JUNE 21st, 2011 – YOUNG RESEARCHERS' PRE-CONFERENCE
Chairman: Luis Orea

YR Session A: SFA - Methods and Applications, 09:00-10:30

Chaired by William Horrace

1. Precise efficiency score estimation by using Data Envelopment and Stochastic Frontier Analysis - A systematic comparison and an evaluation of simple approaches to combine efficiency estimates,
   Mark ANDOR, Frederik Hesse, (Discussant: Finn Førsund)
2. Measuring Capital for Micro and Small Enterprises in Indonesia,
   Anne Prestvik, (Discussant: Christine Amsler)
3. Consistent estimation of a true fixed-effects stochastic frontier model,
   Federico BELOTTI, Giuseppe Ilardi, (Discussant: William Horrace)

YR Session B: Services - Parametric Applications, 09:00-10:30

Chaired by Gary Ferrier

1. Demand uncertain, excess of capacity and allocative efficiency: an application to the Spanish Port Authorities in the period 1986-2007,
   Soraya HIDALGO-GALLEGO, Ramón Núñez-Sánchez, (Discussant: Sergio Perelman)
2. Does weather matter on efficiency and productivity? An empirical analysis of the Electricity Distribution Market in South America,
   Karim Anaya, (Discussant: Philippe Vanden Eeckaut)
3. How to compete in the Higher Education Market? - Empirical Evidence for Economies of Scale and Scope of German Higher Education Institutions,
   Maria OLIVARES, Heike Wetzel, (Discussant: Gary Ferrier)

YR Session A: Enviromental Efficiency, 11:00-12:30

Chaired by Sergio Destefanis

1. Separating Environmental Efficiency into Production and Abatement Efficiency - A Nonparametric Model With Application To U.S. Power Plants,
   Benjamin Hampf, (Discussant: Timo Kuosmanen)
2. The US Agriculture Greenhouse Emissions and Environmental Performance,
   Tshepelayi Kabata, (Discussant: Shawna Grosskopf)
3. Analysis of the Effects of Soil Organic Matter (SOM) on Efficiency and Agricultural Productivity,
   Kepifri Lakoh, (Discussant: Sergio Destefanis)

YR Session B: Innovation and ICT, 11:00-12:30

Chaired by Cinzia Daraio

1. Information Technology and the International Productivity Gaps,
   Tero Kuusi, (Discussant: Robert Russell)

2. An analysis of ICT-enabled innovation in Norwegian firms: Are ICT users more innovative?,
   Marina Rybalka, (Discussant: Jaap Bos)
3. An efficiency approach to innovation systems,
   Monica MIhaela Matei, (Discussant: Cinzia Daraio)

YR Session A: Public Sector, 14:00-16:00

Chaired by Kris Kerstens

1. Classic and bayesian stochastic frontier analysis for the Italian water sector,
   Valeria Di Cosmo, (Discussant: Mike Tsionas)
2. Private Partners in the Waste Sector: Opportunists or Allies?,
   Pedro SIMÕES, Rui Marques, Pedro Carvalho, (Discussant: David Saal)
3. Measuring Local Governments' Spending Efficiency: An Application to French Counties,
   Stefan SEIFERT, Maria Nieswand, (Discussant: Kris Kerstens)

YR Session B: Productivity Growth, 14:00-16:00

Chaired by Federico Perali

1. The sensitivity of total factor productivity decomposition to different stochastic frontier approaches.,
   Magnus Kellermann, (Discussant: Peter Schmidt)
2. On the external drivers of TFP: The Italian case,
   Gianluca Santoni, (Discussant: Carlos Arias)
3. The Returns to Scale Effect in Labour Productivity Growth,
   Hideyuki Mizobuchi, (Discussant: Bert Balk)
4. Market Structure and the Sources of Labor Productivity Growth,
   Jeremy Mallen, (Discussant: Federico Perali)

YR Session A: Agriculture, 16:30-17:30

Chaired by Spiro Stefanou

1. Heterogeneous Farm Output and Technical Efficiency Estimates,
   Phatima MAMARDASHVILI, Raushan Bokusheva, (Discussant: Bob Chambers)
2. Conversion From Rice to Fish Farm in Bangladesh: Efficiency and Productivity Perspective,
   Md.Akhtaruzzaman Khan, (Discussant: Spiro Stefanou)

YR Session B: DEA - Methods and Applications, 16:30-17:30

Chaired by Kostas Triantis

1. Financial Development and Macroeconomic Efficiency in Transition Countries,
   AnastasiaRi, (Discussant: Leopold Simar)
2. An integrated method using fuzzy goal programming and data envelopment analysis for estimating favored targets on efficiency measurement,
   Mojtaba Ghiyasi, (Discussant: Kostas Triantis)

JUNE 22nd, 2011 – DAY ONE

PLENARY SESSION. Rolf Färe: Two (short) papers on directional distance functions, 09:30-11:00

Chaired by Robert Chambers. Discussants: Bert Balk & Finn Forsund

Two Stages, 11:30-13:00

Chaired by Paul Wilson

1. Matching and Propensity Scoring Approaches to Address Problems with Two-Stage DEA and Stochastic Frontier Analyses,
   Pavlo Demchuk
2. Testing whether Two-Stage Estimation is Meaningful in Non-Parametric Models of Production,
   Cinzia DARAIO, Leopold Simar, Paul W. Wilson
3. Two-Stage DEA: Caveat Emptor,
   Léopold Simar, Paul WILSON

Heterogeneity I, 11:30-13:00

Chaired by Cristina Bernini

1. Comparing Performance of Heterogeneous Production Units: An Augmentation to the Meta-frontier Framework,
   Chris J. O'Donnell, Saeideh FALLA-FINI, Konstantinos Triantis
2. Measuring the productivity of global biotechnology companies: An application of GDF in metafrontier Malmquist productivity indices,
   Jun- Yen Lee, Jy- Wei CHANG, Yung- Hsiang Lu
3. Modelling Metafrontier function under different technological sets,
   Cristina BERNINI, Andrea Guizzardi

Regulation and Energy, 11:30-13:00

Chaired by Luis Orea

1. Incentive regulation and quality: An efficiency analysis of the Italian electricity distribution sector,
   Carlo Cambini, Annalisa CROCE, Elena Fumagalli
2. Distributed Generation in Electricity Networks - Benchmarking Models and Revenue Caps,
   Maria-Magdalena Eden, Robert Hooper, Endre BJØRNDAL, Mette Bjørndal
3. Flexible Specification of Cost and Input Distance Functions for Diversified and Integrated Firms,
   David SAAL, Pablo Arocena, Thomas Triebs, Subal Kumbhakar
4. Estimating Marginal Cost of Quality Improvements: The Case of the UK Electricity Distribution Companies,
   Luis OREA, Tooraj Jamasb, Michael Pollitt

Public Services, 11:30-13:00

Chaired by Stephane Vigeant

1. Public Expenditure Efficiency of German Local Authorities,
   Maria Nieswand
2. Efficiency Measurement in Postal Delivery using Panel Data,
   Massimo Filippini, Martin KOLLER
3. The politician and the vote factory: How funding sources lead to an efficient election campaign,
   Étienne Farvaque, Martial Foucault, Stéphane VIGEANT

Health Sector, 11:30-13:00

Chaired by David Roibas

1. Efficiency of Hospitals in the Czech Republic,
   Jana PROCHAZKOVA, Lenka Stastna
2. Pharmaceutical clinical research and medical-care industry efficiency: evidence from Italian regional system,
   Greta Falavigna, Roberto IPPOLITI
3. The response of decentralized health services to demand uncertainty and the role of political parties in the Spanish public health system,
   Ana Rodriguez-Alvarez, David ROIBAS-ALONSO, Alan Wall

Climate Change Effects, 11:30-13:00

Chaired by Kenneth Løvold Rødseth

1. Efficiency analsysis of application of ISO 14001 in Turkish SMEs,
   Mehmet Fatih ACAR, Nizamettin Bayyurt, Yavuz Agan
2. Transport and CO2: Productivity Growth and Carbon Dioxide Emissions in the European Commercial Transport Industry,
   Heike Wetzel, Lisann KRAUTZBERGER
3. Emission Constrained Firms: A Materials Balance Approach to Pollution Modelling,
   Kenneth Løvold Rødseth

Efficiency in Agriculture I, 11:30-13:00

Chaired by Alan Wall

1. Scale Efficiency in Organic and Conventional Dairy Farming,
   Giannis Karagiannis, Klaus SALHOFER, Franz Sinabell
2. Environmental Costs and Production Efficiency in Argentine Agriculture,
   Silvina M CABRINI, Carlos P Calcaterra, Daniel Lema
3. Land fragmentation, production risk and technical efficiency in conventional and organic citrus farms in Spain,
   Andrés Picazo-Tadeo, David Roibás, Alan WALL

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE I, 14:30-16:30

Chaired by Jacques Mairesse

1. Researcher mobility and its impact on scientific productivity,
   Aldo GEUNA, Ana Fernández-Zubieta, Cornelia Meissner
2. Entrepreneurial Scientists and their Publication Performance. An insight from Belgium,
   Malwina Mejer
3. Collaborations & productivity in a research group context,
   Hannah Van der Deijl
4. Can We Account for Individual Productivity Differences in Scientific Research? A Comparative Econometric Analysis of Publication Records of French University and CNRS Physicists,
   Jacques MAIRESSE, Michele Pezzoni

Directional Distances, 14:30-16:30

Chaired by Leopold Simar

1. Probabilistic characterization of directional distances and their robust versions,
   Leopold Simar, Anne VANHEMS
2. Dynamic Luenberger Productivity Measures,
   Teresa Serra, Spiro STEFANOU, Alfons Oude Lansink
3. Measuring and Comparing the Effects of Demand Constraints on Welfare,
   Ryan SIEGEL, Robin Cross
4. Statistical Inference for DEA Estimators of Directional Distance Functions,
   Leopold SIMAR, Anne Vanhems, Paul, W. Wilson

Advanced SFA, 14:30-16:30

Chaired by Mike Tsionas

1. How confident can we be about confidence intervals for firm specific inefficiency scores from parametric Stochastic Frontier Models?,
   Phill WHEAT, Andrew Smith, William Greene
2. How does the choice of the scaling function in BC92-type models affect inefficiency estimates? Observations and generalisations,
   Andrew SMITH, Phill Wheat
3. Omitted Relevant Variables and Stochastic Frontier Efficiency Rankings,
   SheltonSchmidt
4. A Distribution Free SFA Model,
   Aljar Meesters
5. Assessing measurement error in stochastic frontier analysis,
   Mike Tsionas

Advanced DEA I, 14:30-16:30

Chaired by Giovanni Cesaroni

1. Efficent Frontiers with Streaming Data,
   José DULA', Francisco López
2. Local exponential estimation of nonparametric frontiers,
   Carlos MARTINS-FILHO, Hudson Torrent, Flavio Ziegelmann
3. Methods for determination of multiple reference sets in the DEA models,
   Vladimir KRIVONOZHKO, Finn Forsund, Andrey Lychev

4. Computing efficiency scores in the R Open-Source platform: State-of-the-Art and perspectives,
   Philippe VANDEN EECKAUT, Per Agrell
5. Industry cost efficiency and average-cost efficiency in DEA analsysis,
   Giovanni Cesaroni

Engineering and Stage Production, 14:30-16:30

Chaired by Kostas Triantis

1. Decomposing Fuzzy Efficiency Metrics under Price Uncertainty,
   Adel HATAMI-MARBINI, Ali Emrouznejad, Per J. Agrell, Madjid Tavana
2. Stage efficiency measure on production processes: a non parametrical model,
   David Alcaide, Rafaela DIOS-PALOMARES, Angel Prieto
3. Measuring scale elasticity in two-stage network DEA,
   Biresh SAHOO, Bernhard Klemen
4. Engineering and Performance Measurement: Issues and Future Research Opportunitie,
   Konstantinos Triantis

Agglomeration and Productivity, 14:30-16:30

Chaired by Frank Asche

1. The Effect of Agglomeration Economies on Productivity and Efficiency of Manufacturing Firms,
   Abid BURKI, Mushtaq Khan
2. Does being in an Industrial Agglomeration enhances Productive Performances?: Evidence from Egypt using a Geo-Spatial model,
   Mohamed Mekki Ben Jemaa
3. Quality of life experienced by human capital: an assessment of European cities,
   Paulo MORAIS, Ana Camanho, Vera Miguéis
4. Profiting from agglomeration?,
   Frank ASCHE, Kristin Roll, Ragnar Tveteras

Eco Efficiency, 14:30-16:30

Chaired by Knox Lovell

1. Global efficiency and environmental protection's effects: evidence from Italian polluting industries,
   Alessandro Manello
2. The impact of local air pollution on airport efficiency assessment: evidence from Italy,
   Gianmaria Martini, Davide SCOTTI, Nicola Volta
3. Environmental efficiency and Sustainability in Manufacturing Industry,
   Heike Wetzel, Yan LI
4. Combining Field Research, GIS and DEA to Guide Ecosystem Management,
   H. K. Millington, J. E. Lovell, C. A. K. LOVELL

Efficiency in Agriculture II, 14:30-16:30

Chaired by Renato Villano

1. Technical efficiency in competing panel data models: A study of Norwegian grain farming,
   Subal C. Kumbhakar, Gudbrand LIEN, J. Brian Hardaker
2. Input Use, Yield Curves and Efficiency in Cropping: Australia's South West,
   Atakelty Hailu
3. Decomposing Productivity Measures in Pig-Based Farming Systems in United Kingdom,
   David Hadley, Renato Villano, Euan FLEMING
4. A Decomposition of Productivity and Efficiency Indicators in Philippine Rice Farming: Evidence from Farm-Household Level Data,
   Renato VILLANO, Euan Fleming, Marc Mariano

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE II, 17:00-18:30

Chaired by Michele Cincera

1. How Effective is the Knowledge Transfer of a Public Research Organization? Evidence from Spain,
   Gian Carlo Cainarca, Cinzia Daraio, Elba MAULEON
2. Ownership and impact of European university patents,
   Francesco LISSONI, Fabio Montobbio, Raffaello Seri
3. Industry Funding of University Research and Scientific Productivity,
   Hanna HOTTENROTT, Susanne Thorwarth
4. Determinants of Scientific Production: An Empirical Study of the World's Top R&D Companies,
   Michele CINCERA, David Dratwa

Heterogeneity II, 17:00-18:30

Chaired by Jean Philippe Boussemart

1. Incorporating heterogeneity into productivity and efficiency analysis.,
   Robert Chambers, Iosif KAFKALAS
2. On Evaluating Efficiency of Groups of Observations,
   Rui MARQUES, Pedro Carvalho
3. Identification of Efficiency Bands: An Application to the English Water Industry,
   Melvyn Weeks
4. Cost effiency of farms with heterogenous production : Application of non convex, scale restricted, partial cost frontier.,
   Philippe Vanden Eeckaut, Jean Philippe BOUSSEMART

Manufacturing and Regional Differences, 17:00-18:30

Chaired by Silvia Bertarelli

1. Determinants of labor productivity growth across Italian regions,
   Simone GITTO, Paolo Mancuso
2. Regional productivity differentials in manufacturing in Brazil in the 21st Century,
   Daniela SCHETTINI, Carlos Roberto Azzoni
3. Are formal firms more efficient than informa firms? Evidence from India manufacturing,
   Vinish Kathuria, Rajesh RAJ, Kunal Sen

4. Productivity differentials across EU-15 countries: a decomposition analysis within a convergence framework,
   Rosa Bernardini Papalia, Silvia BERTARELLI

Dynamic Efficiency, 17:00-18:30

Chaired by Camilla Mastromarco

1. Investment Decisions and Dynamic Efficiency Measurement under Uncertainty,
   Grigorios EMVALOMATIS, Spiro Stefanou
2. Dynamic Efficiency and Machine Replacement: A Discrete Choice Approach,
   Jorge CERDEIRA, Elvira Silva
3. Efficiency Measurement in a DSGE Framework,
   Camilla MASTROMARCO, Ulrich Woitek

Agriculture and Ecology, 17:00-18:30

Chaired by Francesco Vidoli

1. Environmental efficiency and vegetable production in Pakistan's Punjab: Implicationsfor sustainable agriculture,
   Abedullah ABEDULLAH, Asjad Tariq, Shahzad Kouser, Khalid Mushtaq
2. Eco-efficiency assessment of olive farms in Andalusia (Spain),
   Jose Antonio GOMEZ-LIMON, Andres Jose Picazo-Tadeo, Ernest Reig-Martínez
3. Sustainable Value in Italian agricultural field: parametric and semi-parametric frontier efficiency models,
   Francesco VIDOLI, Concetta Cardillo, Giancarlo Ferrara

Transportation, 17:00-18:30

Chaired by Robin Sickles

1. Persistent and region-specific maintenance cost inefficiency in European and North American rail infrastructure: a panel data stochastic frontier approach,
   Gian Carlo SCARSI, Andrew Smith, Phillip Wheat
2. Measuring Input Congestion for Rail Transport with Consideration of Environmental Factors,
   Erwin LIN, Chun-jia Chiang
3. How Efficiently Do U.S. Cities Manage Roadway Congestion,
   Anthony Glass, Karligash Kenjegalievay, Robin SICKLES

Fisheries, 17:00-18:30

Chaired by Kristin Roll

1. Applying Efficiency Analysis to Fisheries Management,
   Manuela M. Oliveira, Ana S. CAMANHO, Miguel B. Gaspar
2. Decomposing Economic Inefficiency in a Revenue setting: The Norwegian Ground Fishery,
   Kristin Helen Roll

Water Management , 17:00-18:30

Chaired by Corrado Lo Storto

1. What is the role of environmental factors in the cost efficiency of Swiss water distribution utilities?,
   Andrea Baranzini, Anne-Kathrin FAUST
2. Benchmarking local regulatory authorities: the case of integrated water services in Italy,
   Clementina BRUNO, Fabrizio Erbetta
3. Measuring efficiency in the Italian water management sector: an empirical analysis,
   Corrado lo Storto

JUNE 23rd, 2011 – DAY TWO

PLENARY SESSION. Peter Schmidt: Fixed effects estimation of the panel data stochastic frontier model, 09:00-10:30

Chaired by Léopold Simar. Discussants: Abdelaati Daouia & Mike Tsionas

SPECIAL SESSION. Good Modelling of Bad Outputs, 11:00-13:00

Chaired by Robert Chambers

1. On Modeling Pollution-Generating Technologies,
   Sushama Murty, R. Robert RUSSELL, Steven Levkoff
2. Good Modelling of Bad Outputs,
   Finn R Førsund
3. NETWORK TECHNOLOGIES WITH GOOD AND BAD OUTPUTS,
   Rolf Fare, Shawna GROSSKOPF, Carl Pasurka

Parametric Advances, 11:00-13:00

Chaired by Subal Kumbhakar

1. Estimation and Inference in Parametric Deterministic Frontier Models,
   Christine AMSLER, Michael Leonard, Peter Schmidt
2. A State Contingent Approach to Estimating Efficiency under Production Uncertainty,
   Teresa Serra, Robert G. Chambers, Spiro E. STEFANOU
3. Expected Ranks in Parametric Frontier Models,
   William HORRACE, Seth Richards-Shubik
4. Estimation and Decomposition of Inefficiency when Producers Maximize Return to the Outlay,
   Subal KUMBHAKAR, Frank Asche, Ragnar Tveteras

Advanced DEA II, 11:00-13:00

Chaired by Jesus T. Pastor

1. Common sets of weights as summaries of DEA profiles of weights,
   Nuria RAMON, José L. Ruiz, Inmaculada Sirvent
2. On the uniqueness issue of the slacks-based network DEA efficiency scores,
   Miki TSUTSUI, Kaoru Tone

