sectors, perhaps due to the limitation of statistics. This paper presents an economy-wide study and hence attempts to fill the void in the literature.

A stochastic frontier method is used to estimate productivity growth, which is decomposed into two components: technological progress and efficiency change. The former refers to shifts in the frontier and the latter to movement towards the frontier. Applying the newly released regional GDP data, this study aims to (1) examine the contribution of productivity to economic growth in China, (2) investigate the sources of productivity growth in the reforming Chinese economy, and (3) shed some light on the trend of convergence and catch-up in terms of productivity performance among China's regional economies in the 1980s and 1990s.

Key Words: Productivity, technical efficiency, technological progress, convergence and catch-up.

II. THE EMERGENCE OF A TWO TIER BANKING SECTOR: A MALMQUIST INDEX APPROACH

Jenifer Piesse, University of London, U.K.
Grzegorz Rogowski, Bank Zachodni SA Wroclaw, Poland

A major obstacle to reform in the transition economies has been the absence of the necessary institutions to support a market economy. This paper measures the progress made in the introduction of a two-tier banking system in Poland, using panel data from 64 banks in 1994 and 1995. The two commonly used methods of modelling financial institutions are combined, resulting in a production initial stage and an intermediation second stage. A non-parametric model is used to avoid behavioural assumptions or the imposition of any individual technology, and a Malmquist index is constructed for each bank and for the sector as a whole.

Keywords: Transition, Banking, Productivity, Malmquist index

III. EXPLORING A REGIONAL EFFICIENCY FRONTIER IN THE FORMER USSR

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Using 1971-90 panel data from a Siberian province, two econometric methods are used side by side to examine technical inefficiency with a suggestion as to how the methods might be used in sequence. Estimates derived from a random effects method reveal that technical inefficiency is both substantial and not time invariant. Results using either a random effects or fixed effects method suggest that existing estimates of technical inefficiency in centrally planned economies may be biased downward because of the choice of the estimation method. Using either method, the increasing inefficiency found is one cause of the decline in the performance of centrally planned economies.

IV. A DECOMPOSITION OF TOTAL FACTOR PRODUCTIVITY GROWTH: THE CASE OF CHINESE STATE ENTERPRISES DURING THE REFORM PERIOD

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Yiping Huang, Australian National University, Australia

The impact of China's economic reform on productivity growth of the state enterprises has been a controversial issue. Some studies have concluded that there has been an acceleration in total factor productivity growth, while others have argued that economic reforms have failed to stop the stagnant productivity growth in the state enterprises. Assessment of state enterprises' performance and its relation to reform measures are crucial for further policy-making to sustain China's overall economic growth. A central assumption in all the above studies is that enterprises are operating on their frontiers realising their potential outputs. In the context of state enterprises in several developing and centrally planned economies, this is a restrictive assumption. This study relaxes that assumption and decomposes the sources of total factor productivity (TFP) growth into technological progress and changes in technical efficiency within the framework of the varying coefficients frontier production function. A survey data set of about 800 state enterprises over fifteen years between 1980 and 1994 is used. The results suggest that not only were the technical inefficiencies significant in the state enterprises, but also there was no overall significant TFP growth consistently during the reform period.

Session 8B: Incentives and regulation

I. BENCHMARKING REGULATED FIRMS: A DUAL APPROACH

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Studies by Denny, Fuss, and Waverman (1981) and Granderson and Linvill (1996a) have demonstrated that total factor productivity growth (TFPG) in regulated industries differs when the regulatory constraint is explicitly incorporated. Bauer (1990), Ray and Mukherjee (1996), and Granderson and Linvill (1996b) have shown that inefficiency should be explicitly taken into account in estimating TFPG. Färe and Logan (1983) have shown that the effects of the regulation constraint can be extracted from the regulation constrained cost function using duality theory to derive the traditional production function. This paper combines the insights of these three strains of work to produce one estimate of TFPG that reflects the purely technological components of productivity growth and a second estimate of l FPG that reflects both technological and regulatory components of productivity growth. Both estimates allow for the contribution of technical, allocative, and scale inefficiencies.

Both sets of TFPG are important because each contains unique information about the relative efficacy of managers in promoting firm growth. The first extracts the effects of regulation us demonstrates the effectiveness of managers in promotion conventional productive efficiency improvement while the second demonstrates the effectiveness of managers in promoting regulation constrained efficiency improvement. Distinguishing between these two measures of effectiveness is important because increases in firm costs could be due to relatively poor management of technology or they could be due to relatively poor management of the regulatory environment.