3. Choosing weights of extreme efficient DMUs in DEA: A comparison of some proposals with application to the Spanish banking sector,
   Begona GONZALEZ-PEREZ, Enrique Lopez-Gonzalez, Cristina Mendana-Cuervo
4. On the non-oriented epsilon-based measure of efficiency in DEA,
   Kaoru TONE, Miki Tsutsui
5. Bounded Radial Models,
   Jesus T. PASTOR, Mette Asmild, Juan Aparicio, Javier Alcaraz

Macro Efficiency, 11:00-13:00

Chaired by Chris O'Donnell

1. Solow Residuals: Decomposition into Frontier and Excess Capacity Components,
   Betty DANIEL, Christain Hafner, Hans Manner, Leopold Simar
2. Comparative analysis of the Energy dependency, Efficiency and Productivity of the Manufacturing Industries: the case of Iran,
   Ali EMAMI MEIBODI, Mojtaba Esfandiari Kaloukan, Zahra Zakeri
3. Efficiency of Factor Allocation and Aggregate Productivity: Cross-Country Evidence in Manufacturing,
   Addisu Abebe Lashitew
4. The Sources of Productivity Change in the Major Sectors of the U.S. Economy,
   Chris O'Donnell

University, 11:00-13:00

Chaired by Emili Grifell-Tatjé

1. The Dynamics of Labor Productivity in Swiss Universities,
   Thomas BOLLI, Mehdi Farsi
2. Comparing German and Italian universities: Convergence or divergence in the higher education landscape?,
   Tommaso Agasisti, Carsten POHL
3. DYNAMIC ANALYSIS OF PRODUCTIVITY IN HIGHER EDUCATION: CASE STUDY OF BELARUS,
   Alexander Gedranovich, Mykhaylo SALNYKOV
4. A Cost Constrained approach to asses Efficiency and Productivity Growth for the Mexican State Universities.,
   Pablo Arocena-Garro, Emili Grifell-Tatjé, Herberto RODRIGUEZ-REGORDOSA

School, 11:00-13:00

Chaired by Kathy Hayes

1. The optimal allocation of resources for secondary education schools,
   Carla HAELERMANS, Kristof De Witte, Jos Blank
2. Measuring the efficiency of publicly financed schools in Spain: an unbiased comparison using propensity score matching,
   Eva CRESPO-CEBADA, Francisco Pedraja-Chaparro, Daniel Santín
3. The efficiency of public spending on secondary education: An empirical analysis,
   Tommaso Agasisti

4. Do Central Administrators Produce Local Public Goods?,
   Shawna Grosskopf, Kathy HAYES, Lori Taylor, Bill Weber

Sectorial Analysis I, 11:00-13:00

Chaired by Christophe Bontemps

1. Monitoring the productivity change of retailing stores,
   Clara VAZ, Ana Camanho
2. The Relationship Between Technical Efficiency and Industrial Concentration : Evidence from the Indonesian Food and Beverages Industry,
   Maman SETIAWAN, Grigorios Emvalomatis, Alfons Oude Lansink
3. FDI productivity spillover and technological gap in small versus large establishments in the Malaysian manufacturing sector,
   Noor Aini KHALIFAH, Salmah Mohd Salleh
4. Technical Change vs Efficiency Change: How do Food Industries Evolve over Time,
   Christophe BONTEMPS, Céline Nauges, Vincent Requillart, Michel Simioni

Energy, Environment and Eco-Efficiency, 11:00-13:00

Chaired by Diego Prior

1. Benchmarking countries environmental performance,
   Andreia ZANELLA, Ana S. Camanho, Teresa G. Dias
2. Measurement of environmental productivity and efficiency in the steam power generation of the Japanese electric utility firms,
   Jiro NEMOTO, Akiko Okamoto
3. Eco-efficiency and convergence in OECD countries,
   Mariam CAMARERO, Juana Castillo-Giménez, Andrés J Picazo-Tadeo, Cecilio Tamarit
4. Electric Utilities, Environmental Externalities and Cost Measured Productivity Growth,
   Gerald Granderson, Diego PRIOR

SPECIAL SESSION. Regulation of Local Monopolies in Electricity Distribution, 14:30-16:00

Chaired by Timo Kuosmanen

1. Application of the StoNED method in the regulation of electricity distribution in Finland: The regulator's perspective,
   Matti Ilonen
2. Cost efficiency analysis of electricity distribution networks: Application of the StoNED method in the Finnish regulatory model,
   Timo Kuosmanen
3. Implementation of Stochastic Frontier Models in Regulation: Some Lessons from the Finnish Regulatory Model of Electricity Distribution,
   Timo Kuosmanen, Sami PAKARINEN

Advanced Panel, 14:30-16:00

Chaired by Christin Amsler

1. A Finite Sample Improvement of the Fixed Effects Estimator of Technical Inefficiency,
   Daniel Wikström
2. A State-Space Stochastic Frontier Panel Data Model,
   Antonio PEYRACHE, Alicia Rambaldi
3. Using copulas to model time dependence in stochastic frontier models,
   Christine Amsler, Artem PROKHOROV, Peter Schmidt

Heterogeneity III, 14:30-16:00

Chaired by Carlos Arias

1. Estimation of an Endogenous Threshold,
   Hung-pin Lai
2. How to Measure the Impact of Environmental Factors in a Nonparametric Production Model?,
   Luiza BADIN, Cinzia Daraio, Leopold Simar
3. Econometric Problems in Identifying Class Switching in a Latent Class Model,
   Antonio Alvarez, Carlos ARIAS

Regulation I, 14:30-16:00

Chaired by Maria Laura Parisi

1. Knock-On Effect of Regulation on Manufacturing Sectors: a Stochastic Frontier Approach,
   Marco Fioramanti
2. Impact of regulatory standards on the eco-efficiency of firms,
   Francisca BAUER, Christoph Bremberger, Mikulas Luptacik, Stephan Schmitt
3. Service deregulation, competition and the performance of French and Italian firms,
   Francesco Daveri, Remy Lecat, Maria Laura PARISI

Explaining Health Efficiency, 14:30-16:00

Chaired by Hervé Leleu

1. Two-stage procedure based on data envelopment analysis to evaluate the efficiency of the Italian health system.,
   Arianna DE NICOLA, Simone Gitto, Paolo Mancuso
2. Analyzing scale efficiency estimates for Greek public hospitals: A system-of-equation two stage DEA approach,
   Roxani Karagiannis
3. Optimal productive size of hospital's intensive care units,
   Hervé LELEU, James Moises, Vivian Valdmanis

Energy and SFA, 14:30-16:00

Chaired by Scott Atkinson

1. US Residential Energy Demand and Energy Efficiency: A Stochastic Demand Frontier Approach,
   Massimo FILIPPINI, Lester Hunt

2. Estimating the cost of improving quality in electricity distribution: A parametric distance function approach,
   Tim Coelli, Axel Gautier, Sergio PERELMAN, Roxana Saplacan-Pop
3. Flexible estimation of firm production with multiple good and bad inputs and outputsPUTS,
   Scott ATKINSON, Dan Primont

SPECIAL SESSION. A Tribute to Sydney Afriat, 16:30-18:30

Chaired by Knox Lovell and Finn Forsund

1. Testing for separability in a DEA framework,
   Simone Pieralli
2. Value Data and Index Numbers,
   Robin CROSS, Rolf Fare
3. The role of convexity assumptions in weakly disposable DEA technologies,
   Timo Kuosmanen, Victor PODINOVSKI

Economic Growth and TFP Advances, 16:30-18:30

Chaired by Helmas Heshmati

1. Changes in Industrial Structure and Economic Growth in Japan,
   Sumio Hamagata
2. Does intangible capital affect economic growth?,
   Felix ROTH, Anna Thum
3. Corruption as a Source of Heteroscedasticity in Cross-Country Productivity Comparisons,
   Antti SAASTAMOINEN, Timo Kuosmanen
4. Efficiency change over time in amultisectoral economic system,
   Mikulas LUPTACIK, Bernhard Mahlberg
5. Exogenous Technical Change Modeled via Time Trend and Technology Shifters: Application to OECD Countries,
   AlmasHESHMATI, Subal C. Kumbhakar

Scale and Scope Economies, 16:30-18:30

Chaired by Sverre A.C.Kittelsen

1. Investigating economies of scope by robust non-parametric methods,
   Pedro CARVALHO, Rui Marques
2. Equivalences in Measuring Returns to Scale in Multi-output-Multi-input Technologies,
   Valentin Zelenyuk
3. A non parametric method for decomposing economies of scope into scale efficiency and product mix effect.,
   Mario FORTIN, Andre Leclerc
4. Bootstrapping scale elasticities and optimal scales in DEA,
   Dag F. Edvardsen, Finn R. Førsund, Sverre A.C. KITTELSEN

Non Convexity, 16:30-18:30

Chaired by Hal Fried

1. Container Ports Efficiency: A Robust Non-parametric Approach,
   Susila MUNISAMY, Wang Danxia
2. Nonconvex Nonparametric Least Squares Regression and its Application in Frontier Estimation,
   Abolfazl KESHVARI, Timo Kuosmanen
3. Discriminating efficient units using super-efficiency FDH,
   Shinn SUN, Shing-Cheng Hu
4. Predicting the Success of Entrepreneurial Ventures Using Order-m FDH,
   Harold FRIED, Loren Tauer

Research and Development, 16:30-18:30

Chaired by Russel Cooper

1. R&D Efficiency in Manufacturing: A Non-Parametric DEA Approach,
   PetraZLOCZYSTI, Jens Schmidt-Ehmcke
2. Toward an efficient use of R&D: Accounting for heterogeneity and dynamics in the OECD,
   Astrid CULLMANN, Petra Zloczysti
3. Efficiency analysis of knowledge infrastructure and export experience: The role of technology choice mode,
   Nizamettin BAYYURT, Sunil Sahadev, Mehmet Demirbag
4. R&D, ICT, and Endogenous Productivity,
   Nelli Valmari
5. Public IT Infrastructure, productivity and the Standard of Living - Implications for Advanced and Transitional Economies in the European Union,
   Russel Cooper

Services, 16:30-18:30

Chaired by Heike Wetzel

1. Efficiency of Non-profit Organizations: The Case of Russian Homeowners Associations,
   Ekaterina BORISOVA, Anatoly Peresetsky, Leonid Polishchuk
2. Efficiency and firm failure during the economic crisis: An analysis of the construction sector in Spain.,
   Magdalena Kapelko
3. Conceptualizing Service Network Productivity – A Looped DEA Approach,
   Jörg Becker, Dominic Breuker, Hans Peter RAUER
4. Baumol's Cost-Disease, Efficiency, and Productivity in the Performing Arts: An Analysis of German Public Theaters,
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Program committee

Program committee of the Young Researchers Pre-Conference (June 21st):
Antonio Alvarez, Cinzia Daraio, Luis Orea, Philippe Vanden Eeckaut, Alan Wall, Angelo Zago

Program committee of the main Conference (June 22-24th):
Cinzia Daraio, Philippe Vanden Eeckaut, Angelo Zago

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Note that for papers with more than one author, the presenting author is reported in capital letters

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Precise efficiency score estimation by using Data Envelopment and Stochastic Frontier Analysis - A systematic comparison and an evaluation of simple approaches to combine efficiency estimates

Mark ANDOR, Frederik Hesse, (Discussant: Finn Førsund)

YR Session A: SFA - Methods and Applications

Both researchers and policy makers are in certain circumstances faced by the challenge to determine individual efficiency scores for every decision making unit under consideration. In these cases the rank correlation, in numerous studies the performance criterion, is of secondary importance and the estimation of the individual efficiency score has to be as precise as possible. In this study we use a Monte Carlo simulation to analyze the optimal approach to determine individual efficiency scores. While there exists an abundant literature, which compares the two most popular estimation methods, data envelopment (DEA) and stochastic frontier analysis (SFA), using empirical data, simulation studies using cross sectional data are relatively scarce. Banker et al. (1993) is the first study analyzing the performance of DEA and a stochastic frontier model within a wide range of different settings. In analogy, Ruggiero (1999) and Jensen (2005) compare the deterministic COLS and the SFA.

Motivated by the statement of Ruggiero (1999), that it would be an useful extension to analyze DEA and SFA across situations not considered in Banker et al. (1993), our first research objective is a systematic comparison of the two methods using cross sectional data. Hereby we extend the existing comparisons in several ways. Thus, we are able to identify the factors of influence on the performance of the methods and give additional information about the reasons for the performance variations. Due to the fact that none of the methods is absolutely superior, the combination of the estimates of DEA and SFA is seen as 'best-practice' in real-world application, like energy incentive regulation systems. Despite the fact that this procedure is also suggested in the efficiency analysis literature, it was not analyzed in simulation studies before. Hence, in a second step, we compare approaches to transform the estimates into efficiency scores with the elementary estimates of the methods.

We use a Monte Carlo simulation to compare DEA, SFA and combination approaches.

We want to highlight two important results of the first investigation step: * The distribution of the inputs has an influence on the performance of DEA. * Our results suggest that the misspecification of the production function does - in the majority of cases - not considerably affect neither the SFA nor the DEA. We show that the different performance criteria are leading in certain circumstances to diverging conclusions and some factors have contrary influence on the different criteria. If users are faced by the challenge to determine individual efficiency objectives, the mean absolute deviation should be prioritized. Our results demonstrate that combination approaches can be actually 'best-practice' for estimating precise efficiency scores. We demonstrate that the simple mean of the two methods is a compromise, which outperforms the estimates of both methods.

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Banker, Gadh, and Gorr (1993). A Monte Carlo comparison of two production fron- tier estimation methods: Corrected ordinary least squares and data envelopment analysis. European Journal of Operational Research, 67:332-343.

Jensen (2005). Misspecification Preferred: The Sensitivity of Inefficiency Rankings. Journal of Productivity Analysis, 23:223-244.

Ruggiero (1999). Efficiency estimation and error decomposition in the stochastic frontier model: A monte carlo analysis. European Journal of Operational Research, 115:555-563.

Measuring Capital for Micro and Small Enterprises in Indonesia

Anne Prestvik, (Discussant: Christine Amsler)

YR Session A: SFA - Methods and Applications

Micro and small enterprises (MSEs) in developing countries are policy relevant as they provide employment and livelihood to a great number or people. Their advocates see them as more productive, labor intensive and flexible than large enterprises, but they are also believed to inefficient and hiding unemployment in a large informal sector. For these reasons, productivity analysis of MSEs is interesting and included in efficiency studies of micro survey data. However, micro data from developing countries frequently suffers from missing observations and measurement errors. Most MSEs are informal and do not have to report neither income nor capital stock to any formal institutions. The result may be incomplete data on input and output based on memory. The measure of capital stock is particularly challenging and often left out of industrial censuses because of its complexity in measurement.

Researchers have solved and avoided the problem of measuring capital in different ways. The most detailed studies include sufficiently detail data to use the perpetual inventory method which have its own weaknesses. When data is missing, measures of replacement costs of capital, physical measures or energy use is used as a substitute for the capital measure. However, using imperfect data may lead to selectivity bias and in worst cast inconsistent estimators. Tybout (1992) proposes a method to correct for the missing data problem by using an instrument for capital stock and a maximum likelihood estimator of the production technologies.

This paper attempts to find the best way of measuring capital in micro and small enterprises by using different methods of making the capital measurement, among them the perpetual inventory method (PIM), a physical measure and a simple aggregation of the capital stock. The data used is from a cross sectional survey of 250 small wood furniture enterprises in a district in Indonesia. Detailed data of investment flow is present for about half of the sample, effectively halving the sample when PIM is used to measure capital. Stochastic frontier analysis of the production function will be used to investigate the suitability and sensitivity of the capital measures. However, with a less than perfect measure of capital, production efficiency is not likely correctly measured. Therefore, an adaptation of the method presented by Tybout (1992) will also be applied.

The different methods of making the capital measure are not expected to yield significantly different results in the stochastic frontier analysis. The maximum likelihood function is expected to yield significantly different estimators and coefficients, suggesting that measures based on the capital stock are only crude substitutes of the true capital input.

Tybout, J. R. (1992). "Making noisy data sing : Estimating production technologies in developing countries." Journal of Econometrics 53(1-3): 25-44.

Consistent estimation of a true fixed-effects stochastic frontier model

Federico BELOTTI, Giuseppe Ilardi, (Discussant: William Horrace)

YR Session A: SFA - Methods and Applications

The classic Stochastic Frontier (SF) panel data models provide no mechanism to disentangle individual unobserved heterogeneity from inefficiency. Greene (2005) proposes two new specifications, termed as "true" SF models, which distinguish these two latent components and allow a time varying inefficiency distribution. However, the true fixed-effects variant may produce severe biased estimates due to the incidental parameters problem. Recently, Wang and Ho (2010) proposed a solution for a restricted class of SF models with unobserved heterogeneity using a marginal maximum likelihood approach. Their estimator is based on a first-difference transformation before the marginalization of the inefficiency term from the joint distribution of the inefficiency and the idiosyncratic error.

The resulting estimator is a valid proposal in terms of finite sample performances, but it relies on the assumption of a deterministic time variability of the inefficiencies which restrains the direct applicability to the original Greene's model.

In this work, we propose two consistent inferential procedures for the true fixed-effects specification, namely Marginal Maximum Simulated Likelihood and Pairwise Difference estimators.

The first is based on the marginalization of the inefficiency term via simulations. We propose to estimate the first-differenced model using the method of maximum simulated likelihood treating the marginal likelihood function as an expectation of a multivariate random variable. As in the Wang and Ho (2010) case, we are forced to impose a technical restriction in order to use the simulated likelihood principle: the parameter of the inefficiency distribution cannot be expressed in terms of time variant exogenous explanatory variables. This assumption may appear reliable in certain economic applications and in short panel.

In the second inferential procedure, we propose a different estimation solution by exploiting the analytical closeness property of the marginal likelihood in the case of T=2. This estimator is defined as maximizer of a second-order U-statistic built from all the pairwise quasi likelihood contributions. This procedure leads to a computationally efficient M-estimator which requires no additional restrictions beyond those stated in the Greene's model.

By relying on the first-difference transformation, both proposals eliminate the nuisance parameters achieving the consistency also for N –> INF with fixed T. Evidence from Monte Carlo simulations shows accurate finite sample performances in terms of bias and MSE even in presence of a limited number of individuals.

Greene, W. (2005). Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. Journal of Econometrics, 126, 269-303.

Wang, H. and Ho, C. (2010). Estimating fixed-effect panel stochastic frontier models by model transformation. Journal of Econometrics, 157, 286-296.

Demand uncertain, excess of capacity and allocative efficiency: an application to the Spanish Port Authorities in the period 1986-2007

Soraya HIDALGO-GALLEGO, Ramón Núñez-Sánchez, (Discussant: Sergio Perelman)

YR Session B: Services - Parametric Applications

Spanish ports of general interest are managed by a Landlord port authority model. This management system is characterized by the public sector owns the infrastructure, but as many activities as possible are realized by the private sector. One of the main features of port infrastructure is its indivisible nature, this means that port infrastructure can't adapt immediately to changes in demand, therefore port authorities should maintain excess of capacity to prevent unexpected increases in demand. This paper tries to analyze the impact of port demand variability on the allocative efficiency of the Spanish port authorities during the period 1986-2007. From a distance function model we can obtain a measure of allocative efficiency using two different approaches: error components approach and parametric approach. This paper is the first one modelling the port demand variability from the cyclical component of traffic series by applying the Hodrick-Prescott filter. The results show that the inclusion of variability does not affect the efficiency measures, except in the case of containerized general cargo. Moreover, we demonstrate that port authorities have excess of capacity and their resources are misallocated, this is difficult to resolve given the limited substitution possibilities among the different pairs of inputs.