An eleven year panel of data from the interstate natural gas industry is used to estimate a stochastic regulation constrained cost function and a non-parametric regulation constrained cost frontier. Having parametric estimates allows us to use duality theory to estimate characteristics of the true production technology. Having a non-parametric, regulation constrained frontier allows us to readily incorporate the effects of inefficiency in TFPG

II. YARDSTICK COMPETITION AND THE REGULATION OF NATURAL MONOPOLIES

Göran Ek, Swedish Electricity Network Authority, Sweden

This paper considers the regulating question of asymmetric information between the regulator and the agents, and how to construct a regulation mechanism that gives transparency and incentives for higher efficiency and productivity change. Another regulating problem is the case with many local monopolies. To control them with usual auditing methods will give a huge workload. And furthermore, there is in this case a need to differentiate the demands on higher productivity depending on differences in efficiency. The need for regulating monopolies is motivated by the loss of both price- and cost efficiency in monopoly markets. Natural monopolies, like the distribution of electricity, gas, water, telecommunications and other network services are given areas for regulation. The regulation mechanism that is proposed uses bench-marking information extracted from measurement with the front production concept. The measurements of efficiency and productivity change reduce the informational rents the agents would have without a bench-marking process. Armed with this information the regulator can formulate a revenue cap. The formula sets both a general X-factor reflecting the technological change in the sector and an individual firm specific factor of rationalization reflecting the potential for being more efficient. With focus on both the level and the change and with the differentiation of the revenue caps, the regulator can eliminate monopoly rents and increase efficiency. And in the end there will be lower tariffs.

III. FIRM PRODUCTIVITY GROWTH AND COMPETITION

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Erik Strøjer Madsen, University of Copenhagen, Denmark
Valdemar Smith, University of Copenhagen and Århus School of Business, Denmark
Mogens Dilling-Hansen, University of Århus, Denmark

Competition within an industry is normally expected to reduce the profit margin, reduce the inefficiency in production and increase the effort spend on innovations. Thus, theoretically there are good reasons to believe that competition will increase the productivity of the firms. In a recent study based on around 670 UK companies Nickel (1996) found that a highly competitive environment enlarge the productivity growth of firms.

Manager may also be under pressure from their shareholder if the ownership is concentrated among a small number of owners. There could be a financial pressure too from their banks if they have borrowed a lot. Nickel et al (1996) found a significant positive effect on firms performance from the rate of debt services and the degree of owner control from the financial sector.

In this paper we will study the productivity growth of Danish firms and the factors affecting the growth rates. The study is based on a longitudinal sample of around 10,000 firms from both the manufacturing and the service sectors. The data set includes account information on individual firms at a 5-digit industry level for a period of eight years. The aim of the study is to investigate how firm productivity growth is affected by the number of competitors in the market, the level of profit in the industry, the rate of interest payments and the type of ownership.

IV. EVALUATING SOLVENCY AND EFFICIENCY PERFORMANCES IN U.S. PROPERTY- LIABILITY INSURANCE COMPANIES

P.L. Brockett
William W. Cooper, University of Texas at Austin, USA
J. J. Rosseau
Y. Wang

Using 1989 data obtained from Best & Co., a supposed conflict between efficiency as a managerial objective and solvency constraints imposed by regulatory agencies is found to be nonexistent for both stock and mutual insurance companies in the U.S. The same result holds for both agency and direct marketing systems. Stock companies are found to be more efficient than mutuals and agency systems more efficient than direct marketing systems, except in the case of mutuals.

Session 8C: Decomposition

I. DISTINGUISHING TECHNICAL AND SCALE EFFICIENCY ON NON-CONVEX AND CONVEX TECHNOLOGIES: AN ILLUSTRATION USING UK RATES DEPARTMENTS

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Philippe Vanden Eeckaut, Université Catholique de Louvain, Belgium

This paper defines a decomposition of technical efficiency for a series of nonparametric deterministic reference technologies related to the Free Disposal Hull. More specifically, introducing several returns to scale assumptions into this non-convex production model allows one to distinguish between technical and scale inefficiencies.

These technologies and the resulting efficiency decomposition are illustrated with data on UK rates departments used earlier by Thanassoulis, Dyson and Foster (1987) and contrasted with results based on the traditional, convex Data Envelopment Analysis models.

JEL classification: D24

Keywords: Decomposition of technical efficiency; FDH; DEA.

II. THE DECOMPOSITION OF TOTAL FACTOR PRODUCTIVITY GROWTH: A DUAL APPROACH

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Many econometric efficiency measurement studies assume that all firms in a sample have the same technology except from (composite) intercept terms. Furthermore, most econometric efficiency studies employ the frontier production function approach which suffers among other things from endogeneity problems (of input quantities) and the difficulty to estimate a coherent set of input demand equations.
This paper develops the concept of relative efficiency whereby all firms have a different technology through intercept terms and slope parameters. In this framework, a sample is considered as a set of technologies. Relative output efficiency is determined for each firm in the sample as the ratio of the own output to the highest obtainable output in the set of technologies, at given quantities of inputs.
This paper also demonstrates that output technical efficiency can be determined from a dual system of input demand and output supply equations by using the concept of virtual prices. Virtual prices allow for transforming an output supply equation from the input price space to the input quantity space. Advantages of using the dual rather than the primal approach are that prices instead of (endogenous) input quantities are used as explanatory variables and that a system of equations can easily be estimated.
The paper also gives a formal demonstration of the decomposition of total factor productivity growth in a scale effect, an efficiency change effect and an exogenous technological change effect. The methodology is applied to panel data of Dutch potplant firms over the period 1975-1995.

III. THE COMPONENTS OF TOTAL FACTOR PRODUCTIVITY CHANGE

Bert M. Balk, Statistics Netherlands, The Netherlands

A frequently employed measure of TFP change is the ratio of an output quantity index and a deflated cost index (a discrete time version of the Solow residual). For empirical implementation one usually employs Tørnqvist indices. By using various duality-theoretic insights it appears possible to decompose this empirical TFP change measure into five independent components:

- input technical efficiency change - technological change
- the contribution of input allocative efficiency (change)
- the effect of non-marginal cost pricing of the outputs
- the effect of local returns to scale.

The only assumption made is that each period's technology can be represented by a translog cost function with time-invariant second-order coefficients. This decomposition can be seen as the discrete time version of a decomposition derived by Bauer (1990). Besides being advantageous from an empirical point of view, our decomposition provides additional detail.

Session 9A: Economic reform in centrally planned economies 2

I. PRODUCTIVITY OF MONGOLIAN GRAIN FARMING: 1976-89

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T. J. Coelli, University of New England, Australia

This paper uses stochastic frontier production function models applied to farm level input-output data to attempt to measure and explain efficiency, technological change and productivity changes in Mongolian grain farms during the pre-reform period (1976-89). The results obtained point towards a 13.6 percent decline in efficiency, a 6.4 percent decline in technology and an 18.3 percent overall decline in TFP over the 14 year study period. However, it is notable that in the final nine years of the study period this trend was reversed, with a 56 percent growth in TFP. This suggests that the shift away from policies encouraging increased input usage (prevalent in the 1970*s) towards the "intensive" technology and incentive reform policies of the 1980*s was beginning to achieve considerable success.
Results also indicate that farm efficiency levels were significantly and positively correlated with vocational technical education, experience of the farmers, levels of Russian technical advice and the incentive systems used on the farms. We also found evidence of constant to mildly increasing returns to scale, suggesting that the current economic reform of splitting the original State Farms into smaller units may not justified on the grounds of scale economies.

II. SECTOR LEVEL EFFICIENCY AND PRODUCTIVITY IN HUNGARIAN PRIMARY, SECONDARY AND TERTIARY INDUSTRIES: 1985-91

Jenifer Piesse, University of London, UK
Colin Thirtle, University of Reading, UK

The stages of growth and structural transformation literatures suggest that during the development process agriculture declines in importance relative to industry and later the service sector. However, in Central and Eastern Europe, industrialisation was a central feature of development plans and the relative decline of agriculture was forced prematurely by policy. This study uses firm-level accounting data from 1985 to 1991 for 189 firms in agriculture, manufacturing and services to compare productivity in the primary, secondary and tertiary sectors. These data suggest that in 1985 all three sectors had firms on the technical efficiency frontier, but the average efficiency of the service sector was highest, followed by manufacturing and then agriculture. Then, as progress towards the formation of a market economy continued, productivity declined by 37% in services, 29% in manufacturing and 21% in agriculture, reversing the earlier ranking. Thus, Hungary's comparative advantage appears to be in agriculture. This suggests that liberalisation and reliance on market forces may temporarily reverse the normal direction of structural change in the transitional economies and therefore reindustrialisation should not be forced too soon.

Key words: Transitional Economies, Sectoral Multilateral, Malmquist Productivity Indices, Decomposition, Structural Transformation.