Does weather matter on efficiency and productivity? An empirical analysis of the Electricity Distribution Market in South America

Karim Anaya, (Discussant: Philippe Vanden Eeckaut)
YR Session B: Services - Parametric Applications

The paper remarks the importance of international benchmarking as an instrument for better regulation when proper comparisons are made. The application of international benchmarking by regulators increases competition and incentives utilities to be more efficient.

This is the first study that aims to measure companies' efficiency and productivity in the South American region using parametric methods, including quality and weather variables. In addition to the traditional outputs and inputs, the inclusion of quality and weather variables would provide new findings regarding their effect on efficiency and productivity. The study involves a total of 82 electricity distribution utilities from Argentina (18), Brazil (39), Chile (11) and Peru (14), which account for more than 90 per cent of the total energy delivery in these markets. Weather data was collected from 428 meteorological stations and 3,423 coordinates from NASA (flash rate), period 1998-2008.

Stochastic Frontier Analysis (SFA), a parametric approach, is used for evaluating efficiency. Stata and Frontier software are used for this purpose. In contrast with the deterministic approach, this method allows to split up the error term into a stochastic component and inefficiency term. An input distance function was selected due to its characteristic to accommodate multiple inputs and outputs. This function is more appropriate when companies have more control on inputs than on outputs. The translog approach is commonly used due to its flexibility and capacity to apply the homogeneity constraint. Panel data specification is adopted due to the availability of time series data. This relaxes the strong distributional assumptions made when cross sectional data is used, Kumbhakar and Know Lovell (2000). Battese and Coelli (1992) approach is followed for computing technical inefficiency. Under this method a common trend is allocated to all utilities. Two different methods are used to incorporate weather variables: (1) in production and (2) in inefficiency. For a better discussion the results will be compared with those calculated when pooled-frontier regressions (half normal and truncated distribution) are selected. The stochastic frontier estimators will be used for calculating total factor productivity change. The general method developed by Orea (2002) but related to the input distance function, is used for this purpose.

Preliminary results show that the inefficiency component is statistically significant, that means companies are not fully efficient. Efficiency scores from cost-quality models are higher than those from pure cost models. Weather variables such as maximum and minimum temperatures and total rain, are among the variables that could explain companies efficiency. Companies from Brazil and Peru are those which operate in less favourable weather conditions. Under the cost-quality models the effect on average is much lower. From this appears to be that companies have internalised the effect of weather and have adapted their networks considering their own environment. In terms of total factor productivity change, weather produces a small variation in comparison with its influence on technical efficiency.

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How to compete in the Higher Education Market? - Empirical Evidence for Economies of Scale and Scope of German Higher Education Institutions

Maria OLIVARES, Heike Wetzel, (Discussant: Gary Ferrier)
YR Session B: Services - Parametric Applications

The enlargement of university autonomy and with it an increasing responsiveness on the use of financial resources has changed the higher education sector substantially. In particular, as the public authorities' interest seems to be creating an environment of quasi-markets more severe competition pressures publicly financed universities to use

their acquired funding sources efficiently. Stronger than in the past, and especially due to recent funding constraints and the expansion of higher education, universities increasingly compete for external funding, high potential academic personnel and students in order to achieve e.g. a high research impact and ranking position. In fact, higher education institutions aim to position in the market by differentiating more and more against their competitors. There is a horizontal differentiation observable in a sense that universities differ with respect to the subject mix they offer and the orientation of being rather teaching, research orientated, or being a full university with a combination of teaching and research activities. Assuming an effect of differential strategies by positioning on the market against competitors, this paper explores the existence of economies of scale and scope of higher education based on efficiency measures. Using a stochastic frontier analysis approach, we estimate the technical efficiency for German higher education institutions throughout the period of 2001-2007. We use an extensive panel data set at discipline level with detailed information on input and output measures such as scientific and non-scientific personnel, research grants, the number of students, as well as information on environmental determinants.

Separating Environmental Efficiency into Production and Abatement Efficiency - A Nonparametric Model With Application To U.S. Power Plants

Benjamin Hampf, (Discussant: Timo Kuosmanen)

YR Session A: Enviromental Efficiency

In the last two decades the measurement of environmental efficiency of decision making units (DMUs) has become one of the major issues in the field of nonparametric efficiency evaluation. Since the traditional approaches like data envelopment analysis (DEA) do not account for the unintended production of undesirable outputs like pollutants, a majority of papers deals with different ways to incorporate emissions in nonparametric efficiency analysis. Most of these approaches treat the DMUs as black boxes which use inputs and produce desirable and undesirable outputs. Environmental efficiency is analyzed without taking into account that the DMUs produce good outputs and try to abate emissions in different stages, which is the basic idea behind classic end-of-pipe abatement technologies (e.g. scrubber technologies). Moreover, these approaches have in common that they neither formulate an explicit production nor an abatement process of the emissions (see Forsund (2009) for critical remarks). In this paper we propose a model that allows separating the environmental efficiency of DMUs, which use an end-of-pipe technology to reduce their undesirable outputs, into production and abatement efficiency. We divide the overall production process into two sub-technologies, the production technology where the DMUs use both polluting and non-polluting inputs to produce the good outputs which also results in the production of undesirable outputs, and an abatement technology where the DMUs reduce the amount of pollutants that are released to the environment. Since the amount of these undesirable outputs before abatement is mostly non-observable for the researcher, we incorporate the materials balance condition (MBC) to estimate the amount of emissions (see Coelli et al. (2007) for an application of the MBC in nonparametric efficiency analysis). To analyze the environmental efficiency of the DMUs we propose a new environmental efficiency measure that can be decomposed into production and abatement efficiency, and evaluate it using a two-stage DEA similar to the model by Sexton and Lewis (2003). We show how different efficiency measures (e.g. input distance functions or hyperbolic efficiency measures) can be applied to analyze the efficiency of the production stage of the DMU, hence the productive efficiency. The efficiency of the abatement activities is evaluated for the hypothetical situation that the DMU operates efficient in the first stage. For an empirical example, we apply our model to U.S. fossil-fueled power plants using data for the year 2009. Preliminary results show, that the abatement and the environmental efficiency of the power plants differs far more among the DMUs than the productive efficiency.

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The US Agriculture Greenhouse Emissions and Environmental Performance

Tshepelayi Kabata, (Discussant: Shawna Grosskopf)

YR Session A: Enviromental Efficiency

This study aims at assessing the environmental performance the U.S. agriculture with respect to GHG emissions across states. To reach this objective, this paper utilizes alternative non-parametric approaches. The graph measure of technical efficiency accounting for undesirable outputs reveals that regulations of agriculture GHG emission would be effective in all states but Delaware, as they would be binding and impose a 'cost' in terms of reduction of desirable output. Results show also that on average regulations would improve technical efficient for about 3.5%. States operating on the frontier shift from one to seven when the regulation is accounted for. But the opportunity cost of binding to this regulation amounts to 3.7% reduction of agricultural output. The Malmquist index and its components reveal that on average the efficiency change has been invariant to the treatment of the undesirable output as input. The average productivity growth is 2.2 percent when GHG emissions are treated as inputs whereas it is 2 percent when they are complementally ignored. In both cases, the productivity growth is driven by technological change.

Analysis of the Effects of Soil Organic Matter (SOM) on Efficiency and Agricultural Productivity

Kepifri Lakoh, (Discussant: Sergio Destefanis)

YR Session A: Enviromental Efficiency

There has been rapid growth in the biofuel industry over the past seven years. While this creates a ready market for Nebraskan farmers, there are concerns over how technically and environmentally efficient are the more intensive farming practices that have ensued. These concerns have been mainly for the sustainable growth of production. This study therefore aims at estimating technical and environmental efficiency ("TE" and "EE") across some counties in Nebraska. We also estimate total factor productivity ("TFP") for these counties for the period 1960 to 2008. Statistical cluster analysis was then carried out over these three efficiency measures to determine the most efficient performers and create a platform to understand how other factors like irrigation, soil composition etc. might account for efficiency and productivity differences. While the vast literature on "EE" measures have treated environmental impacts as an undesirable output (Färe et al., 1989, 1996, 2004, Tyteca (1997).. etc.), in this case we argue that an important environmental impact is changes in the soil structure. Soil organic matter (SOM) has been the most known natural component of maintaining or improving soil structure. (FAO Soil Bulletin 2005). SOM does not only determine production levels but also the carbon sequestering potentials of the particular soil. We therefore use an index of SOM as our proxy for environmental impact. The SOM index was developed collectively by the Agronomy and Soils Science Departments of the University of Nebraska in Lincoln. This index is constructed using data from the Soil Survey Geographic (SSURGO) Database. This study used county-level data from 36 counties obtained from the National Agricultural Statistics Service (NASS) and NRCS. Variables include two outputs (Corn

and Soybeans) and three "conventional" inputs (Land, Fertilizer and Chemicals) and one "nonconventional" Input (SOM). SOM becomes an environmental problem when SOM is in limited proportion in the soil. More formally it is defined as an input whose reduction in supply is unfavorable for the production process (i.e. f(x) = delta x where delta is positive). EE is a measure of the ability of a county to decrease conventional inputs and increase "nonconventional inputs" while increasing the level of output. Here we model EE as graph measure and TE as an input based measure as described in Fare et. al. (1996). "TFP" is estimated by a simple nonparametric Input-based Malmquist productivity index using DEA as outlined in Fare et al (1994) and disaggregated into Pure Technical Change and Efficiency Change. From our results, twelve counties were environmentally and technically efficient while at the same time being the most productive. These were Franklin, Adams, Thayer, Lancaster, Saunders, Cuming, Antelope Wheeler, Cedar, Johnson, Burt and Holt counties. The cluster analysis showed very useful clusters that explains several accompanying trends. For instance, Franklin, Adams, Thayer, Webster and Buffalo happen to represent a group of counties that had the highest rainfall in 2008. From the clustering results, all five of these counties formed one cluster given the three performance measures used. A similar sub cluster was also observed for counties with the lowest rainfall.

Information Technology and the International Productivity Gaps

Tero Kuusi, (Discussant: Robert Russell)

YR Session B: Innovation and ICT

This paper deals with recent industry-level empirical findings, which imply that an increase in ICT intensity is not positively correlated with multi-factor productivity (MFP) growth in ICT-using industries, the largest cause of cross-country growth differentials. As MFP measures growth in output when input growth has been accounted for and thus is associated with the potential spillovers from the use of inputs, the result is somewhat controversial. A well-established literature on the effects of ICT suggests that its use should provide pecuniary benefits. This paper postulates that even in absence of the positive correlation ICT is still a very important source of the growth differentials, because 1) The potential of the technology provides pecuniary benefits for those, who use ICT with the best practices and 2) catching-up the best users of ICT by investments is difficult due to friction in the adaptation of the technology.

It is well-known fact, that the new technology, although potentially increasing productivity, requires additional resources to deploy organizations in radically different and productivity-enhancing ways (Bresnahan et al., 2002). This paper contributes to the hard task of measuring the potential of the technology and the related frictions separately. The paper builds on the idea that the "true" potential of ICT can be measured by observing the productivity of the best-practice users of ICT. Following the efficiency analysis literature, the best practice users can be defined as the most efficient users of inputs and found with the DEA.

The EU-KLEMS industry data used in this paper shows strong heterogeneity in the productivity growth performance of industries with similar input combinations, which implies that the best practice frontier may be very different, compared to the average performance of the industries. To analyze these differences systematically, the components of productivity growth are decomposed to input factor accumulation (a measure of the potential) and multi-factor productivity (a measure of technological change and the frictions). In practice, a growth factorization introduced by Kumar and Russell (2002) is used. The estimations are based on a panel data of ICT -using manufacturing and service industries covering the period between years 1990 and 2005, as provided by the EU-KLEMS project.

This study proceeds then to investigate a series of hypotheses concerning average qualities of production technologies and frictions in the adaptation of technology. A battery of econometric tests using IV approach robust to the DEA errors indicate that ICT exceeds its nominal factor share, when inputs are used with best practices, but on average the investments are associated with falling behind the efficient frontier.

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An analysis of ICT-enabled innovation in Norwegian firms: Are ICT users more innovative?

Marina Rybalka, (Discussant: Jaap Bos)

YR Session B: Innovation and ICT

Business innovation is regarded as a key determinant of both individual business success and national economic growth. At the micro level, business innovation has the potential to increase consumer demand through improved product or service quality and simultaneously decrease production costs. At the macro level, strong business innovation increases multifactor productivity thus lifting international competitiveness, economic growth and real per capital. Therefore, it is of great interest to businesses and policy makers alike, to identify those factors which stimulate innovation and to understand how these factors interact.

Information and communications technologies (ICT) provide substantial efficiency gains and have the potential to increase innovation by speeding up the diffusion of information, favouring networking among firms, enabling closer links between businesses and customers, reducing geographic limitations, and increasing efficiency in communication. Previous analysis confirms that ICT play an important role in enabling business innovation, e.g. Crespi et al., 2007; Van Leeuwen, 2008; Polder et al., 2009. These studies evaluating effects of ICT use and innovation on productivity, however, do not directly focus on the link between ICT use and innovation.

The aim of this study is to assess the effects of ICT as an enabler of innovation in Norwegian firms. Do effects differ for different types of innovations? Four types of innovations are under investigation: a new (or improved) product, a new (or improved) production process, an organisational innovation and a new marketing method. One obviously important factor behind innovations is R&D, but it is not the only one. The availability of high-skilled workers is another important factor. Both these factors I control for in the analysis. Moreover, the effects of ICT use can vary depending on the firm's size and industry. To investigate this variation I control for the firm size and provide the analysis for manufacturing firms and firms in services separately. Through a series of logistic regressions I test a set of hypotheses about the effects of ICT use on innovation, grouped under 3 themes:

* Innovation capabilities; * Innovation trajectories; * Cooperation in innovation.

For the analysis, I use Norwegian microdata covering firms included in the 2004 and 2006 innovation surveys and in the 2003-2006 ICT business surveys. Innovation surveys contain information on the inputs and outputs of firms' innovative activities, whether the design of the ICT business survey is to show how good the access to ICT is and how these technologies are used in the firms. These data were supplemented with information from different registers.

The results of this study support the hypotheses that ICT act as an enabler of innovation, in particular for marketing innovation and for innovations in services. However, I did not find any evidence that ICT use increases the capability of a firm to cooperate with other firms/institutions nor that ICT intensive firms have higher capacity to introduce more "innovative" (new-to-the-market) products. These results suggest that ICTs enable firms to adopt innovation but they do not increase their "inventive" capabilities, i.e. the capability to develop truly new products.

An efficiency approach to innovation systems

Monica MIhaela Matei, (Discussant: Cinzia Daraio)

YR Session B: Innovation and ICT

Innovation is a complex phenomenon which has a systematic nature and it is considered one of the main drivers for sustained economic growth. The innovation system is a concept defined by Lundvall as "the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge located within or rooted inside the borders of a nation state". We think that ranking countries according to their innovation system performance may represent an useful tool for the policy makers who design and implement innovation policies. We present in this paper an evaluation based on the information provided by European Innovation Scoreboard (EIS) which is one of the instruments designed to understand the sources and patterns of innovative activity. The innovation systems are ranked according to their efficiency scores obtained from an output oriented DEA model. A bootstrap algorithm was used in order to test the return to scale, to estimate the bias and the 95We propose a ranking based on bias corrected estimates of the efficiency scores. This shows that the countries considered innovation leaders, because their innovation performance reflected by Summary Innovation Index is well above that of EU average, are not also technically efficient when transforming innovation inputs into innovation outputs.

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Classic and bayesian stochastic frontier analysis for the Italian water sector

Valeria Di Cosmo, (Discussant: Mike Tsionas)

YR Session A: Public Sector

The Italian water sector is characterized by the presence of several water companies, with different ownership types; Fabbri and Fraquelli (2000) and Antonioli and Filippini (2001) have analyzed the presence of economies of scale and scope in the sector. In recent years, the Italian water sector has been subject to a large reorganization, following the implementation of the EC Directive 60/00 for the harmonization of the pricing rules and polluting principles of the Member States. However, the reorganization of the sector is far from being accomplished, and the Italian water companies still face strong regulatory uncertainty associated with the absence of an independent authority. The lack of clear regulatory principles and the presence of almost 100 different companies managed differently across the territory requires the re-analysis of the possible sources of inefficiencies, in order to understand what kind of policy measures might be implemented to improve the performance of the water utilities. This paper estimates both a classical and bayesian stochastic frontier to empirically investigate the main sources of inefficiency for a sample of 65 Italian water companies. Firstly, this paper investigates whether a positive relationship exists between the firm's ownership type and efficiency; secondly, this paper investigates whether the presence of economies of scale in the Italian water sector still exist after the merging process that recently took place as part of the sector reorganization. The estimation results show that ownership is not related to the firm's performance and that the Italian water sector is still characterized by the presence of economies of scale. This result indicates that local communities may benefit from merging into larger water districts.

Private Partners in the Waste Sector: Opportunists or Allies?

Pedro SIMÕES, Rui Marques, Pedro Carvalho, (Discussant: David Saal)

YR Session A: Public Sector

Private sector participation has grown uncontrollably (and often in an unregulated fashion) in the waste sector in Portugal and elsewhere, especially as far as refuse collection entities are concerned. However, this circumstance raised some doubts about the actual benefits for the sector. The conclusions on the effects of privatization are mixed. A priori, the main reason for this option relies on better performance.

This paper intends to evaluate the effects of private sector participation in the Portuguese waste sector, including both 'retail' (refuse collection) and 'wholesale' (waste treatment) markets. The data was collected from 228 utilities: 32 regional entities in charge of waste treatment (for the period between 2001 and 2008 covering the whole population of the country), and 196 local entities responsible for refuse collection (for the year 2008).

An efficiency and productivity analysis was carried out in the 'wholesale' market, while the 'retail' market was only subject to an efficiency analysis. We used the traditional robust non-parametric benchmarking techniques to estimate the efficiency and productivity of both 'wholesale' and 'retail' markets, such as the data envelopment analysis (DEA), Malmquist indexes and the bootstrap and order-m approaches. Moreover, we adopted a new statistical test (adapted from the Li statistical test) which uses the robust non-parametric method of order-m instead of full frontier methods, such as DEA, in order to allow for the comparison of the efficiency distributions of public and private waste firms rather than making comparisons only based on averages or medians (Carvalho and Marques, 2011).

We concluded that although the benefits of private sector participation are quite clear in the 'retail' market, the outcomes in the 'wholesale' market are not so evident as expected.

Measuring Local Governments' Spending Efficiency: An Application to French Counties

Stefan SEIFERT, Maria Nieswand, (Discussant: Kris Kerstens)

YR Session A: Public Sector

The efforts being undertaken by France during the last decades towards broader decentralization has led to greater autonomy of subordinate government tiers associated with additional responsibilities and duties. The Counties (départements), which constitute the intermediate governmental tier between regions (régions) and municipalities (communes) are now in charge of a larger variety of local public services, e.g. social services and education infrastructure. Furthermore, counties play a major economic role with total public spending of more than 60 billion Euros in 2008. With regard to the ongoing financial pressure in public budgets an efficient use of such resources is crucial. This paper applies non-parametric efficiency analysis and second stage regression to analyze the spending efficiency and its determinants for a unique data set comprising the 96 Counties in metropolitan France between 2004 and 2008. To our knowledge, this is the first empirical analysis of spending efficiency on the intermediate government level. Thus, it provides distinct insights regarding public spending. A large body of literature investigates government spending efficiency using well-established efficiency measurement techniques, i.e. Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). Existing analyses, however, mainly concentrate either on cross-country comparisons (e.g. Afonso et al., 2005) or on small local entities, e.g. municipalities (e.g. De Borger and Kerstens, 1996). The public sector itself might not operate like other decision making units such as firms. Therefore, standard microeconomic concepts, e.g. production functions and cost minimizing behavior, would not apply. Hence, particularly two questions are addressed by the

existing literature: i) how to model the transformation process of inputs to outputs, ii) how to measure inputs and outputs. Furthermore, determinants of the performance are considered. This paper applies DEA and adopts recent approaches in describing public sector inputs, outputs and technologies in the context of the intermediate government level. Investigation of performance determinants has predominantly been tackled by Tobit regression. In order to overcome estimation biases due to serial correlation, we apply the bootstrap truncated regression proposed by Simar and Wilson (2007). This paper uses two financial indicators to approximate the governments' input, i.e. total expenditure and current expenditure, respectively. Governments' output is measured by different variables related to the main tasks of French counties, i.e. education infrastructure, care for elderly, social welfare, road construction and maintenance and general administrative tasks. Furthermore, following Afonso et al. (2005), we combine all outputs into a single indicator to evaluate the results obtained with a more general measure. In the second stage, efficiency scores are used to evaluate the impact of geographical, economic and political variables, which are assumed to be strictly exogenous to the transformation process. Preliminary results show notable spending inefficiencies for French counties. The second stage regression suggests that geographical and economic factors have significant impact on the counties' performance, while political variables do not. These findings are robust across different model specifications: the efficiency distributions are found to be similar and to possess rather high rank correlations.

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The sensitivity of total factor productivity decomposition to different stochastic frontier approaches.

Magnus Kellermann, (Discussant: Peter Schmidt)

YR Session B: Productivity Growth

Agricultural production is characterized by heterogeneous natural conditions (e.g. soil quality, altitude, precipitation, temperature, length of growing season, etc.). This heterogeneity has to be taken into account, to obtain meaningful results when firm specific efficiency and productivity measures are of interest. Various panel data models are described in the literature to tackle this issue in a stochastic frontier setting. In recent years several authors, e.g. Farsi et al. (2005) have compared the performance of conventional stochastic frontier panel data models and the "true" panel data models more recently introduced by Greene (2005). The main focus of these studies is on the models abilities to distinguish unobserved heterogeneity from inefficiency to produce unbiased efficiency scores. The aim of this paper is to extend this comparison for the case where different models are used to analyze total factor productivity (TFP) change in a panel data set. To do so, we apply a number of different stochastic frontier models to a fairly rich data set of more than 1600 dairy farms in an unbalanced panel, covering the years 2000 to 2008. The number of observations for each farm varies from 4 to 9, resulting altogether in 12182 observations. Translog output-oriented distance functions are utilized to represent the production technology. Based on the estimated parameters and the inefficiency estimates we use a generalized Malmquist index to decompose the sources of TFP change into technical progress, changes in technical efficiency and a scale effect. The different abilities of the models to derive unbiased coefficient estimates and to disentangle both, unobserved heterogeneity from inefficiency and technical change from changes in technical efficiency leads to various potential sources of variation in the respective TFP results. Models that fail to take unobserved heterogeneity into account are likely to produce coefficient estimates that are biased by omitted firm-specific variables. This may lead to biased production elasticities. Other models that produce unbiased coefficient estimates may be unsuitable as they produce time-invariant efficiency scores or

are unable to distinguish between unobserved heterogeneity and inefficiency. The formulation proposed by Kuenzle (2005) which extends Greene's "true" random-effects model with Mundlak's (1978) approach, showed promising results to overcome the aforementioned shortcomings in previous applications. First results from our data set support findings of previous studies. In regard to TFP results, we find substantial differences for the different models. We conclude that the choice of the model can play a crucial role if results are used to explain and decompose TFP growth.

On the external drivers of TFP: The Italian case

Gianluca Santoni, (Discussant: Carlos Arias)

YR Session B: Productivity Growth

The productivity of firms can be determined not only by internal factors but also by external elements. In fact, the variability in productivity between firms, given their equal internal conditions (such as management, human capital and the use of particular technologies) can be largely explained by external drivers. However, in a country with large disparity in infrastuctural endowment, such as Italy, these aspects could have a greater impact. A Survey conducted by the Bank of Italy in 1997 shows that the 95% of entrepreneurs operating in industrial districts were born in the area where they operate. The aim of this study is to investigate the impact of external factors on the Total Factor Productivity (TFP) of Italian firms, given the fact that entrepreneurs tend to choose their natal province to establish their firm. The analysis is conducted at province level, using structural indicators of the local economic environment and firm-level data (taken from AIDA), over the period 2000-2008. I apply a panel technique with appropriate control for grouped errors at province level. Results show that, controlling for the relevant individual characteristics, the infrastructure endowment, as well as financial and communication capability of a province, is a key determinant of firm productivity and growth.

The Returns to Scale Effect in Labour Productivity Growth

Hideyuki Mizobuchi, (Discussant: Bert Balk)

YR Session B: Productivity Growth

Economists broadly think of productivity as measuring the current state of the technology used in producing the firm's goods and services. Hence productivity growth is often identified by the shift in the production frontier, reflecting changes in production technology. However, even in the absence of changes in the production frontier, changes in the inputs used for production can lead to productivity growth, moving along the production frontier and making use of its curvature. Productivity growth that is induced by the movement along the production frontier is called the returns to scale effect. Labour productivity relates labour inputs to outputs, holding technology and capital services fixed. The short-run production frontier, which consists of labour inputs and the maximum output attainable from them, represents the current state of technology to translate labour inputs to outputs. Both technical progress and capital input growth, which have been identified as the sources of labour productivity growth, induce labour productivity growth throughout the shift in the short-run production frontier. However, the returns to scale effect, which is the extent of labour productivity growth induced by movement along the short-run production frontier, has never been exposed. We decompose labour productivity growth into two components: 1) the joint effect of technical progress and capital input growth, 2) the returns to scale effect. First, we propose theoretical measures representing the two effects by using distance functions. Second, we derive the index number formulae consisting of prices and quantities and show that they coincide with theoretical measures, assuming a

translog functional form for the underlying technology and the firm's profit maximizing behaviour. Our approach to implementing theoretical measures is drawn from Caves et al. (1982). Using the distance function, Caves et al. (1982) formulate the (theoretical) Malmquist productivity index, which measures the shift in the production frontier, and show that the Malmquist productivity index and the Törnqvist productivity index coincide, assuming the translog functional form for the underlying technology and the firm's profit maximizing behaviour. They also derive the returns to scale term if the underlying technology does not exhibit constant returns to scale. Triplett and Bosworth (2006) observed that labour productivity growth in the service sector was much less than in the service sector in U.S. economy since the early 1970s. As we discussed above, there are two underlying factors to LP growth; therefore, two explanations are possible for the low LP growth in the services sector: 1) the joint effect of technical progress and increases in capital inputs is modest, or 2) an increase in labour inputs induces negative returns to scale effects. We apply our decomposition result to U.S. industry data in the period 1987-2007 to compare the relative contributions of the two effects.

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Market Structure and the Sources of Labor Productivity Growth

Jeremy Mallen, (Discussant: Federico Perali)

YR Session B: Productivity Growth

In this paper, I analyze how the micro-foundations of Labor productivity growth vary across time and across French industries. Helpful the decomposition of Labor productivity growth, I propose to distinguish the restructuring macroeconomic processes. In other words, when the French manufacturing sectors are drove by an internal restructuring effect characterized by the idiosyncratically firm's growth or when are drove by an external restructuring effect characterized by the firm's selection effect. I try to approximate the influence of the sectoral's parameters on these restructuring process like Teixera and Carreira (2004).

The firstly contribution is to study the restructuring process in the French manufacturing sectors case. Furthermore the sectors are delimited by their respective technological degree. Secondly this paper contributes to the better understanding of the mainly parameters, like as the concentration index or the output growth, which influence the restructuring process.

Thus I proceed in two main steps. First, I use the Foster, Haltiwanger and Krizan (1997) methodology to decompose Labor productivity growth in French Manufacturing industries over the 1990 -2007 period. I use the OCDE Technology classification for distinguish the technological level between the Industries. In a second step, I use regression analyses to investigate to what extent industry characteristics determine the relative importance of each source of productivity growth in the Incubents firm case.

Consistently with previous literature, I show first that, in the major part of French industries, the principal source of productivity growth is the within effect which reflects productivity gains internal to the firms. Nonetheless, the relative importance of market reallocations, i.e. the between effect, has increased in the most recent period, i.e. from 2001 to 2006. It has even become the main source of productivity growth in Low Tech Industries over this period. By contrast, High-Tech industries still display stronger within and entry effects than between effects during this period. I conclude from these basic findings that the recent accelerating trend of deindustrialization in France has induced strong external restructuring in the Low-Tech industries. On the contrary, High Tech industries have been less sensitive to the decline in French manufacturing while experimenting substantial Internal restructuring process.

The parametric approach results corroborate these firstly results. As a theoretical framework for this empirical investigation, I use the model of Jovanovic (1982) which predicts that the more concentrated is an industry, the

strongest should be the market selection effects. These results are consistent with the accelerating trend of des-industrialization in France which is accompanied by higher External effect especially in Low-tech industries which are more concentrated for the last period. Globally, those results provide new empirical support to the link between the competition degree and sources productivity growth

Heterogeneous Farm Output and Technical Efficiency Estimates

Phatima MAMARDASHVILI, Raushan Bokusheva, (Discussant: Bob Chambers)

YR Session A: Agriculture

This paper evaluates technical efficiency of Swiss dairy farms. Since most Swiss farms are extensively involved in different activities beyond agriculture, such as rural tourism or production of regional specialty goods, a standard SFA model with a single-output representation of the production technology might be too restrictive and provide biased estimates of production technology and technical efficiency in the Swiss farming context. In this study we evaluate the adequacy of the SFA production function model to represent Swiss dairy farms production technology by comparing its estimates with the estimates of output distance functions which allow consideration of multiple outputs. In both approaches we employ a translog specification of production technology. Our empirical analysis is based on an unbalanced panel for dairy farms in the plain region of Switzerland for the period from 2003 to 2009. According to our estimation results, the average technical efficiency estimates do not differ substantially between two approaches. However, we reveal serious differences in the estimates of technical efficiency for individual farms. In particular, the SFA production function approach seems to underestimate seriously technical efficiency of farms which define the frontier according to the output distance function estimates. Additionally, our estimations of two alternative specifications of the distance function suggest that Swiss farms' input allocation is seriously influenced by ecological cross compliance regulations. The consideration of cross compliance subsidies as a separate output increases the elasticity of land by more than two times and accordingly reduces the productivity of further inputs.

Conversion From Rice to Fish Farm in Bangladesh: Efficiency and Productivity Perspective

Md. Akhtaruzzaman Khan, (Discussant: Spiro Stefanou)

YR Session A: Agriculture

Rice is the main agricultural product and also most important staple food in Bangladesh. Even though, rice price have increased in recent years, many rice farmers have been converting land from rice to fish since last two decades. We evaluate the causes of land conversion from rice to fish and the profit efficiency status of fish farmers after conversion of land using cross sectional primary data collected from Mymensingh district in Bangladesh. Translog form of stochastic profit function is more dependable than that of Cobb-Douglas form under the farming condition in the study area. Result reveals that fish farmers are able to earn around four times more profit than rice farmers per unit of land. Profit efficiency scores suggest that most of the rice farmers are operating near frontier level and are operating in a range of decreasing returns to scale. Even higher input intensity is having a negative impact on their profitability. On the contrary, farmers who have converted land from rice to fish farm exhibit substantially higher variation in performance. The regression results suggest that one percent increase in efficiency levels can contribute to overall profitability by two percent. Results also reveal that farmer's age, education, credit, extension services, training and years of land conversion can significantly reduce profit loss of fish farms. In the wake of these

findings, greater role by the government in the form of technical training & advice and provision of credit is highly recommended for the farmers to adapt to the best practices being followed in the sector.

Financial Development and Macroeconomic Efficiency in Transition Countries

Anastasia Ri, (Discussant: Leopold Simar)

YR Session B: DEA - Methods and Applications

As conventional wisdom says and as recent history has shown, planned economies were less efficient in resource allocation than market economies. Moroney and Lovell (1997) quantified this macroeconomic inefficiency gap by applying the stochastic frontier approach to aggregated production function. During the last twenty years, transition countries have challenged a complete transformation from planned economic systems to decentralized market-based economies. A profound restructuring of domestic financial systems from mono-bank structure to two-tier banking systems and de novo creation of financial markets were needed and have played indeed a crucial role in this process. Following Arestis, Chortareas and Desli (2006) and Méon and Weill (2010), in this paper we attempt to show how important financial development is for improvement in productive efficiency and, thereby, for economic growth in 27 transition countries of Central and Eastern Europe and the former Soviet Union in the period from 1995 to 2009. We do so by using a two-stage procedure. In the first stage, we apply the data envelopment analysis (DEA) to macroeconomic aggregates in order to construct an efficiency frontier. Then, in the second stage, the inefficiency scores, calculated in the first stage, are put into relation to financial development variables. Like Arestis et al. (2006), we opt for this two-stage DEA method against the one-stage SFA approach [Moroney and Lovell (1997), Meon and Weill (2010)] owing to the fact that DEA method does not require to specify an a priori functional form of the frontier and to make any assumptions on the distribution of inefficiency and random terms. The analysis shows that financial development, measured by different indicators, is positively associated with aggregate productive efficiency in transition economies. These results appear to be robust considering a number of alternative variables describing financial development and alternative regressions. We might conclude that further quantitative and, most importantly, qualitative development of financial systems in these countries will necessarily produce a positive impact on their macroeconomic efficiency. Thus, a well developed financial system could be considered as one of the key elements of a successful economic transition.

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An integrated method using fuzzy goal programming and data envelopment analysis for estimating favored targets on efficiency measurement

Mojtaba Ghiyasi, (Discussant: Kostas Triantis)

YR Session B: DEA - Methods and Applications

Data envelopment analysis (DEA) is a method to estimate relative efficiency of decision making units (DMUs).This method provides information how to remove inefficiency that is to obtain benchmarking information. In conventional DEA models, the DM's view is ignored and the performance of each DMU is evaluated based on the observations.

This essay will use structural similarity of DEA and multiple objective programming to presents a method to approximate a favored target for the input and output levels, considering the DM's view in the process of evaluation of DMUs. This study present a target that is be close to DM's view and efficient frontier as far as possible and also propose an interactive procedure by considering minimum and maximum acceptable objective levels. Moreover, the situations that no level of inputs and outputs of the estimated benchmark may worsen will analyzed. The proposed approach is applied to a sample of real data.

Matching and Propensity Scoring Approaches to Address Problems with Two-Stage DEA and Stochastic Frontier Analyses

Pavlo Demchuk

Two Stages

In the efficiency and productivity analysis we oftentimes compare not only the sample of decision making units to the production frontier, but also groups within the sample (e.g. small vs. large banks, agricultural vs. industrial regions, etc.). This is done in a two-stage setting; first, we find the efficiency scores and then regress them on the explanatory variables of interest. Wang and Schmidt (2002) show that when the efficiency measure depends on the explanatory variables ignored at the first stage, we have serious biases: at the first stage we have an omitted variable bias which leads to a bias at the second stage. In this paper we adjust propensity scoring techniques to the two-stage efficiency analysis procedure and provide an alternative that is similar to the DEA and SFA in results it provides, but is not plagued by the omitted variable bias and doesn't cause problems at the post-estimation stage. We use simulated data as well as data on electricity generators in Texas during 1994-2010 to test our model.

Demchuk P., and Zelenyuk, V., 2009. Testing differences in efficiency of regions within a country: the case of Ukraine. Journal of Productivity Analysis, 32, 81-102. Kim, M., and Schmidt, P., 2008. Valid tests of whether technical inefficiency depends on firm characteristics. Journal of Econometrics, 144, pp.409-427 Wang, H.J., Schmidt, P., 2002. One-step and two-step estimation of the effects of exogenous variables on technical efficiency levels. Journal of Productivity Analysis 18, 129-144.

Testing whether Two-Stage Estimation is Meaningful in Non-Parametric Models of Production

Cinzia DARAIO, Léopold Simar, Paul W. Wilson

Two Stages

Simar and Wilson (J. Econometrics, 2007) provided a statistical model that can rationalize two-stage estimation of technical efficiency in non-parametric settings. Two-stage estimation has been widely used, but requires a strong assumption: the second-stage environmental variables cannot affect the support of the input and output variables in the first stage. In this paper, we provide a fully non-parametric test of this assumption; in addition, we provide a theoretical link to results obtained by Politis et al. (Statistica Sinica, 2001), allowing us to estimate critical values for our test statistics using bootstrap sub-sampling while optimizing the choice of sub-sample size by minimizing a measure of volatility. Our simulation results indicate that our tests perform well both in terms of size and power. We present a real-world empirical example by updating the analysis performed by Aly et al. (R. E. Stat., 1990) on U.S. commercial banks; our tests easily reject the assumption required for two-stage estimation, calling into question results that appear in hundreds of papers that have been published in recent years.

Two-Stage DEA: Caveat Emptor

Léopold Simar, Paul WILSON

Two Stages

This paper examines the wide-spread practice where data envelopment analysis (DEA) efficiency estimates are regressed on some environmental variables in a second-stage analysis. In the literature, only two statistical models have been proposed in which second-stage regressions are well-defined and meaningful. In the model considered by Simar and Wilson (2007), truncated regression provides consistent estimation in the second stage, where as in the model proposed by Banker and Natarajan (2008), ordinary least squares (OLS) provides consistent estimation. This paper examines, compares, and contrasts the very different assumptions underlying these two models, and makes clear that second-stage OLS estimation is consistent only under very peculiar and unusual assumptions on the data-generating process that limit its applicability. In addition, we show that in either case, bootstrap methods provide the only feasible means for inference in the second stage. We also comment on ad hoc specifications of second-stage regression equations that ignore the part of the data-generating process that yields data used to obtain the initial DEA estimates.

Incentive regulation and quality: An efficiency analysis of the Italian electricity distribution sector

Carlo Cambini, Annalisa CROCE, Elena Fumagalli

Regulation and Energy

In the past ten years a number of European regulatory authorities have introduced incentive regulation in the electricity distribution sector. It is well known, however, that a potential conflict exists between incentive regulation and the provision of efficient levels of service quality. For this reason, several European regulators have introduced quality-specific regulation, often in the form of penalty and reward schemes. In this paper we analyse how incentive regulation and quality-specific regulation have affected the choices of Italian electricity distributors. We estimate benchmarking models using Data Envelopment Analysis to measure technical efficiency and we introduce quality as an input variable. As a matter of fact, whether benchmarking models should also incorporate quality of service is an open issue: Giannakis et al., (2005) and Growitsch et al., (2009) argue for inclusion; on the contrary, Coelli at al. (2008) find that, in their study, quality does not have a significant effect upon technical efficiency scores. To the best of our knowledge this is the first paper that analyse this issue in the Italian context. In fact, the few empirical studies on the Italian distribution sector date from before the liberalization reform. Moreover, we have access to a much larger data set the allows us to open the "toolbox" of regulation and to investigate whether quality is sensitive to regulatory incentives. Our dataset is a comprehensive and balanced panel for 115 different distribution zones, that belong to the largest Italian distribution utility, Enel Distribuzione, observed from 2004 to 2009, for a total of 690 observations. The dataset comprises a wide set of information: technical variables (e.g. area served, number of customers, energy supplied, transformer capacity, network length), accounting data and quality-related variables (e.g. number and duration of unplanned interruptions, differentiated by causes and origin). Moreover, a key novelty of our dataset is the detailed information on the regulatory incentive mechanisms and monetary transfer for quality provision, namely, yearly information on regulatory standards and on the amounts of monetary incentives paid in penalties or received in rewards for, respectively, failing to or meeting the regulatory standards. Overall our results show that it is possible to achieve cost savings together with quality improvements. Moreover, we also show that for a distribution utility that serves a vast territory, large rewards in areas where quality is already high can mask the weight of penalties in poor performing areas. This last result can be important for regulatory decisions regarding the next tariff period.