JEL Classification Numbers: O47, P5, Q15 and Q16

III. THE MATHEMATICAL PROGRAMMING APPROACH TO TECHNICAL EFFICIENCY OF PUBLIC AND PRIVATE IRANIAN TEXTILE INDUSTRY

Nosratollah Nafar, Göteborg University, Sweden

This study considers measurement of technical efficiency of 250 Iranian public and privately owned textile companies during 1992. The non-parametric mathematical programming approach to frontier production (DEA) is used for this

purpose. Output increasing method is followed. Two assumptions of variable and constant returns to scale are considered. Empirical results show that most of the enterprises are operating at efficiencies of more than 80%. The mean efficiency is 83% and 80%, indicating that, on average, there exists potential for an increase in output of 17% and 20% in the case of VRS and CRS, respectively. Public firms are found to operate more inefficiently than private ones under both assumptions. Empirical results also show negative relationship between number of labor and technical efficiency indicating that smaller firms are operating more efficiently.

Session 9B: Service and education

I. EVALUATING AND ENHANCING THE PERFORMANCE OF A REGION

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There are 310 metropolitan statistical areas (MSAs) in the U.S. People, resources and firms freely move among these areas and other parts of the country in search of the best opportunities. Not only do firms compete with other firms for customers, but so do locations compete with other locations for firms, people, and resources. Some locations benefit and thrive, others lose and decline.

The purpose of this paper is to evaluate the provision of local government services by a particular region relative to the 310 MSAs in the country, and to provide guidance for this region to provide local government services more effectively. The first step is to specify the inputs and the outcomes for the regional provision of government services.
The single input is expenditure. The outcome measures cover education, administration of public welfare, sewer hookups, road maintenance and public safety. It is important to use outcome measures which are not proxies for expenditure to avoid outputs justifying resource usage by construction. The Capital Region of New York State is evaluated using an input oriented, variable returns to scale, DEA model. Regions belonging to the efficient reference set for the Capital Region are potential role models that can be used to improve performance. However, there may be even more useful inefficient regions which dominate the Capital Region. To expand the list of potential role model regions, we "peel the onion" by deleting the first round efficient role model regions from the data set, re-calculating the model, and identifying the new members of the efficient reference set on the shrunken frontier.
The expanded list of role model regions is screened for particularly good matches with the Capital Region through discussions with local experts. Five regions are selected for more extensive examination to reveal possible sources for their superior performance. A case study approach is used. The objective is to discover operational practices at the functional level which may be transferable to the Capital Region, and enhance its ability to provide local government services.

This paper makes methodological and practical contributions to the literature on productivity analysis: (1) Modeling the provision of government services by a region, (2) Expanding the role model list by "peeling the onion," (3) Incorporating the rich institutional knowledge of local experts with a secondary screen, and (4) Using potentially transferable practices at the individual functional level to provide guidance for enhancing regional performance.

II. SETTING PERFORMANCE TARGETS FOR PUPILS

Emmanuel Thanassoulis., Warwick Business School, UK

This paper develops an approach for setting performance targets for school children. At the centre of the approach is Data Envelopment Analysis (DEA) which is used to identify benchmark pupils who achieve the best observed performance, after allowing for contextual factors. The achievements of these pupils, after allowing for random noise,form the basis for estimating the targets of achievement for the rest of the pupils. As well as estimating targets, the procedure identifies those of the benchmark pupils who offer values on the contextual variables which match those of

each given weaker pupil. Such matching of weaker and stronger pupils not only makes the targets set for each pupil transparent, but it also offers indirectly guidance as to how underperforming pupils might achieve better results. Themethod can be used within a school, or even class, provided there are sufficient pupils. Where pupils from several schools are used the method can lead to judgments on comparative school effectiveness. The targets of each pupil can be decomposed into a part that the pupil should be capable of delivering, given the effectiveness of his/her school, and a part that the pupil can only deliver if the effectiveness of his/her school improves.

Keywords:
Target Setting, Performance Measurement, Data Envelopment Analysis

III. MARKETING CAPABILITY AND PERFORMANCE OF DAIRY COOPERATIVES IN INDIA

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Mukesh Bhargava

The dairy development program Operation Flood was instituted over three decades ago in India to set up non-profit cooperatives with the purpose of marketing rurally available milk in urban areas. The effectiveness of these cooperatives with respect to compliance with their mandate and marketing is relevant in light of the environmental and societal changes that have taken place in India over the past decade. In this paper, marketing performance of the cooperatives is examined using Data Envelopment Analysis.