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Distributed Generation in Electricity Networks - Benchmarking Models and Revenue Caps

Maria-Magdalena Eden, Robert Hooper, Endre BJØRNDAL, Mette Bjørndal
Regulation and Energy

The main focus of this paper is the regulation model for the grid companies in Norway, and how the model compensates the companies for including distributed generation in their grid. The present regulatory regime relies on DEA-based models for determining efficiency scores for distribution and regional transmission, respectively. For the distribution activity a two-stage approach is used, where the first stage consists of a pure DEA model, and where the efficiency scores are adjusted for, e.g., distributed generation (DG) in the second stage. The efficiency scores are calibrated so that the resulting cost norms secure a sufficient level of profitability for the industry as a whole. We analyze in depth how variations of one DG project affects the regulated revenue caps of a few companies. We found that the regulation model makes the project very lucrative, but that the second stage regression coefficient for distributed generation is sensitive to DG investments in the industry. This effect, together with the calibration of the efficiency scores, implies that a project undertaken by one company may have significant and unpredictable impacts on the revenue caps of other companies. The revenue effect, and hence the profitability, of a DG project undertaken by a particular company is therefore to a large degree dependent on how other companies in the industry act. We also look at a possible future regulation model where more output variables are moved to the second stage, and we find that this change makes DG projects even more lucrative, but that the second stage coefficients now become less sensitive to changes in the industry. We also analyze the effect of changing some of the model parameters (e.g. rho - the weight of real costs vs. model costs), and we illustrate the revenue effects of investment contributions collected directly from the DG owners.

Flexible Specification of Cost and Input Distance Functions for Diversified and Integrated Firms

David SAAL, Pablo Arocena, Thomas Triebs, Subal C. Kumbhakar
Regulation and Energy

The modelling of input distance and cost functions for specialized and diversified firms has been complicated by the difficulty of mathematically representing zero observations for output and by the imposition of undue technological constraints across firms. Thus, it is likely that specialized and non specialized firms may employ different technologies (Weninger 2003) and therefore an identical technology should not be imposed a priori. In this respect, earlier studies use quadratic or composite cost functions or the Box Cox transform of the translog specification to allow for zero outputs, but still do not allow for different technologies across firm types. This paper therefore develops an approach that not only allows the use of the generally more tractable translog form and the inclusion

of zero outputs, but is also flexible across firm types. We illustrate this approach with data for US public electricity utilities, which includes data for integrated firms as well as specialized generators and distributors. The estimated model and our data allow us to test for economies of scope without extrapolation and to formally test whether specialized and diversified firms use the same technology. We test various restrictions associated with cost complementarities, vertical integration, scale and scope economies, etc., using this unified econometric approach. Finally, to analyze the potential bias that results when estimating economies of scope with only integrated firm data we compare the estimates for sub-samples including and excluding specialized firms.

Estimating Marginal Cost of Quality Improvements: The Case of the UK Electricity Distribution Companies

Luis OREA, Tooraj Jamasb, Michael Pollitt

Regulation and Energy

In recent years many regulators have adopted incentive regulation of natural monopoly electricity distribution networks. Within this context, an important issue has been how to ensure the utilities provide the right level of quality of service. From a theoretical point view, quality of service should be improved up to the point where the marginal cost of quality equals the willingness-to-pay of the customers for the extra level of quality. Therefore, regulation of quality of service depends on the information available to the regulator on market demand curve for service quality (i.e. the price customers are willing to pay for quality) and marginal cost of quality improvements.

On the demand side, several studies have attempted to quantify the value of service reliability using the direct costs incurred by customers from service interruptions (Allan et al., 1999; Kariuki et al., 1996) or estimation of the consumers' willingness-to-pay (WTP) to avoid power interruptions (Yu et al. 2009a). On the cost side, while previous papers have incorporated WTP and quality of service variables in non-parametric regulatory benchmarking (Giannakis et al., 2005; and Yu et al. 2009a, 2009b), marginal cost of quality improvements were not explicitly estimated.

The main aim of this paper is to develop an econometric approach to estimation of marginal costs of improving quality of service. We then implement this methodology, applying it to the case of the UK electricity distribution networks. The UK distribution networks have been subject to incentive regulation since 1990 (based on benchmarking since 1995) and present a suitable and interesting case to empirically apply our method. In addition, the estimated marginal costs of quality allow us to shed light on the effectiveness of the current UK incentive regulation with regards to improving service quality, and to derive optimal quality levels and associated welfare economic losses due to provision of sub-optimal levels of service quality. Moreover, the proposed method also allows us to measure the welfare effect of the observed quality improvements in the UK networks between 1995 and 2003.

Our results suggest that while the incentive schemes established by the regulator to encourage utilities to reduce network energy losses lead to improvement in sector performance, they do not provide utilities with sufficient incentives to avoid service outages interruptions. We find that the observed improvements in service quality during the period of this study only represent 30% of the potential customer welfare gains (based on 2004 willingness to pay survey values), and hence indicate that there was still a substantial scope for further improvements in quality of service.

Scale Efficiency in Organic and Conventional Dairy Farming

Giannis Karagiannis, Klaus SALHOFER, Franz Sinabell

Efficiency in Agriculture I

Recently a number of studies compared the performance of conventional and organic farms. These contributions focused on technical and allocative efficiency. In this paper we add to the literature by comparing the scale efficiency of organic and conventional farms. Our point of departure is the "bilateral" production frontier function where a dummy variable is incorporated to allow for technology differences between the two farming practices. Given that our "bilateral" production frontier is of a translog form we can apply Ray's (1998) method of estimating output-oriented scale efficiency. The data utilized is a panel of specialized bookkeeping Austrian dairy farms between 1997 and 2002. The sample is unbalanced and includes 182 observations for organic farms and 595 observations for conventional farms. Output is measured in terms of total farm revenues. To account for differences in product quality we use different deflators for organic and conventional milk. Four inputs are included in the production function: labour, land, capital and intermediate inputs. We adjust for differences in land and labour quality. In the empirical model we apply Green's (2005) true fixed effects model. Our main results are: For both farm types technical efficiency and technology do not significantly change over time. However, conventional farms are slightly more technical efficient. Conventional farms are significantly more scale efficient. However, organic farms are catching up in regard to scale efficiency. A switch in the technology from conventional to organic farming decreases the scale efficiency.

Environmental Costs and Production Efficiency in Argentine Agriculture

Silvina M CABRINI, Carlos P Calcaterra, Daniel Lema

Efficiency in Agriculture I

The objective of this research is to study the efficiency level in crop production in the main agricultural region of Argentina, considering explicitly environmental costs associated with production practices. Specifically, firms that produce mainly soybeans, corn and wheat in Pergamino, Buenos Aires are studied. The environmental costs associated with changes in three soil properties: nutrients balances, organic matter balance and water erosion, is modeled as inputs for efficiency estimation. Based on experts' opinions, these soil properties are key environmental impact indicators of agricultural production in the area of study (Viglizzo et al, 2006). A stochastic frontier model is employed to measure efficiency (Coelli, 1995). This model allows a simultaneous estimation of the efficiency level and the relationship between characteristics of the firms and efficiency. Data is available from a survey conducted in 2007 within crop producers in Pergamino department, an area located in the most productive region of Argentina. The stratified sample consists of 70 firms randomly selected within three strata, according to land size. The survey data include detailed information of inputs, outputs and management practices for crop year 2007, as well as several characteristics of the firms and managers. Efficiency level is estimated for each crop separately and for agricultural production as a whole. Preliminary efficiency estimates are around 85% for the crops considered. This value is high compared to efficiency estimates for extensive agricultural systems reported by other authors (Bravo-Ureta and Pinheiro, 1993). The measurement of production efficiency in agriculture and the detection of characteristics of firms and managers related to higher efficiency have important implications in policy design for the agricultural sector. This study adds to the ongoing debate about the factors behind agricultural efficiency by considering in the measurement not only those inputs traded in the market but also environmental costs associated with changes in soil productivity. Results will be useful for farmers, extension agents and policymakers interested in promoting higher efficiency levels in agricultural production, based on efficiency measures that incorporate the effects of agricultural production on the environment.

Land fragmentation, production risk and technical efficiency in conventional and organic citrus farms in Spain

Andrés Picazo-Tadeo, David Roibás, Alan WALL

Efficiency in Agriculture I

Land fragmentation, where a single farm comprises several different plots of land, may affect farms' productivity in several ways. Negative effects on productivity may arise from an increase in traveling time between parcels, leading to lower labour productivity and higher transport costs for inputs and outputs; a reduction in the efficiency of machines compared to what could be achieved in large, rectangular fields; and loss of productive land due to plot boundaries and access routes. Among the positive aspects of land fragmentation is that differences in elevation and soil type can be exploited by farmers, permitting a more diversified portfolio of crops and allowing harvests to be synchronized with available family labour so the need for hired labour is reduced. Moreover, land fragmentation may reduce production risk (variability) associated with climatic conditions and pests.

The impact of land fragmentation on agricultural production is ultimately an empirical issue. Several empirical studies have found a negative impact of fragmentation on agricultural production (Rahman and Rahman, 2008) whereas others have found no significant effect (Wu et al., 2005). Our objective in this paper is to empirically analyse the effects of land fragmentation on productivity for a sample of citrus farms in Spain. The dataset consists of a cross-section of 276 citrus farms corresponding to the season 2008/09, containing information on 130 conventional farms and 146 organic farms. This introduces the possibility of checking whether these two different types of farms are affected in different ways by land fragmentation.

In our empirical analysis we estimate a stochastic production frontier where the technical inefficiency component will be modeled as a function of land fragmentation (number and size of plots) and other available variables which may affect inefficiency (e.g., socio-economic variables). To check the impact of fragmentation on production risk while allowing for the existence of technical inefficiency we will estimate the model proposed by Battese, Rambaldi and Wan (1997) which extends the Just-Pope production function to a frontier setting.

Our expected result is that land fragmentation increases technical inefficiency but that it will reduce production risk. Moreover, as conventional and organic farms use different production strategies we would expect that the impact of land fragmentation will be different across these two types of farm. Given that organic farms can be considered more exposed to production risk we would expect that the impact of land fragmentation be more beneficial for this type of farming than for conventional farms.

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Comparing Performance of Heterogeneous Production Units: An Augmentation to the Meta-frontier Framework

Christopher O'Donnell, Saeideh FALLA-FINI, Konstantinos Triantis

Heterogeneity I

The meta-frontier framework has been used extensively in the literature for evaluating the efficiency of heterogeneous production units that can be classified into different groups. The idea is that a separate frontier can be developed for each group of homogeneous production units. The group frontiers are then compared to each other

and to a global meta-frontier using what are called meta-technology ratios (MTRs). MTRs measure the potential improvements in group performance that are possible when the production units are given access to the production technologies of other groups. A shortcoming of standard meta-frontier methods is that estimated MTRs may vary with the type of function that is used to represent the different technologies. For example, if an input-distance function is used to represent a variable returns to scale meta-frontier then the MTRs will generally differ from those obtained when an output-distance function is used, even though both functions identify the same meta-frontier. The problem arises because MTRs are usually computed with respect to a single production unit, and this makes them sensitive to the returns to scale and/or scope properties of the production technologies. This paper addresses this shortcoming by measuring MTRs as changes in measures of maximum Total Factor Productivity (TFP). Points of maximum TFP are technically efficient points of optimal scope and scale. Thus, the paper computes MTRs in a way that is invariant to the functional representation of the technology and still takes technical efficiency as well as the scale and scope properties of production technologies into account. The developed framework is applied to a panel dataset of highway maintenance contractors that are using two different highway maintenance contracting strategies/technologies. The first strategy pertains to the 180 miles of Virginia's interstate highways maintained by the Virginia Department of Transportation using "traditional" maintenance practices. The second strategy pertains to the 250 miles of Virginia's interstate highways maintained via a Public Private Partnership using a "performance-based" maintenance approach. The preliminary findings, based on the historical data, suggest that road authorities that have used traditional contracting have been more efficient than road authorities that have used performance-based contracting for maintaining the highway network in their administrative area. The panel structure of the dataset makes it possible to compute indexes of TFP change and decompose them into measures of technical change, technical efficiency change as well as scale and mix efficiency change. The preliminary findings suggest that changes in TFP have been mainly driven by changes in output and input scale and mix.

Measuring the productivity of global biotechnology companies: An application of GDF in metafrontier Malmquist productivity indices

Jun- Yen Lee, Jy- Wei CHANG, Yung- Hsiang Lu

Heterogeneity I

In the 21st century, the era of knowledge economy, the biotech industry is seen as emerging industries, and every country began to develop vigorously. Recently, global financial turmoil, various industries have been affected. In contrast, the biotech industry was less affected, and even some countries in the biotechnology industry to grow slightly. Therefore, the biotech industry is valued, and every country regard it as one of the key developments. However, under conditions of limited natural resources, how efficient use of resources and achieve efficiency is the current important issues. Manufacturers measure the efficiency will help manufacturers to improve government decision-making. There are many ways to measure performance, the most commonly used for both DEA and SFA. But these two methods assume that all vendors are all the same level of production technology, in fact, the group usually exists some differences between the levels of technology. The biotechnology industry in the world because of the time, economic developments, technological level, human and policy factors of production are different, which led to the development of national biotechnology industry has been the difference. In order to measure the technical efficiency between the different groups, Pastor & Lovell (2005) presented the global Malmquist productivity index, this method can compare groups' technical efficiency under different time. Battese & Rao (2002) proposed metafrontier method, this method can be compared efficiency under different level of technology. Oh & Lee (2009) combined the concept of above mentioned, and proposed metafrontier Malmquist productivity index. Generally used in the method for the Malmquist Productivity distance function is the distance function. But distance function is the radiation efficiency, it will affect the outcome measure while selected the input or output-oriented, and ignore the slacks existing. Therefore, Portela & Thanassoulis (2002) presented the geometric distance function to solve the above problem. This study combine the metafrontier Malmquist productivity index (Oh & Lee, 2009)and

geometric distance function (Portela & Thanassoulis, 2002) to estimate the productivity of the global biotechnology company. In order to understand the sources of productivity, this study is decomposed into technical efficiency and productivity changes, best practices and technology gap between rates of change.

Modelling Metafrontier function under different technological sets

Cristina BERNINI, Andrea Guizzardi

Heterogeneity I

Recent literature on productivity and efficiency has underlined that not controlling for heterogeneity may lead to biased results. O'Donnell et al. (2008) suggest that the metafrontier approach is a valid tool to handle for heterogeneity in firms. The Authors define the metafrontier as an envelope of individual stochastic frontiers for different groups, each having their own technology and environmental factors. From a practical matter of view, in empirical analysis the same production function (Cobb-Douglas or Translog) to all the firm groups is usually imposed, regardless of the significance of the input set used by the different groups. Being the Metafrontier an envelope of the group frontiers, not considering for this difference may lead to biased estimates of both the Metafrontier parameters and efficiency measures. In investigating this hypothesis, tourism industry is considered. Tourism activities are fairly widespread across the different sectors of economic activity, that is a large number of tourism industries exist. Heterogeneity is particularly relevant in the hotel industry, being characterised by diversity in either goods and services provided to tourists or in organisational, ownership and operational terms (Leiper, 2008). In this sense, hotel sector can be an useful set to verify our thesis.

In this paper, we examine whether using different technological sets for the different groups (that is considering for each group frontier only its significant input set) may improve metafrontier and efficiency estimates and modify the firm ranking (Moreira et al., 2010). In particular, we investigate the relevance of this assumption within the hotel industry, as a case study, and by using Montecarlo simulation.

Using a huge administrative data set of 3,124 hotels representing 82% of the total Emilia-Romagna room supply, we estimate stochastic frontier production functions for different firm groups, defined by simultaneously considering several environmental variables. Metafrontier production functions are then estimated either imposing the same technological set to all the hotel groups or relaxing this restriction. Metafrontiers are also compared with the pooled frontier, evidencing a bias in efficiency measures tied to not considering the different input set used by hotel groups. Finally, a simulation study is provided to test the robustness of our approach under different settings of technological set.

Preliminary results strongly reject the hypothesis of a single frontier for the Italian hotel industry in Emilia Romagna. We find evidence that seasonality, quality (star rating) and size significantly affect hotel production technologies. Heterogeneity between hotel groups with respect to technological set is detected. Furthermore, restricting the metafrontier to be an envelope of only the significant groups' input sets, we expect to find changes in Metafrontier parameter estimates, efficiency measures and firm ranking.

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Public Expenditure Efficiency of German Local Authorities

Maria Nieswand
Public Services

Extended Abstract (max. 500 words)

In 2010 cities and municipalities in Germany incurred the highest deficit ever, amounting to at least 11 billion Euros on aggregate. Beneath the Federal Government (Bund) and Federal States (Länder), they constitute the lowest layer of public administration and discharge a broad variety of communal tasks, e.g., social and educational services. Because local authorities' revenues and expenditures are increasingly diverging, budget deficits are expected to persist, or even increase, severely confining the authorities' capacity to act. Benchmarking can help identify potential room for improvement in expenditure patterns. This paper provides the first country-wide and non-radial efficiency analysis of local public expenditures for a unique sample of 977 German local authorities in 2005.

There is ample literature on evaluating public sector performance by means of well-established efficiency measurement techniques, i.e. Stochastic Frontier Analysis, Data Envelopment Analysis and Free Disposal Hull (e.g., De Borger and Kerstens, 1996). This paper applies the non-parametric approach of Multi-directional Efficiency Analysis (MEA) proposed by Bogetoft and Hougaard (1998) out of theoretical considerations. Asmild et al. (2011) use this approach to investigate staff decisions in bank branches. The main considerations are as follows: i) behavioral assumptions underlying cost or production functions may be inappropriate when evaluating the public sector; ii) input prices cannot be determined (particularly for capital) or price levels may differ between regions; iii) radial efficiency measurement implies that inputs are simultaneously reduced by the same factor to approach the efficient frontier. Relaxing the latter assumption, MEA provides nuanced information on the excess use of each resource based on the idea of subvector efficiency. The algorithm includes two steps. First, potential improvement directions are determined for each input separately, holding all other inputs fixed. Second, the excess in these potential improvement directions is determined, the maximum excess value representing the overall efficiency of a decision making unit. The results can indicate strategies for improving performance (Bogetoft and Otto, 2010), which local authorities could compare with their own possibilities or preferences.

Four inputs, i.e. personnel expenditure, material costs, investment spending and other expenditure, are considered separately to account for their different characteristics and to discuss model specifications in which some of the inputs are treated as non-discretionary (e.g., capital is quasi-fix or the political objective may be to maintain current levels of social welfare payments). The inputs are used to provide communal services, with the current analysis concentrating on mandatory ones. Five output variables approximate these tasks: social services, basic educational services, sanitation, road infrastructure, territory organization.

The preliminary results indicate that the relative excess use of resources (slacks) varies among input categories, while input-specific excess patterns are similar among the different model specifications. For example, larger slacks (60% excess use) occur most frequently for investment spending while they are less frequent for personnel expenditure. However, these inefficiencies may not be exclusively due to waste but may follow some rationale (Bogetoft and Hougaard, 2003). This rationale may conceivably originate from the concept of slack-maximizing bureaucrats, an approach proposed in public choice theory.

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JEL Codes: C14, D24, H72

Efficiency Measurement in Postal Delivery using Panel Data

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Public Services

Switzerland has been gradually liberalizing its postal market over the last decades in order to enhance efficiency, improve product innovation, heighten quality levels, and to keep prices affordable while maintaining the provision of the universal postal service. One of the most challenging tasks for the universal service provider, Swiss Post, is to improve efficiency given the universal service obligations it faces. These obligations include the delivery of mail and parcels in every year-round occupied residential area at every working day. To finance this universal service, delivery of letters up to 50 grams is reserved for Swiss Post. With regard to future discussions concerning extent and financing of the universal service as well as possible incentive regulation schemes, it is important to have information on the cost efficiency of the delivery units of Swiss Post.

The purpose of this study is to estimate the cost efficiency of Swiss Post's delivery units. We pay special attention to the consideration of unobserved heterogeneity in the data by the use of different panel data model specifications. Similar models have recently been applied in other sectors, e.g. in water distribution (see Filippini et al. (2008)). In the reviewed studies in the postal sector, the issue of unobserved heterogeneity remains mainly undiscussed, as none of the authors made use of sophisticated models in order to separate unobserved effects from inefficiency.

We specify a model that explains total costs C of Swiss Post's delivery units i by the following variables: C-it = f(Q-1it,Q-2it,Q-3it,Q-4it,D-it,U-it,W-it,H-it,dS-it,dY-it,EFF-it), where four output variables (letters (Q-1), parcels (Q-2), payment services (Q-3), and post office box delivery (Q-4)), two input variables (prices of labor (P-L) and capital (P-C)) and six environmental characteristics to account for further heterogeneity (mailbox density (D), urbaneness (U), weather influences (W), postal services at the doorstep upon request (H), seasonal (dS)) and year dummies (dY) are included. We apply panel data with 16 quarters t to the model and estimate it using a translog functional form. Finally, the unobserved level of inefficiency (EFF), is estimated by four stochastic frontier models: i) the stochastic frontier model of Aigner et al. (1977), SFM, ii) the random effects model proposed by Pitt and Lee (1981), RE, iii) the true random effects model, TRE, and iv) the random coefficient model, RP, both proposed by Greene (2005). Results Preliminary results indicate that the efficiency values of SFA fluctuate strongly over time. Besides, if there is unobserved heterogeneity that is correlated with observed variables, we expect biased coefficients. The RE exhibits relatively low inefficiency scores, because time-invariant unobserved factors are interpreted as inefficiency. Therefore, inefficiency is probably overestimated. The TRE shows relatively high efficiency scores. If there is persistent inefficiency, then this model underestimates inefficiency. RP is a generalization of TRE in that not only the constant, but also the coefficients are firm-specific. Further efforts will be made to find the most appropriate model for this data.

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The politician and the vote factory: How funding sources lead to an efficient election campaign

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Public Services

The paper assesses the performance of candidates in the French legislative election using a two-stage DEA method. The "units" assessed, in the language of management science decision making unit (DMU) are the objects under study are the winners in the second round of the election, excluding the triangular (there was about forty of those in 2002). The candidates are modeled as a small production unit producing votes in the first and second round of the election using inputs that are proxied by the breakdown of the funding sources (there are actually six different origins for the monies available to the candidate, thus leading to six inputs). They integrate in the technology the fact that incumbent do not produce in the same conditions as challengers; this is done by modeling this information as a quasi-fixed input à la Banker and Morey (1986). They find that there are about a quarter of the candidates that are efficient. To characterize the efficiency estimates, they used a statistical two-stage approach as developed by Simar and Wilson (2007). They suppose that the efficiency can be explained by a linear combination of exogenous variables in a truncated error structure. The estimation results show that riding characteristics are more likely to explain efficiency than biographical information on the candidates. In other words, the number of house owners is more informative on the efficiency than candidates' education. An interpretation of these results goes by saying that it is better to know your electors than being known by your electors.

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Efficiency of Hospitals in the Czech Republic

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Health Sector

The paper estimates cost efficiency of 99 general hospitals in the Czech Republic during 2001 - 2008 using the Stochastic Frontier Analysis (SFA). Efficiency of Czech hospitals has been measured only in Dlouhy et. al (2007) so far, who analyzed technical efficiency of a cross-sectional sample of 22 hospitals in 2003 using only the Data Envelopment Analysis (DEA). Not only was the sample quite small, but no effects of environmental factors on inefficiency were taken into account.

We aim to contribute to the field of missing research with a comprehensive SFA analysis of efficiency of Czech hospitals. We aim to answer the following questions: (i) how efficient Czech hospitals are; (ii) which exogenous environmental factors, such as hospital status or geographical setting influence the estimated efficiency scores and what effect they have; (iii) considering two methods (SFA with and without determinants), how much individual efficiencies differ in terms of ranking.

We employ the SFA methodology developed by Battese & Coelli (1992) and Battese & Coelli (1995) assuming a truncated normal distribution of the inefficiency term with non-zero mean in both cases. That is, we analyze efficiency of Czech hospitals firstly without determinants and consequently employ potential determinants of inefficiency into the mean of the truncated normal distribution of the inefficiency term in an additional analysis. We estimate a Cobb-Douglas cost function in which total inpatient costs adjusted for inflation is used as the dependent variable. Inpatient days, doctor/bed and nurse/bed ratios and salaries are used as independent variables. A means to account for severity of cases in inpatient days was developed.

As expected, all output variables increase costs; however, in the analysis without determinants, nursing days included probably some hidden effect of size. Including environmental factors improved efficiency scores considerably. Teaching status increases inefficiency since additional costs connected with teaching material are expected to be incurred. Positive effect on inefficiency was further uncovered with the share of the elderly in municipality, not-for-profit status and more than 20,000 patients treated a year. Inefficiency was found to decrease with the size of the population in the municipality where the hospital is situated, treating less than 10,000 patients a year and

the number of hospitals in the region. Determinants exerted asymmetric effects on the rankings of hospitals; each hospital changed its position by 13.5 ranks on average across methods, with the change being most profound for hospitals treating between 10,000 - 20,000 patients a year.

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Pharmaceutical clinical research and medical-care industry efficiency: evidence from Italian regional system

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Health Sector

When appraising national health care systems, one of the main characteristics that is taken into account concerns patients' access and the ageing process can only make this issue even more pertinent in political debates. In any social state there is the necessity to guarantee health care for all sick people but, at the same time, there are constraints linked to the national budget, as well as interest in not laying all the burden on future generations. Several solutions have been adopted by administrations in order to increase efficiency of the health care system but this is still an open issue, especially after the financial crisis of last years. This paper tries to give an innovative way through which this efficiency could be achieved.

Clinical research is a specific phase of pharmaceutical industry in which candidate drugs are tested on patients to collect data on safety and effectiveness. Taking Italy into account, patients can represent a regional resource on the national market of human experimentation but, at the same time, pharmaceutical clinical research could be an efficiency factor of the regional industry of medical-care. Assuming each experimental medical treatment as an innovative medical option that can increase the expected health status of patients, rational people should be positively affected by these innovative processes. Imagining no barriers to the entrance of each regional supply of medical-care, the natural consequence will be mobility towards those regions that are more competitive on the market of human experimentation, that is to say where the innovation in medical knowledge will be higher. This is the innovation of this paper: treating the human experimentation as a potential factor able to affect efficiency of the regional industry of medical-care, which human experimentation could be considered as a specific sub-environment.

The proposed issue is analyzed both by a theoretical model, introducing the decisional process of potential consumers of this market, and by an empirical analysis, supporting the proposed correlation between the pharmaceutical clinical research and the efficiency of regional industries. In details, two main empirical analyses are proposed, following the two-stage procedure suggested by Simar and Wilson (2007). In the first stage the DEA output-oriented procedure with bootstrap is used for estimating the efficiency of each medical-care regional industry, whereas in the second stage the regression analysis is interested into showing correlations between efficiency scores and some key explanatory variables (e.g. pharmaceutical clinical research). According to the proposed theory, the positive mobility (patients immigration) will be used as output in the DEA methodology whereas as inputs will be used variables representing the effort spent by regional system (e.g. physicians, nurses, bed). The mobility will be weighted on a base of regional distance covered by patients for moving. The sample analyzed considers Italian regions on panel data (2000 - 2007).

According to the theoretical model and results of the empirical analysis, a regional public policy will be proposed. A policy aimed to increase the efficiency of regional industry of medical-care through this specific productive process of pharmaceutical industry.

The response of decentralized health services to demand uncertainty and the role of political parties in the Spanish public health system

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Health Sector

Decentralization of health systems became standard policy in Western Europe in the last half of the 20th century. While there has been some debate in recent years as to whether there exists an increasing tendency towards recentralization since the beginning of this century, at least in Northern Europe, Spain has continued to move towards greater decentralization. The Spanish health system is now completely decentralized with health care being managed and provided by the regional health services of its 17 Autonomous Communities.

Among the arguments in favour of decentralization in health systems from a political theory perspective is that closer linkages are provided between decision-makers and users. In particular, in a decentralized system decision-makers should be more in tune with the needs and preferences of the local population. One of the positive aspects of this process in Spain has been that the Autonomous Communities have indeed adapted resources to the needs of the local population.

Decentralization also provides citizens with the opportunity to choose among political options for regional government taking into account their public health management policies. However, the influence of political parties in the management of the health system is an issue that has been relatively overlooked in the literature.

Using data on public hospitals in Spain covering the period 1996-2006, we analyse whether decentralization has lead to different management of the health resources between central and regional authorities and whether there are differences between the decentralized health authorities themselves according to the political party in local government. We focus on a specific aspect of public hospital management, namely how health authorities maintain reserve capacity in the form of beds, equipment, personnel etc in order to minimize the probability of excess queuing or turning away patients when faced with demand uncertainty.

Our theoretical framework is therefore one in which public health authorities choose hospitals' reserve capacity taking into account the trade-off between the probability of demand exceeding capacity and the economic cost of reserve capacity. Our working hypothesis is that regional authorities in a decentralized administration will try to manage the trade-off between reserve capacity and economic costs in keeping with the preferences of local citizens. In our empirical study we use a tool from production economics, the output distance function, to analyze reserve capacity as a function of the degree of demand uncertainty, economic costs and the political party in power in the region in order to reveal managerial differences between central and decentralized authorities and among the different political parties that administrate regional health services.

Decentralization of public health in Spain has provided regional authorities with greater flexibility to manage reserve capacity in line with citizens needs and preferences.

Efficiency analsysis of application of ISO 14001 in Turkish SMEs

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Climate Change Effects

Climate change and environmental pollution have become hot topics in research and other circles. Global warming will remain a hot topic because the CO2 in the atmosphere won't dissipate for another 90 years. In fact even if we stop all production completely today, the earth's temperature will increase 1-2 C degrees. On the contrary, we are increasing production and therefore CO2 emissions in the world.

In the European Union, more than 99.8% enterprises are Small and Medium Sized Enterprises (SMEs) so they are responsible for 70 percent of that pollution (Pimenova and van der Vorst, 2001, KPMG, 1997). SMEs can organize their activities with considering environmental pollution because of government regulations, customer pressure or idea of social responsibility. Therefore some of them apply the requirements of ISO 14001 Environmental Management System for different aims.

In this study we intend to research the efficiency of application of ISO 14001 Environmental Management System. 144 SMEs filled the survey and it has two parts, one of them is related with why a firm applies ISO 14001 Environmental Management System (EMS), and the second part is consequences of the application of ISO 14001 EMS. Questions of first part are determined as follows; why do your company apply ISO 14001; to increase profit, profitability, market share, to enhance firm image and to gain competitive advantage. Moreover answers are scaled between 1 -means certainly no-, and 5 -means certainly yes-. In addition, questions of second part is determined as follows; how much proportion do the profit, profitability, market share, firm image and competitive advantage increase. Similarly, answers are scaled between 1-means nothing-, and 5-means too much-. Expectations (first part) are considered as input and consequences (second part) are our output. In the research, the main question can be described as; do the efficiency scores depend on sectors and number of workers (firm size)? Furthermore, using quantile regression model, these claims will be checked for firms which have different efficiency scores. It is expected that sector and number of workers (firm size) are critical factors for efficiency.

Transport and CO2: Productivity Growth and Carbon Dioxide Emissions in the European Commercial Transport Industry

Heike Wetzel, Lisann KRAUTZBERGER

Climate Change Effects

In 2008 transport activities accounted for almost one-quarter of total carbon dioxide (CO2) emissions in the EU27. While total CO2 emissions decreased by around 7% from 1990 to 2008, transport related CO2 emissions increased by around 24% which is mainly due to high growth rates in all modes of transportation (UNFCCC 2011). These figures emphasize the importance of transport related CO2 emissions and their reduction regarding the current climate protection efforts of the European Union. The question is how to promote a sustainable transport sector that meets environmental protection targets as well as economic requirements. In this context, this paper analyzes the productivity development of the European commercial transport sector with special consideration to CO2 emissions for the period between 1995 and 2006. We utilize a unique data set that links greenhouse gas emissions with economic figures on an industry level. Assuming an improving or at least unchanged production technology, we calculate a sequential Malmquist-Luenberger productivity index that measures CO2 sensitive productivity growth. Decomposing the index into its components, we analyse different sources of productivity growth and compare the results to conventional productivity measures that ignore CO2 emissions.

Emission Constrained Firms: A Materials Balance Approach to Pollution Modelling

Kenneth Løvold Rødseth

Climate Change Effects

There are many desirable features of production models that accurately capture the joint production of desirable and undesirable outputs. Not surprisingly, developments of model frameworks that treat pollutants have become

increasingly important in the productivity literature. The current literature primarily suggests treating pollutants either as inputs or outputs in the technology. Despite their simple empirical implementation, these models have several conceptual problems. In particular, they are inconsistent with the materials balance condition; a law of physics that is fundamental to the generation of pollutants (Coelli et al. 2007). This paper proposes a set theoretical productivity framework that overcomes the weaknesses of existing pollution models, but which still allows for simple empirical treatment. The framework is applied to illustrate how environmental regulations influence the costs of employing polluting inputs and lead to forgone profits. Consequentially, assessing efficiency without taking environmental regulations into account erroneously makes firms that operate efficiently under their regulatory constraints appear allocative inefficient. Existing literature on polluting technologies, on the other hand, focuses on the effect on technical efficiency of including pollutants in the technology set. I build on previous studies by Krysiak and Krysiak (2003) and Murty and Russell (2010) and I define the polluting technology as the intersection of the conventional technology set and a pollution generating mechanism, where the latter is explicitly modeled through the materials balance principle. Firms which are constrained in terms of undesirable outputs are also implicitly constrained in terms of input usage by the materials balance condition. I therefore treat environmentally regulated producers similar to expenditure constrained producers (Lee and Chambers 1986; Färe et al. 1990). In contrast to the exogenous treatment of expenditure constraints, environmentally regulated firms may soften the regulatory constraints through end-of-pipe abatement or purchases of emission allowances. These choices come at a cost. A menu of tools for complying with environmental regulations, i.e. input substitution, reductions of desired outputs, and abatement activities, is now identified. This offers more flexible producer responses as compared to current modelling approaches, and allows for evaluating the least cost way of compliance. Hence, marginal abatement costs may readily be identified. Comparing optimal allocations with and without regulatory constraints further allows identifying biases in efficiency measurements. In the United States, power plants reduced their overall NOX emissions by 67 percent and SO2 emissions by 54 percent in the period 1995-2009, largely due to new regulations. Programming of emission restricted profit Data Envelopment Analysis (DEA) models is performed for 67 power plants with fuel switching options to disentangle the impacts of the regulatory reform on electricity production. Comparisons of Nerlovian efficiency scores calculated with and without emission constraints show that emission restrictions have significant impact on the measurement of allocative inefficiency. Marginal abatement cost estimates that lie close to allowance prices for NOX and SO2 are obtained from the dual problem of linear programming.

Efficent Frontiers with Streaming Data

José DULA', Francisco López

Advanced DEA I

It has been proposed that DEA should be released from its original efficiency paradigm and be used as a general data mining tool. In this setting the task is the geometric identification of "frontier outliers" among the data points. These are points that are potentially interesting because they exhibit extreme properties in that the values of their attributes, either alone or combined, are at the upper or lower limits of the data set to which they belong. Applications involving large data sets can be found in auditing, appraisals, fraud detection, and security. In many settings the situation is dynamic. The data domain is constantly changing as new entities arrive in the course of time. This new environment extends frontier analysis and its applications domain. A real challenge for this type of frontier analysis in these realistic scenarios arises when data stream in at high rates and the analysis needs to be performed quickly. We present the framework for this extension of the concept of frontier analysis which we refer to as "Streaming DEA". New specialized tools to deal with high speed streaming data will be introduced.

Local exponential estimation of nonparametric frontiers

Carlos MARTINS-FILHO, Hudson Torrent, Flavio Ziegelmann

Advanced DEA I

In this paper we propose a local exponential estimator for a multiplicative nonparametric frontier model first introduced by Martins-Filho and Yao (2007). We improve their estimation procedure by adopting a variant of the local exponential smoothing introduced in Ziegelmann (2002). Our estimator is shown to be consistent and asymptotically normal under mild regularity conditions. In addition, due to local exponential smoothing, potential negativity of conditional variance functions that may hinder the use of Martins-Filho and Yao's estimator is avoided. A Monte Carlo study is performed to shed light on the finite sample properties of the estimator and to contrast its performance with that of the estimator proposed in Martins-Filho and Yao (2007). We also conduct an empirical exercise in which a production function and associated efficiencies for branches of financial institutions in the United States is estimated.

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Methods for determination of multiple reference sets in the DEA models

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Advanced DEA I

In the scientific literature on DEA, it is well known that multiple solutions in a reference set may occur in the DEA models. To deal with this problem an interesting approach was proposed [1], which was based on using strong complementary slackness conditions (SCSC) in the DEA models. However, our computational experiments show that the SCSC/DEA method may not be efficient even for the medium size real-life datasets [2]. First, the size of the SCSC/DEA model increases significantly in comparison with the BCC model. Second, economic interpretation of some constraints of the SCSC/DEA model does not make sense because in this model one has to add variables measured in quite different units during the solution process. These two aspects result in ill-conditioned basis matrices, which lead to wrong computational results. In our work we propose methods in order to determine all units in a reference set, or, to be more precise, to find all vertices of the specific face of the production possibility set. Our methods can be described in the space of inputs and outputs and have clear economic interpretation. Our computational experiments show that proposed methods are reliable and efficient for solution of real-life problems. Without any loss in generality we consider the BCC model, since the BCC model can approximate any model from a large family of the DEA models [3].

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Computing efficiency scores in the R Open-Source platform: State-of-the-Art and perspectives

Philippe VANDEN EECKAUT, Per Agrell

Advanced DEA I

Statistical computing and graphical presentation is increasingly made using open- source platforms, such as R. R (Ihaka and Gentleman, 1996) is an open-source development drawing on the proprietary system S (1976). The open-source character and free access for researchers makes it particularly interesting to develop computational modules, called packages, to provide visibility and application for recent statistical methods and procedures. The first non-parametric efficiency analysis package for R was "FEAR" by Paul Wilson (Wilson, 2005) introducing also advanced features such as bootstrapping and order-m metrics. The forerunner for parametric measures was "Frontier" introduced by Tim Coelli and Arne Henningsen (Coelli and Henningsen, 2008) based on the legacy software for stochastic parametric estimation: Frontier 4.1 (Tim Coelli). In 2010, new packages are proposed as well for parametric estimation like "sfa" by Ariane Straub [2011], the non-parametric estimation package like "nonparaeff" by Dong-hyun Oh [2010] and also the integrated package "Benchmarking" was introduced by Peter Bogetoft and Lars Otto [2010]. This last package combines parametric and non parametric estimations and is supported by a tutorial and book. This paper reviews the existing based of packages in terms of computational correctness, stability and performance, as well as the completeness and usefullness for applied work. We conclude with open areas of development for the efficiency analysis computational resources on R.