Session 9C: Sensitivity and computations of efficiency:

I. GRAPHHYPERBOLIC EFFICIENCY AND PRODUCTIVITY MEASURES

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The definition of the so called in the literature hyperbolic efficiency measures with respect to a graph representation of the technology holds great potential regarding economic analysis since it allows researches to consider both the output and input dimensions in defining measure of compared performance. The empirical implementation has not had, by far, the echo of the output or input oriented measures just because it seems to good to be true being able to increase a firm's efficiency or productivity by expanding outputs and reducing inputs at the same time. Even if this measures should be regarded as the theoretically best one in confronting plants within a firm or firms within an industry under certain conditions, it is surprising that it isn't usually computed in order to compare them to the standard output or input oriented ones that drop one of the dimensions. Besides the fact that hyperbolic measures might not be theoretically appealing because of market considerations (i.e. in regulated industries, such as the energy one were electric utilities supply tends to be fixed, an input based measures could be more adequate), we believe that the actual unleashed potential is due in part to the fact that no adequate estimation procedures have been yet available. In the present note we propose the correct way to measure hyperbolic efficiency scores, state its properties regarding different definitions of the technology, i.e. returns to scale, and show potential uses regarding technical and economic analysis, i.e. environmental assessments of efficiency when undesirable outputs are considered.

II. A COMPARISON OF DEA COST-EFFICIENCY MEASURES

Jesus T. Pastor, Universidad Miguel Hernández, Elche, Spain
Jose M. Pastor, IVIE and Universidad de Valencia, Spain

Radial DEA measures have been widely used in the productivity literature. They are easy to interpret and to compute. However they have a serious problem: they do not account for nonradial inefficiencies, as given by the slacks. To remedy this problem, several authors have propose nonradial measures, such as Russell. In this paper we are going to focus on input reduction. Any of our inputs correspond to a specific type of costs, and, consequently, we want to reduce total costs. In some cases it may be wise to reduce some inputs and increase some others in order to achieve the maximal cost reduction. Here we propose a new non-radial DEA measure that accounts for maximal cost reduction. We compare it with other radial and non-radial cost measures and use them to analyze the efficiency of the Spanish banking system during the period 1985-1995.

III. CONVEX INPUT AND OUTPUT PROJECTIONS OF NONCONVEX PRODUCTION POSSIBILITY SETS

Peter Bogetoft, The Royal Veterinary and Agricultural University, Copenhagen, Denmark
Joseph M Tama, University of Notre Dame, Indiana, USA
Joergen Tind, University of Copenhagen, Denmark

In this paper, we characterize the smallest production possibility set that contains a specified set of input-output combinations. In accordance with neo-classical production economics, the productions possibility set is required to have convex projections on the input and output spaces (convex isoquants), and to satisfy the assumption of free disposability. We show how to form the minimal production possibility set by a recursive process. We give necessary and sufficient conditions for the process to be finite and present an illustrative example for the finite case. We also discuss how to obtain a good approximation in the infinite case.

IV. PERFORMANCE BENCHMARKING IN STOCHASTIC ENVIRONMENTS USING MEAN-VARIANCE DATA ENVELOPMENT ANALYSIS

Thierry Post, Erasmus University Rotterdam, The Netherlands

This paper extends the performance measurement and performance benchmarking technique Data Envelopment Analysis to generate efficiency score and reference units that are robust with respect to external effects, outliers and measurement error, by incorporating mean-variance conditions derived from stochastic dominance theory. The resulting technique is called Mean-Variance Data Envelopment Analysis (MV-DEA). The mean-variance conditions employed are consistent with rational choice behaviour for general preference structures and disturbance distributions, and, consequently, preserve the conservative nature of the conventional deterministic DEA methodology. Moreover, these conditions can be incorporated in conventional deterministic DEA models by simply imposing additional restrictions, and, therefore, do not require complementary analysis. In addition, the mean-variance conditions preserve the attractions of the conventional deterministic DEA mathematical programming structure, such as a convex feasible set and feasible and statistical consistent solutions. The basic concepts and characteristics of the MV-DEA technique are illustrated by means of an example MV-DEA assessment, using previously reported operating performance data of UK university departments.

Key words: performance benchmarking, Data Envelopment Analysis, stochastic dominance theory, mean-variance analysis.

Session 10.A: Agriculture and the environment

I. DECOMPOSED EFFICIENCY ANALYSIS IN FARM BUSINESS ADVISORY

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Danish research and extension organisations have developed a computerised benchmarking system whereby individual farms can be compared to the most efficient group of similar farms. The similar farms are interactively selected from a central database containing nearly 15,000 Danish farm accounts. The most efficient group of similar farm units is found and estimated using a non-parametric model framework.

More than 4,000 efficiency analyses have already been carried out. Obtained experiences indicate that farmers and local advisers are very satisfied with the new system. The benchmarking system has been used to identify and diagnose some overall problems and potential development areas in the farm businesses. As another example, the system makes it possible to obtain an objective evaluation of past economic performances, which can be discussed with the individual farm manager. The analysis system can, however, only make an overall analysis, which means that it is not possible to identify specific actions to improve the performance on the farm. Thus, the next task will be to develop a decomposed efficiency analysis allowing the farmer and his advisers to identify and analyse more specific problems existing on the farm firm.

The paper will give a brief overview of the applied system and discuss some of our model, implementation and advisory experiences. Furthermore the paper will discus the decomposition problem and give some ideas to solve it.

II. A MEASUREMENT OF TECHNICAL AND ALLOCATIVE EFFICIENCY WITH A PANEL DATA OF ITALIAN DAIRY FARMS: THE EFFECT OF THE NORMALISATION OF THE SHADOW PRICE VECTOR.

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The decomposition of cost efficiency into the two components of technical and allocative efficiency is still experimental.

As suggested by Lau, Yotopulos (1971), Atkinson, Cornwell (1994) and Kumkhakar (1996, 1997) have modelled allocative inefficiencies via shadow prices. By treating allocative inefficiencies as fixed parameters in a parametric dual approach, it is possible to decompose cost efficiency into the two components after having adequately specified the cost function and cost share estimation equations.

Particularly, since input technical efficiency does not enter the cost share equations, it can be modelled as an additive component in the specification of the actual cost function; input price distortions are modelled as coefficients of market prices that enter both the actual cost function and cost share equations using a flexible functional form like the translog. Technical efficiency is generally imposed time-invariant and it is estimated as an individual fixed effect in a system that consists of n equations and n unknows (n is the number of inputs), after normalising the vector of shadow prices.

However the effect of the normalisation over the measurement have not been explored yet. Atkinson, Cornwell (1994) choose arbitrarily one input as the numeraire and normalise the relative price distortion coefficients; generally a variable input (i. e. materials) is chosen assuming that its shadow price is always equal to the market price over all the period examined. On the other hand, Balk (1996) suggestes to normalise through the condition that the weighted sum of the price distortions is equal to one, where the weights are the actual cost shares.

Objective of this paper is to estimate input technical and allocative efficiencies on a panel data of 40 Lombardia dairy farms, which are observed over the period 1980-1992. In particular, the paper intends to decompose cost efficiency into the two components and investigate whether the two mentioned normalisations affect the results obtained in terms of inefficiency.

III. PRODUCTIVITY OF THE U.S. AGRICULTURAL SECTOR: THE CASE OF UNDESIRABLE OUTPUTS

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Desirable outputs are often produced jointly with undesirable outputs. Examples include electricity and SO_2 , paper and water borne effluents. Concern over such byproducts in agriculture prompted USDA to develop a state by year panel data set (1960-1993), which includes undesirable outputs such as nitrates and pesticides which leach into ground water, as well as runoffs into surface water. This data set is used here to estimate productivity growth and quality changes in the U.S. agricultural sector.

The productivity measure is defined in terms of directional technology distance functions. These distance functions generalize Shephard's input and output distance functions by (i) simultaneously scaling inputs and outputs and by (ii) not necessarily using the zero input/output as the origin of the ray along which inputs and outputs are scaled.

These distance functions allow us to decompose productivity into technical change, quality change and changes in efficiency. Technical change is the shift in the production technology, while efficiency change or catching up measures how an observation over time approaches the production frontier. Our quality change measure is introduced to capture how the undesirable outputs have increased or decreased over time.

The productivity measure used here does not require price (which are not available for undesirable outputs) and can be computed using linear programming techniques.