Industry cost efficiency and average-cost efficiency in DEA analsysis

Giovanni Cesaroni

Advanced DEA I

In the literature on efficiency and productivity analysis, we approach the problem of cost efficiency at the industry level, an issue that appears to be not addressed yet. Technical efficient organization of an industry has been discussed by Ray and Hu (1997), but we are not aware of any contribution dealing with its cost analogue. In doing so, we allow for both an industry-level and a firm-level measure in a multiple input-output setting. As for the second measure, from the simple idea of obtaining the minimum cost for the total output of an industry (i.e. a set of DMUs) as a sum of individual minima, an average-cost efficiency measure can be devised. This is the ratio between the ray average cost of a DMU and that of its optimal scale size (Baumol et al., 1982), and it compounds cost efficiency with scale efficiency. It can be shown that the set of optimal scale sizes (OSS) is represented by the subset of cost benchmarks that minimizes the ray average cost ratio for some DMU, while an OSS need not coincide with a most productive scale size. The average-cost efficiency can be decomposed in to the sum of a 'technical' plus an allocative component. The proposed measure is both different in definition and more general than some seemingly analogous ratios, because it neither puts any restriction on the direction in which the DMU scale has to be altered (Maindiratta, 1990) nor it requires a constant returns to scale assumption on the technology (Sueyoshi, 1997). On its part, the determination of a cost efficiency at the industry level demands for a different solution. Within a DEA production set, the solution will be given as a single OSS replicated an optimal number of times, sufficing for producing the industry output (Ray and Hu, 1997). That is, the programming problem for industry cost efficiency is a non-linear one. Without recurring to any constant returns to scale assumption on the technology, we propose a step-by-step procedure for solving it. Results from application to some public sector data show that the individual measure (i.e. average cost-efficiency) is a very good approximation of the proper industry measure. This sort of 'duality' is very important because the pursuit of optimal management policies at the firm level moves

the cost efficiency of the industry towards the target level calculated by the 'policy-maker'. The cost efficiency notions we have so far introduced have special relevance with respect to public-service sectors, public utilities and regulated industries.

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Technical efficiency in competing panel data models: A study of Norwegian grain farming

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Efficiency in Agriculture II

Stochastic frontier (SF) estimation has been extensively used the last decades to estimate technical efficiency in applied economic research. Both cross-sectional and panel data are used for this purpose. Estimates of technical efficiency measures in these models often depend on model specification, distributional assumptions, temporal behavior of inefficiency, etc. Given the interest of these efficiency measures in policy discussions, there is a need to examine the robustness of such results in both cross-sectional and panel data models.

Among panel data models, that are our main focus in this study, the inefficiency specification used by Battese and Coelli (1995) is most frequently used in empirical studies. Their model allows inefficiency to depend on some exogenous variables so that one can investigate how exogenous factors influence inefficiency. This model mix firm effects with inefficiency. Two other models, viz., the 'true-fixed' and 'true-random' effects frontier models for panel data (Greene 2005) have become popular in recent years. These models separate firm effects (fixed or random) from inefficiency, where inefficiency can either be iid or can be a function of exogenous variables. Although there are many other specifications, empirical researchers mostly seem to use either the Battese and Coelli or the Greene models, apparently often without fully considering the assumptions behind these models. So the questions are: (i) Why are these particular models preferred? (ii) How do they compare with others that are seldom applied or even discussed?

The goal in this study is neither to give an exhaustive review of SF models for panel data, nor to recommend a particular model. Rather we have selected some alternative panel models that address inefficiency with or without heteroskedasticity and have applied these to a single dataset from Norwegian grain farmers for the period 2004 to 2008, to illustrate the extent to which results from such studies are model dependent.

Several models have been developed based on the assumption that all the time-invariant (fixed or random) effect is (persistent) inefficiency. This is in contrast to the 'true' random or fixed effect models by Greene (2005) in which firm-specific effects are not parts of inefficiency. The model proposed by Kumbhakar and Heshmati (1995) is in between. This model treat firm effects as persistent inefficiency and include another component to capture time-varying technical inefficiency. Since none of these assumptions outlined above may be wholly satisfactory, we introduce a new model that may overcome some of the limitations of earlier approaches. In this model we decompose the time-invariant firm effect as a firm effect and a persistent technical inefficiency effect.

We found that efficiency results are quite sensitive to how inefficiency is modeled and interpreted. Consequently, we recommend that future empirical research should pay more attention to modeling and interpreting inefficiency as well as to the assumptions underlying each model when using panel data.

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Input Use, Yield Curves and Efficiency in Cropping: Australia's South West

Atakelty Hailu

Efficiency in Agriculture II

This paper uses individual farm input and output data along with rainfall information to estimate yield curves and efficiency levels for crops grown in the South West of Australia. A stochastic production frontier approach is used. Efficiency is linked to farm and environmental factors in a single stage framework. The results show wide variation in farm efficiency and the significance of financial and other farm characteristics. The frontier models are built for use in agent-based simulation models of land use change policy.

Decomposing Productivity Measures in Pig-Based Farming Systems in United Kingdom

David Hadley, Renato Villano, Euan FLEMING

Efficiency in Agriculture II

In this paper, we examine the sources of total factor productivity in pig farming in England and Wales using data derived from the Farm Business Survey of more than 2,800 farms in England and Wales. Farms are selected from a random sample that is stratified according to region, economic size of farm and type of farming. A balanced set of panel data covering the production years 2000 to 2004 were extracted from this dataset for 51 specialised pig farms - where specialisation was defined as those farms where at least 60

DPIN (Decomposing Productivity Index Numbers) is applied to decompose productivity on these pig farms into technology, output and input technical efficiency, output and input scale efficiency, and output and input mix efficiency. Three output and seven input variables were constructed using this method. The output variables are revenue from pig production, other livestock production and from crop production. Input variables are labour, size of pig herd, expenditure on crop inputs, livestock feed costs, veterinary and medical input costs, other livestock input costs, and the area of the farm.

Our principal concern in this paper is the relative importance of input mix as a source of inefficiency. Emphasis in efficiency analysis studies in agricultural production was historically placed on technical inefficiency as a single concept until methodological advances enabled it to be decomposed into pure technical inefficiency and scale inefficiency. But this advance was insufficient to identify what we consider to be the major source of inefficiency in agricultural production, namely mix inefficiency. We consider farm enterprises to be particularly susceptible to input mix inefficiency for four main reasons: putty-clay restrictions on movement around the frontier isoquant; putty-clay effects on the adoption of improved technologies embodied in new vintages of production processes; risk as a source of friction in input allocation decisions; and the potential for inconsistency in simultaneously attempting to reach points of allocative efficiency and mix efficiency in input use. The putty-clay nature of production technology in pig production is especially likely to inhibit input adjustments in response to changed production circumstances in the short run. While their capital-intensive nature is a source of putty-clay technology for all pig farms, those farms operated by family-based sole operators and partnerships are especially prone to input mix inefficiency caused by these factors because of their limited flexibility in varying their labour inputs in response to changing circumstances.

Results confirmed our expectations. Using an input orientation, mean mix efficiency (0.736) was found to be substantially greater than mean technical efficiency (0.975) and mean scale efficiency (0.957) over the study period. We also found that large commercial farming companies engaging in pig farming had a higher mean mix efficiency score (0.926) than family-based sole operators (0.765) and partnerships (0.700). Our results further confirmed that pig farmers can be technically efficient under conditions that preclude them from obtaining high levels of input mix efficiency. An important implication of our results is that efforts to treat technical inefficiency on farms in the past may have been misplaced if most inefficiency was due to mix inefficiency.

A Decomposition of Productivity and Efficiency Indicators in Philippine Rice Farming: Evidence from Farm-Household Level Data

Renato VILLANO, Euan Fleming, Marc Mariano

Efficiency in Agriculture II

In this paper, we revisit the sources of total factor productivity in Philippine irrigated rice farming. The data in this study are derived from the Rice Based Farm Household Survey conducted by the Philippine Rice Research Institute every five years since 1996. The data set contains information on rice production output, inputs used, crop management practices, agroclimatic conditions and socioeconomic characteristics of farmers. Using panel data in three years (1996/97, 2001/02 and 2006/07) for 262 farms in the wet season and 286 farms in the dry season, a DEA-based approach following O'Donnell (2010) is applied to decompose productivity change into changes in technology, output and input technical efficiency, output and input scale efficiency, and output and input mix efficiency. The main methodological improvement in our study over previous studies of productivity change in irrigated rice production in the Philippines is the inclusion of a measure of mix efficiency in addition to technical and scale efficiency. An input orientation is adopted, enabling us to measure the sources of inefficiency in input use. This study focused on the relative importance of input mix inefficiency given the putty-clay nature of production technology in irrigated rice production that is likely to inhibit input adjustments in response to changed production circumstances in the short run. As expected, in both seasons across all years input mix inefficiency proved to be substantially greater than input technical efficiency, which in turn was substantially greater than scale inefficiency. Negligible technical change and technical efficiency change occurred between 1996/97 and 2001/02 in both seasons. Substantial technical progress was achieved between 2001/02 and 2006/07 in both seasons but was largely offset by efficiency decline, due almost entirely to an increase in technical inefficiency. This trend reflects a widening of the gap between rice producers operating on the production frontier and less efficient producers.

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probabilistic characterization of directional distances and their robust versions

Léopold Simar, Anne VANHEMS

Directional Distances

In productivity analysis, the performance of production units is measured through the distance of the individual decision making units (DMU) to the technology which is defined as the frontier of the production set. Most of the existing methods, Farrell-Debreu and Shephard radial measures (input or output oriented) and hyperbolic distance functions, rely on multiplicative measures of the distance and so require to deal with strictly positive inputs and

outputs. This can be critical when the data contain zero or negative values as in financial data bases for the measure of funds performances. Directional distance function is an alternative that can be viewed as an additive measure of efficiency. We show in this paper that using a probabilistic formulation of the production process, the directional distance can be expressed as simple radial or hyperbolic distance up to a simple transformation of the inputs/outputs space. This allows to propose simple methods of estimation but also to transfer easily most of the known properties of the estimators shared by the radial and hyperbolic distances. In addition, the formulation allows to define robust directional distances in the lines of alpha-quantile or order-m partial frontiers. Finally we can also define conditional directional distance functions, conditional to environmental factors. To illustrate the methodology, we show how it can be implemented using a Mutual Funds database.

Dynamic Luenberger Productivity Measures

Teresa Serra, Spiro STEFANOU E., Alfons Oude Lansink

Directional Distances

The economics literature on efficiency has produced a wide range of productivity growth measures. The introduction of the directional distance function has led to the development of Luenberger productivity growth measures, either based directly on the static directional distance function or on its dual representation through static profit or cost function. However, currently available productivity measures including Luenberger measures generally ignore the costs of adjustment of quasi-fixed inputs like labor and capital to their long-run levels and the time interdependence of production decisions. Doing so is essential when analysing productivity growth and its decomposition.

This paper develops dynamic Luenberger productivity growth measures that are based on the dynamic directional distance function and intertemporal cost minimization. The measures explicitly account for the presence of costs of adjusting quasi fixed inputs. The application focuses on a sample of Dutch dairy farms over the period 1995-2005.

Dynamic Luenberger productivity growth measures are derived from a dynamic directional distance functions and a dynamic cost function. Both functions are econometrically estimated. The directional distance function and the dynamic cost function represent an adjustment cost technology in order to account for the presence of quasi-fixed factors of production. The Luenberger productivity growth measures are decomposed to identify the contribution of efficiency growth, technical change, and identify impact the quasi-fixed factor disequilibrium.

The application of the Luenberger productivity growth measures on panel data of Dutch dairy farms shows that productivity growth has been negative. The growth measures based on the dynamic directional distance function and the dynamic cost function are similar in size.

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Measuring and Comparing the Effects of Demand Constraints on Welfare

Ryan SIEGEL, Robin Cross

Directional Distances

Economists generally model consumers as maximizing utility subject to an income constraint. But consumers also face constraints such as time, weather, rationing, or other institutional factors. If shown to have significant

effects on the economy, non-income constraints have implications for increased efficiency and productivity through improved production decisions and inventory planning. In this paper, we separate and compare the impacts of the time and income constraints on store-level demand for live goods.

Paul Samuelson proposed one of the first theoretical models of demand under multiple constraints in response to war time rationing in the 1940s. Since then, authors have expanded theoretical consumer-side results around substitutes/complements and derived results using time as a constraint. Models with two constraints show that more than one constraint may be binding such that time available limits demand (Larson & Shaikh, 2001).

In a separate vein of research, Fare et al. (1989) introduced an empirical method to estimate plant capacity-i.e. the maximum producible amount given an unrestricted variable input. By sequentially relaxing input constraints, output frontier losses can be measured within the DEA framework. Fare and Grosskopf (2000) extended this approach by providing a capacity utilization directional distance measure.

We extend the directional approach to analyze time and budget constraints on consumer demand for retail nursery goods. Outputs are characterized by weekly store-level sales units for 14 live-goods items. Inputs include monthly, state-level time available for gardening, local income, population density, and weekly store-level inventories. We construct time use statistics from the American Time Use Survey's observation database.

By sequentially relaxing constraints we find losses from time to be larger than from income in cooler climates during Fall and Winter months when other activities compete for gardening time. Robustness checks accounting for weather, product types, and data aggregation confirm results. The results suggest that consumers face constraints other than income and that these may be economically significant. Confidence intervals are provided.

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Statistical Inference for DEA Estimators of Directional Distance Functions

Léopold SIMAR, Anne Vanhems, Paul W. Wilson

Directional Distances

In productivity and efficiency analysis, the technical efficiency of a production unit is measured through its distance to the efficient frontier of the production set. The most familiar methods use Farrell-Debreu, Shephard or hyperbolic radial measures. These approaches requires that the inputs and the outputs are positive, which can be critical when using financial data. Recently directional distances have been introduced (Chambers et al., 1998) which can be viewed as additive rather than multiplicative measures of the distance. These distances are not restricted to positives inputs and outputs. In addition, most of the traditional radial measures can be recovered as particular cases of the directional distances. So directional distances provide much more flexibility. However, so far, only FDH estimators (and their conditional and robust extensions) of directional distances have known statistical properties (Simar and Vanhems, 2010). In this paper we fill the gap and analyze the statistical properties of the DEA estimators, which is particularly useful when the convexity of the production set is assumed. We first show that the DEA estimators shares all the known properties of the DEA estimators of radial distances and then we indicate how these properties can be used to build consistent bootstrap algorithms to provide statistical inference (confidence intervals and testing hypothesis). This is illustrated with a test of convexity of the attainable set, in a case where some outputs are negative (performance of mutual funds) and so the traditional methods based on radial measures are useless. References: Chambers, R.G., Y.H. Chung,and R. Färe (1998), Profit, Directional Distance Functions and Nerlovian Efficiency, Journal of Optimization Theory and Applications, 98, 351–364. Kneip, A, L. Simar and P.W. Wilson (2008), Asymptotics and consistent bootstraps for DEA estimators in non-parametric frontier models, Econometric Theory, 24, 1663–1697. Simar, L. and A. Vanhems (2010), Probabilist Characterization

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Decomposing Fuzzy Efficiency Metrics under Price Uncertainty

Adel HATAMI-MARBINI, Ali Emrouznejad, Per J. Agrell, Madjid Tavana
Engineering and Stage Production

Imprecision in point estimates or presence of interval data for input or output prices render standard economic decompositions of non-parametric technical efficiency (TE) measures into cost efficiency (CE), revenue efficiency (RE) and profit efficiency (PE) invalid. The situation is common when part of inputs or outputs are non-marketed, internal to a larger economic organization or non-monetary externalities (noise, congestion, etc). One approach to address this situation is found in fuzzy Data Envelopment Analysis (DEA) formulations (Sengupta, 1992), where crisp parameters in the standard formulations are replaced by their fuzzy equivalents. We derive full decompositions from technical to economic efficiency metrics for the case of fuzzy price/cost parameters, including their interpretation for economic decision-making under imprecise data. The paper is illustrated with a numerical application of the approach.

Stage efficiency measure on production processes: a non parametrical model

David Alcaide, Rafaela DIOS-PALOMARES, Angel Prieto
Engineering and Stage Production

This paper deals with production processes that can be decomposed in different stages. The decision makers are interested in improving the efficiency. A non parametrical multicriteria linear programming model is designed and developed to measure the efficiency in the use of each input and stage of the production process. The method provides to the decision makers a more detailed analysis of their chances of better management of their resources. This analysis concerns with the efficiency of each stage. Different from some DEA models, efficiency scores are assessed to the process stages. The model formulates an objective function for each input in an input orientation. A multicriteria linear programming model is solved for each DMU. The proposed model optimises the consumption of resources for each input, stage, and DMU. Therefore, the model offers more detailed information in order to advice the decision makers than other models proposed in the literature. Numerical examples are also reported for better illustrate the performance of the proposed method.

Measuring scale elasticity in two-stage network DEA

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Engineering and Stage Production

Most of the real-life production processes are multi-stage in nature. Characterization of such processes via concept like returns to scale (RTS)/scale elasticity (SE) is considered very important to firm managers for the stage-specific analysis of their business decisions concerning expansion/contraction to improve productivity. Most

of the data envelopment analysis (DEA) literature considers the evaluation of RTS by treating production technology as a black-box; thereby completely ignore the literature on production control problems dealing with multi-stage production processes where idle capacities arise due to unequal length of production runs of intermediate stages, which leads to scale effects when production is expanded. However, the recent DEA literature that considers modeling the actual multi-stage production process of a firm by linking its various sub-processes is fairly recent (Färe and Grosskopf, 1996, 2000). In this literature the efficiency of the whole production process of the firm is computed by representing the operations of its various sub-processes through conventional envelopment constraints. That is, the intermediate products that connect the two sub-processes are handled independently using different sets of multipliers. On the contrary, however, Kao and Hwang (2008) use the same set of multipliers for the intermediate products connecting the sub-processes. The latter approach that was developed under the assumption of constant returns to scale (CRS) is considered attractive as the efficiency of the whole production process of a firm is expressed as the product of the efficiency scores of its sub-processes. Note that none of these multi-stage production DEA models have paid attention to the estimation of RTS behavior of the whole production process and its sub-processes. To fill in this void, the present contribution, therefore, aims at extending the research effort of Kao and Hwang (2008) in the variable returns to scale framework to estimate SE of each individual firm not only for its whole production process but also for its sub-processes so as to reveal the sources of its RTS behavior. Two DEA estimation models are proposed to show the SE of the whole production process as the product of the SE scores of its sub-processes. This decomposition enables us to argue that the CRS assumption that has long been maintained by the neoclassical theorists for justifying the structure of the black-box characterization of production process does not necessarily allow inferring that there are no scale benefits available in the sub-processes. As we see, most of the real-life production processes are multi-stage in nature, and the real sources of increasing returns mostly lie in the sub-processes. Therefore, unfolding of the black-box nature of technology into various sub-technologies enables us to detect the sources of increasing returns. References Färe, R. and Grosskopf, S. (1996). Productivity and intermediate products: A frontier approach, Economics Letters, 50, 65-70. Färe, R. and Grosskopf, S. (2000). Network DEA, Socio-Economic Planning Sciences, 34, 35-49.