IV. A STOCHASTIC META-FRONTIER APPROACH TO MEASURING FARM CREDIT UNION EFFICIENCY

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Studies of production efficiency using stochastic frontier techniques are often obscured by the functional specifications and methods applied in measuring and attributing the efficiency to causes. The standard stochastic frontier regression of Aigner, Lovell and Schmidt, and van den Broeck, for example, assume the form, $y = g(x) + e$, where y is a dependent variable, $g(x)$ is a function of regressor x, and the asymmetric, composite error e consists of an inefficiency index. There is a voluminous literature on the distributional specification of the composite error, little attention has been directed to the specification of functional form of the frontier function $g(x)$, and how inefficiency actually affects y other than by shifting the frontier function. In reality, efficiency in production is generally input-specific. Some firms may acquire more information, knowledge, and experience with respect to one input's productivity than others. Government policy or regulation on the use of inputs and production processes may be either constraining or beneficial to some, but not to all, inputs. In this paper, we take the view that the production efficiency in the context of a stochastic frontier production function affects production through its improvement in input efficiency. The production efficiency is input-specific, and is in the form of input-augmenting efficiency. The fundamental idea in this approach is that of the stochastic meta-frontier function. We assume that all firms have access to the same production technology and information. All firms have the same underlying frontier production function with input measured in "efficiency-equivalent" units which, in turn, depends upon the characteristic of a firm as well as the level of actual input usage. At a given point in time, there exists an array of production processes that describes production technology, and each firm makes a rational decision according to a firm's preference structure, available information set, and production environment in choosing its own firm-specific production process $gt(x)$. A stochastic meta-frontier postulate that various firm-specific production processes can be pooled together and be represented by a single common frontier function that applies to an "efficiency-equivalent" input set x^*. That is $y = g(x^*) + e$. The unobserved "efficiency-equivalent" input x^* is assumed to be related to the observed input x and a set of input-augmenting factor z, that is, $x^* = f(x,z)$. The stochastic meta-frontier is applied to data on farm credit unions in Taiwan to estimate the minimum cost frontier and its operating efficiency.

V. BENCHMARKING WATER UTILITIES' PERFORMANCE USING DATA ENVELOPMENT ANALYSIS

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As a part of the on going privatisation programme the water supply industry in the UK was privatised in 1989 under a regulatory framework based round RPI-X price controls. Post flotation though there has been considerable discussion about the effectiveness of the price cap regulation to proxy for competitive market processes. The objective of the paper is to analyse the post privatisation performance of these industries using DEA techniques to measure changes in the productive efficiency in water supply.

The results provide some interesting insights into the effect of reference groups on membership and locations of the efficiency frontiers and provide new evidence on the returns to scale properties f decision making units (DMUs) which throw some light on the subsequent restructuring.

Session 10. B. : Health

I. MEASUREMENT OF OUTPUT AND PRODUCTIVITY OF HOSPITAL SERVICES: A DISCUSSION OF THE MALMQUIST INDEX APPROACHES AND WITH AN ILLUSTRATION TO CATARACT SURGERY

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In this paper approaches are suggested for the measurement of output and productivity of hospital services. The framework included in the measurement of output takes as a starting point the effects for the patient in terms of changes in state of health and changes in basic daily life activities. This framework originates from general ideas presented in earlier work by Armatya Sen on well- being, and in particular on Sen's concept of functionings and capabilities. An index measuring changes in output, in terms of changes in living conditions is included in the Malmquist productivity index. The illustration to cataract surgery indicates that measurement of output and productivity may be very misleading if we use proxies such as, e.g., discharges, beddays, etc., as measure of hospital output

II. HAS THE DRG SYSTEM REALLY INFLUENCED HOSPITAL PRODUCTIVITY GROWTH IN PORTUGAL? AN EMPIRICAL ANALYSIS USING PARAMETRIC AND NON-PARAMETRIC METHODS

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The use of Diagnosis Related Group (DRG) as a mechanism for hospital financing is a currently debated topic in Portugal. The DRG system was scheduled to initiate in 1990 as an instrument for the allocation of public hospital budgets funded by the National Health Service and as a method of payment for other third part payers. The DRG system was expected to serve as an instrument to encourage a more efficient hospital resource utilization hospital and a more equitable distribution of hospital budgets. However the introduction of DRGs in the Portuguese National Health Service was slower than anticipated, since there is some argument in both the political and academic communities as to the appropriateness of DRGs as a budget setting criterion as well as to their impact on hospital efficiency in Portugal.

The purpose of this paper is to assess the impact of the DRG system in Portugal on the evolution of capital productivity in hospitals, measured as the sum of the variation of capital efficiency and the technical progress. To this purpose, we use a

unique data-set composed by the DRG discharge abstracts for five of the most frequent DRGs, covering the period from 1992 to 1994. The time span of the sample allows to compare the immediate impact of the DRG system and its longer run effects.

This paper uses a two-stage procedure to estimate the capital productivity growth, using both parametric and non-parametric methods. Therefore, in the first stage, time-varying technical efficiency is computed through the estimation of an input requirement frontier with both deterministic and stochastic methods. Also, technical progress is estimated by introducing in the equation a time trend. In addition, we measure Malmquist indices of productivity change across time, and decompose them into indices of efficiency indices and technological change.

In the second stage, the relationship between the capital productivity growth, and the introduction of the DRGs is analysed. After controlling for variables affecting capital usage (e.g. the patient characteristics and hospital characteristics), the technical efficiency scores are regressed on some indices aimed at capturing the effects of DRGs on the hospital production. This second stage is carried out through limited dependent variable techniques.

The results show that capital productivity in Portuguese hospitals has improved over time and that the DRGs system seems to have played a role in this respect.

III. COMPARING TEACHING AND NON-TEACHING HOSPITALS: A FRONTIER APPROACH

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In light of the growing concern for health care cost-containment, steps are being taken in the U.S. to reduce spending on hospital services for both direct patient care and other hospital activities, i.e., teaching. In the past, teaching was subsidized by the government because of the extra costs teaching imposed on the hospital as well as the social good aspect of teaching. However, due to the policy commitment of reducing overall health care expenditures, changes are being proposed that would limit these subsidies. Compounding the problem of limited governmental funding for teaching hospitals is the competitive nature of the hospital market with hospitals vying for managed care patients by offering discounts. Because of the additional burden of teaching and its associated costs, these hospitals may not be able to effectively compete with non-teaching hospitals.

Whereas, the common wisdom is that teaching hospitals are most costly from an accounting perspective, studies of the resource use differences between teaching and nonteaching hospitals have been lacking. In this paper, we extend previous research ("The Effects of Teaching on Hospital Productivity" by S. Grosskopf, D. Margaritis, and V. Valdmanis, SIU Working Paper, 1997) to compare the productive frontiers of teaching and non-teaching hospitals. We examine the differences in best practice technology between teaching and non-teaching hospitals: The goal is to ascertain if the technology of these hospital types are significantly 'different', if so, then competition for managed care contracts may not be feasible for teaching hospitals even if they have "efficient" practices.

In order to assess productivity, we use a data envelopment analysis (DEA) approach, which employs linear programming techniques to construct a 'best practice frontier' based on the relative performance of hospitals in the sample. We first assess performance for teaching and non-teaching hospitals separately. By stratifying the total sample, we can identify the technology and best practice of each hospital sector. We then compare hospital frontiers to determine if both hospital types have the ability to practice the same technology, i.e., the null hypothesis is that the frontiers for both the teaching and non-teaching hospitals are not statistically significantly different, implying that these hospitals can achieve comparable efficiencies and therefore can compete on equal footing with each other for managed care clients. The alternative hypothesis is that the frontiers are statistically different and that some type of subsidy for teaching hospitals may be warranted to account for the provision of the merit teaching good.

IV. MEASURING PRODUCTIVE PERFORMANCE OF HEALTH CARE SERVICES: A REVIEW OF METHODOLOGIES AND STUDIES

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As a consequence of increased demands on finite health care resources quantitative methods for measuring the efficiency of management and resource use are increasingly being applied in the health care sector. This has resulted in a rapidly growing body of literature. This paper focuses on the concepts of efficiency and productivity. The main methodologies used are briefly presented and the most comprehensive applications in the field are reviewed in terms of methods used, application and results. It is argued that because of the distinct features of the health services provision the different approaches should be applied with due caution.

Keywords: methods; literature review; health care; efficiency measurement

V. THE PERFORMANCE OF SURGERY UNITS IN FRENCH HOSPITALS: EFFICIENCY AND CAPACITY UTILISATION EXPLAINED

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This contribution aims to evaluate the performance of surgery units using a unique very detailed cross section sample of hospitals in a northern region of France (Nord - Pas de Calais - Picardie). The cost containment of the French health care sector raises issues of overinvestment in capital in general. This also applies to highly capital-intensive surgery units, where questions about optimal scale and capacity have hardly been investigated. Empirical analysis can steed light on the debate about horizontal or vertical integration of health care institution or even their closing.

Using non-parametric deterministic technologies capacity utilization and technical efficiency are disentangled. Among others, the results are compared in terms of ownership issues. Furthermore special attention focuses on incorporating highly detailed environmental information (e.g., accessibility, quality of care, ...) and the specialization revealed in the pattern of interventions

Keywords surgery units; efficiency; capacity utilization

Author index

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