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Engineering and Performance Measurement: Issues and Future Research Opportunitie

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Engineering and Stage Production

Engineering is concerned with the design of products, services, processes, and systems. These design activities are managed and improved by the organization's decision-makers. Therefore, the performance evaluation of the production function where engineering plays a fundamental role is an integral part of managerial decision-making. In the last twenty years, there has been growing research that uses performance measurement approaches (e.g., DEA, SFA, non-parametric approaches, fuzzy set theory, etc.) to address key engineering issues. Nevertheless, a number of challenges remain such as: the lack of understanding of the role of the performance measurement literature in informing and improving design decisions and the evolving theory of engineering design, the continued challenges that are present when opening, understanding, and capturing the input/output process transformation box, the continued unavailability of good production and engineering micro data for the validation and verification of results and hypotheses, the in-depth understanding of key behavioral decision making considerations that can impact performance measurement modeling parameters and formulations, and the challenges associated with implementing systems thinking for effective design decision making. In spite of these challenges, the existing performance measurement applications in Engineering have focused on a number of topics that are not limited to

road maintenance operations, turbo fan engineering engines, transportation network performance, computer networks, warehousing operations, manufacturing operations, R&D engineering research project assessment, among others. This paper discusses the previously mentioned challenges that the researcher faces when applying the performance measurement paradigm to engineering problems, i. e., engineering design and decision-making, disaggregated/micro input/output process representation, messy data, behavioral considerations, systems thinking. and focuses on examples from infrastructure management and transportation systems that highlight specific results, issues and research opportunities. In terms of the example from infrastructure management, the assessment of road maintenance operations for the Commonwealth of Virginia suggests that performance based contractors do not perform better than traditional state run operators. This analysis is based on a physical system dynamics model of road deterioration and renewal and a bootstrapped non-parametric meta-frontier approach. In terms of the example from transportation systems, a network DEA evaluation of a downtown space reservation system (DSRS) utilizes data from a microscopic traffic simulation as input to the network radial and slacks based DEA models. The results show that consumer node drives network DEA performance and this constitutes important information for future design considerations of the DSRS. Key words: performance measurement for engineering design and decision-making, infrastructure management, transportation systems, network DEA, bootstrapping, meta frontier, system dynamics. References Triantis, K., "Engineering Applications of DEA," Handbook of Data Envelopment Analysis, Kluwer Publishers, forthcoming, 2011. Zhao, Y., Triantis, K., Murray-Tuite, P., and P. Edara, 2011, "Performance Measurement of a Transportation Network with a Downtown Space Reservation System: A Network-DEA Approach," forthcoming, Transportation Research: Part E. Fallah-Fini, S., Triantis, K., J. del la Garza, and Seaver, B., "Measuring the Efficiency of Highway Maintenance Contracting Strategies: A Bootstrapped Non-parametric Meta-frontier Approach," under review, European Journal of Operational Research.

Researcher mobility and its impact on scientific productivity

Aldo GEUNA, Ana Fernández-Zubieta, Cornelia Meissner

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE I

The importance of scientific knowledge and university research for economic growth and competitive advantage has long been recognised. Policy makers across the world are looking for strategies to encourage scientific production and the exchange of knowledge. The establishment of research networks and mobility of researchers across different countries, fields and sectors has been identified as a major policy goal. It is assumed that scientists' mobility facilitates knowledge and technology transfer, creation of networks and productivity. The few existing papers on researcher mobility have focussed on brain drain or spill-over effects resulting from the movement of academics, while little attention has been given to the consequences for researchers themselves.

Whether and how mobility affects researchers' productivity in terms of publications has yet to be explored. The sociology of science approached this topic much earlier found only some weak evidence of a negative impact of immobility (Hagens and Farr, 1973) and the special role of post-doctoral research stays abroad (Zubieta, 2009). Instead there is some evidence suggesting that rather than fostering productivity, mobility is a characteristic of productive researchers and does not in itself enhance productivity (van Heeringen and Dukwel, 1987; Alison and Long, 1987). Reverse causality from performance to mobility is also found, results by Chan et al. (2002) show that very few researchers are able to move to a higher ranked institution and that these few exceptional scientists are two times more productive than the average academic at the destination university.

Using CV data from a sample of 170 UK university researchers we examine the impact of mobility on scientific performance. CVs were used to construct comprehensive profiles of researchers spanning their entire careers from PhD award through to 2005 and complemented with information from other resources. In our analysis we focus on inter-institutional "real" labour mobility (Crespi et al. 2007), which implies a change in job position from one institution to another. We only consider job changes that occur after the PhD and after the researcher received her first tenured position (Lecturer in the UK) or first full time position in industry; postdoctoral research stays are not

considered. In our sample 61% (105 researchers) change jobs at least once during their career; 17% (29 researchers) spent parts of their career in industry.

In our empirical specification we estimate a dynamic panel data model that compares pre- and post-mobility productivity and considers mobility characteristics, e.g. transition to a higher ranking university. We control for unobserved heterogeneity by including a measure for a researcher's average pre-labour productivity. We address the problem of selectivity by considering the quality of the PhD awarding institution, post-doc mobility and quality of the first position in our analysis. We further aim to address potential endogeneity by finding appropriate instruments and/or using simultaneous estimations.

Preliminary results suggest that mobility helps to increase the productivity of researchers that change between top-universities. Researchers joining academia from industry or those joining one of the top-departments from a lower ranked institution are not able to benefit in terms of scientific output, at least not in the short run.

Entrepreneurial Scientists and their Publication Performance. An insight from Belgium

Malwina Mejer

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE I

Over the last two decades, science has undergone a structural change. Recognizing the importance of publicly funded basic research as driver for economic growth (Adams, 1990; Mansfield, 1995), the US government implemented a number of policies to promote more rapid diffusion of technologies from universities to industry. The landmark in this respect was the adoption of the Bayh-Dole Act in 1980, which allows universities to claim ownership of the intellectual property rights generated from Federally funded research. Similar legislation was implemented in the 1990s in many European countries (OECD, 1999). Furthermore, responding to financial crisis, governments put constraints on the research and development spending (Geuna, 2001). Stagnation in government spending was accompanied with increasing demand for financial resources caused by emergence of new interdisciplinary fields of science and greater science-technology interdependence. This new, research and development driven, scientific environment (Ziman, 1994) has turned academic scientists into academic entrepreneurs. In order to advance their research agendas, scientists had to learn how to compete for public funds, search for opportunities with industry, and explore novel financing possibilities given by patenting, licensing or creating of spin-off companies. Indeed, over the last two decades the share of academic inventors among scientists has grown substantially (Mowery et al., 2004) and the number of university-industry co-authored papers increased, reaching the level of 4.5% of the academic publication output (Calvert and Patel, 2003). Observing these trends, number of scholars has risen concerns that increased collaboration with industry and commercial orientation of researchers may have detrimental effect on dissemination of scientific output, its quality and basicness (Dasgupta and David, 1994). Despite that industrial funding induces higher productivity rates (eg. Gulbrandsen and Smeby (2005)) it is increasingly coming with restrictions, such as control over publishing (Thursby and Thursby, 2007) or excessive secrecy requirements. It is, therefore, important to understand how scientists accommodate industry involvement in the course of their research, what advantages they derive from different types of research collaborations and whether they are able balance benefits and costs embedded in the commercialization of knowledge. This study investigates the link between research collaboration, collaboration on research projects with patentable outcomes and quality of publications. I use data on scientific publication performance of 268 Belgian academic inventors and their non-patenting peers working in the field of life-sciences. Research collaboration is instrumented with bibliometric information on co-authorship and affiliation. This study looks beyond simple patenting activity and consider different patenting environments as indicated by the type of co-applicant. The results of fixed effect Poisson regressions provide evidence that research collaboration contributes to higher quality of scientific output, but with decreasing returns. Collaboration with leading centers of excellence and industry is beneficial for scientists as it generates higher number of publications, which in turn contribute to higher levels of total quality and higher annual citation frequencies. Importantly, collaboration with

industry has no detrimental effect on average quality of the output. The results reveal weak positive link between commercialization via patenting and quality of scientific production. However, when industry is directly involved in the development of patented technology, this relationship becomes negative. As scientific productivity falls so does citation rates, but the average quality remains unaffected. These findings seems to reflect heterogeneity in university-industry collaboration. University-industry co-authored publications may capture joint/collaborative research projects, while joint patent applications may point into contract research project. While the former generates new (publishable) results, the latter, more applied, clearly contracts the output, thus the total quality and annual citation frequencies.

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Collaborations & productivity in a research group context

Hannah Van der Deijl

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE I

In this paper, we explore the importance of the structure of internal and external ties of research groups in a university context. Our main question is: what is the influence of the structure of a groups internal and external ties on group productivity? While previous research has predominantly focused on teams in a company environment, we focus on the existence of teams in the university environment. Moreover, we combine information on team composition with information on the internal and external collaboration network of the team, testing theories on team composition at the same time as theories on optimal network ties for a team.

We build on a theory on "optimal" group social capital by Oh, Labianca and Chung (2006), defined as the efficiency of the internal and external group ties. The theory predicts that group density will have an inverse u-shaped relationship with the existence of strong, multiplex, reciprocated ties. Groups with a greater range of positive nonredundant ties to other groups will be more productive. Groups where external ties are distributed more evenly among the group members will be more productive than groups where external ties are maintained by a few members. Bridging across intra-organizational boundaries of strong ties is more strongly associated with a high productivity than bridging across intra-organizational boundaries of weak ties. The same can be said for so-called "Simmelian bridges" or ties that are embedded in a cluster (Tortoriello and Krackhardt, 2010). What is more, the stronger the relationship between the group formal and informal leader, the greater the productivity of the group. We add considerations on the network heterogeneity of a team, stating that the higher it is, the higher is its productivity (Reagans and Zuckerman, 2005). Groups that have knowledge broadly distributed across group members (groups consisting of generalists) will outperform groups that have unique knowledge concentrated in different group members (groups consisting of specialists). Lastly, we look at inter-team linkages. Our findings in this field will add to the discussion on the importance of on the on hand team membership (associated with

strong ties, trust, and an easy flow of knowledge, Coleman, 1988; Krackhardt, 1992) versus on the other hand the advantages associated with external ties (Granovetter, 1973; Burt, 1992; Reagans and McEvily, 2003; Levin and Cross, 2004; Bouty, 2007).

Our dataset consists of information 200 university research units in the fields of science and biomedical science within one university over the course of 10 years. The boundaries of our teams are defined by the organization structure. We carry out a blockmodeling analysis of collaboration network data for the entire university to distinguish clusters and see whether they coincide with the formal team structure. Building on a theory of fault lines across social identity groups by Lau & Murnighan (1998), we then map score each group for the diversity or heterogeneity of the members in the group, both demographic (gender, age, nationality) and work-related, (the extent of expertise and specialization). Thirdly, we measure the network in and around the group per three years using a several variables: group density, weak vs. strong ties, internal vs. external ties, inter-team linkages, most central individual, group diversity. Finally, we assess the association of these dimensions with the total group productivity as measured by output using regression analysis; both for the formal units and for the clusters identified by blockmodeling.

Can We Account for Individual Productivity Differences in Scientific Research? A Comparative Econometric Analysis of Publication Records of French University and CNRS Physicists

Jacques MAIRESSE, Michele Pezzoni

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE I

In this paper we compare the scientific publication productivity of physicists in French universities and in CNRS (Centre National de la Recherche Scientifique). Such a comparison can help shedding some light on the benefits and costs of the institutional organization of scientific research in France. It also highlights some limits of expanding practices of scientific evaluation at the individual scientist level that are (too) largely based on quantitative publication indicators: in particular the shortcomings of using fractional-counting to "correct" for the extent of coauthorship. However, our main ambition and purpose here is to show, chiefly to non econometricians and statisticians, that an econometric analysis can account for individual productivity differences in scientific research to a significant and informative degree, even if indeed it remains far from explaining them very well and beyond doubts.

We thus consider in our analysis all the non nuclear and particle physicists, active in academic year 2004/2005, who are either teaching and doing research in the French universities as tenured lecturers and full professors ("Maître de Conférences" and "Professeurs"), or who are mainly doing research in the CNRS in the two equivalent statutory ranks of research associates and research directors ("Chargés de Recherche" and "Directeurs de Recherche"). We have gathered the publication records which are available from the ISI Web of Science for all the physicists in these two groups over the period 1979 to 2005. For simplicity we focus on one main indicator of scientific productivity which reflects both the quantity and quality dimensions of publications by weighting all articles by the 5 years average impact factor of the journal where they are published.

We also measure this indicator over subperiods of three years or "triplets" to avoid some of the randomness of yearly publications. The median CNRS physicist productivity appears overall to be twice as large as that of the median university physicist, increasing for both of them over the study period by some 1 to 2 units every triplet in terms of the impact factor weighted productivity indicator or by 0.1 to 0.2 articles in terms of (non-weighted) publications.

In addition to the usual variables of age, gender and rank, we consider as potentially important determinants of scientific productivity the average number of coauthors per article and several other collaboration characteristics: the presence of international coauthors, and for the national coauthors belonging to our two samples of university and CNRS physicists their own average productivity, average number of coauthors and four indicators of the existence and persistence of collaboration between university and CNRS physicists. The arithmetic average of the number

of authors per article are very close for the CNRS and university physicists, increasing from about 3.5 in the early 1980s to 6.5 in 2003-05.

We specify an econometric log-linear regression model accounting for changes and differences in individual productivity separately for CNRS and university physicists, but with respect to the same potential determinants or variables of interest in both. In estimating this productivity equation we try to take into consideration three specification issues that are likely, if disregarded, to result in biases in the estimated effects of determinants of interest or in different interpretations of the meaning that can be attached to their effects.

The first issue is that of important omitted variables which are correlated with included variables of interest, and mainly the so called "fixed effects" or "initial conditions effects", that correspond to unobserved (even unknown) variables that do not vary much over time, such as in our case individual scientist's capability, motivation and talent, and favourable environment and specialization, etc. We have proxied here for these effects by including in our productivity regression the initial productivity of the CNRS and university physicists in our samples as a specific variable (precisely measured by the number of articles and by their average 5 year impact factor in the "first triplet" observed for them and accordingly excluded in estimation from the sample observations).

The second specification issue is that of endogeneity, and in particular that of the rank variable. We take care of it by complementing our productivity regression by a promotion probit equation. Such equation is interesting in itself but also provides a predicted probability of promotion variable, which can help in correcting for the expected rank endogeneity bias if we use it to instrument the rank variable in the productivity equation. We also control for the likely endogeneity of collaboration variables by simply proxying them by their lagged values.

The third issue is one of selectivity, which is akin to an omitted variable problem. It corresponds to the fact that a significant share of physicists in our samples appears not to publish during one triplet or even two consecutive triplets. This share hovers roughly around 5% and 10% for the CNRS and university physicists respectively, tending to be higher for female than male physicists and for senior than junior physicists. It is likely that it is higher in the case of university physicists since they have to teach contrary to their CNRS colleagues. It may be also higher for female physicists due to the occurrence of maternity leaves and for senior physicists due to that of periods of time-consuming administrative responsibilities.

Specifying a log-linear productivity regression as we do and simply deleting the zero- articles triplets in its estimation (or including a zero-articles binary indicator in the regression or using some other form of transformation like Poisson) amount to neglecting what we can possibly learn from periods of non-publishing. In this case too, we can try to complement our productivity regression by a zero-articles selectivity probit equation that is interesting per se and provides a predicted probability of zero-articles occurrence variable. By including this variable in the productivity regression, we can hope to correct for a selectivity bias, which if negative for female and/or seniority effects might be an indirect reflection of unobserved maternity leaves and/or administrative responsibilities, conditional in particular on given "fixed effects" and "other things being equal".

Our results suggest a number of tentative conclusions. Collaboration as evidenced by coauthors characteristics, in particular international collaboration, extent and persistence of collaboration between CNRS and university physicists, and "fixed effects", as proxied by initial productivity, account for a large part of the individual productivity differences between CNRS and University physicists. Personal characteristics of gender and age have also a significant but smaller impact. When we control for zero-articles selectivity and promotion endogeneity, the female negative effect (i.e., the "gender bias") is significantly reduced even becoming positive for University physicists, and the age negative effect tends on the contrary to increase.

While CNRS physicists are in average nearly twice more productive (+90%) than university in terms of number of published articles and impact factor weighted productivity indicator, they would be about 50% "if they were university physicists and conversely" (i.e. if the average determinants of the former and latter were exchanged in their productivity equations!), university physicists would be in average about 30% less productive. Or else, while about 75% of CNRS physicists are more productive than the median university physicist, only 35% of them would be more productive than the median university physicist in such extreme counterfactual hypotheses.

As an aside conclusion, our results illustrate that fractional count is a simplistic and misleading way to take into account coauthorship in assessing individual productivity differences. It is simplistic and misleading. What really matters are the co-authorship characteristics, not the mere number of coauthors.

The Effect of Agglomeration Economies on Productivity and Efficiency of Manufacturing Firms

Abid BURKI, Mushtaq Khan

Agglomeration and Productivity

Geographic concentration of industries is one of the most striking features of economic activity in developed and developing countries. Evidence from developed countries shows that firms and workers are unevenly distributed across spatial units; they agglomerate in some regions more than others [e.g., Henderson et al. (1995), Ellison and Glaser (1997), Maurel and Sedilot (1999), Alonso-Villar et al. (2004), Bertinelli and Decrop (2005)]. The contributions of Paul Krugman (1991) and others, in what has been called the New Economic Geography, provide insights into the factors influencing these location decisions. They point out that firms benefit by locating at concentrated places where they enhance production to cater increasing demand. Moreover, increasing returns tend to decrease per unit cost due to specialization of labour and improvements in technology leading to internal economies [Lall et al. (2004)].

Following Krugman's work, numerous theoretical models have been developed on the economics of agglomeration, but similar claims cannot be made about empirical identification of these theoretical mechanisms [Duranton and Puga (2004)]. Large empirical literature studies agglomeration economies in developed countries, but few such studies explore these issues in developing countries Henderson et al. (2001), Lall and Rodrigo (2001), Lall et al. (2004), Lall et al. (2005). In general, these studies rely on production technology relating output (cost) to primary inputs (input prices, outputs) and a vector of economic geography variables as sources of agglomeration economies. However, these studies assume that managerial inefficiency of firms is always zero, which is least likely as suggested by the vast stochastic frontier literature [e.g., Aigner et al. (1977), among many others. How sensitive is technical inefficiency to these measures of environmental production conditions have not heretofore, so far as we could determine, been investigated in any country.

In this paper we evaluate the effects of agglomeration economies on productivity and technical inefficiency of manufacturing firms by using plant level data of Pakistan from the Census of Manufacturing Industries. We jointly estimate the translog stochastic production frontier and technical inefficiency effects model [Battese and Coelli (1993, 1995)] where we relate the value added output to a vector of inputs for the firm consisting of (a) capital and labour; (b) a vector of agglomeration measures consisting of localization economies (or intra-industry spill-over) and urbanization economies (or inter-industry spill-over); and (c) controls for industry and metropolitan district-effects. To test whether other environmental production conditions have a positive or negative effect on technical inefficiency of firms we specify technical inefficiency effects model reflecting the relevant effects of location change, viz., proxies for market access; measures for labour pooling in each district; other firm-specific variables; and industry and metropolitan district effects. Hypothesis tests would determine (i) whether technical inefficiency effects are absent from the model; (ii) whether inefficiency effects are not stochastic (iii) whether all the explanatory variables in the inefficiency model are jointly zero. We expect increase in market access and labour pooling to significantly lower technical inefficiency of firms.

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Does being in an Industrial Agglomeration enhances Productive Performances?: Evidence from Egypt using a Geo-Spatial model

Mohamed Mekki Ben Jemaa

Agglomeration and Productivity

It is widely accepted that TFP growth holds through three main components i.e.: technical change, efficiency change and scale change. Traditionally, these components are assumed influenced by both internal structure of the firm (input quality, type of management, etc.) and its environment (policy, prices, openness to the international competition, etc.). Few studies in the world have tackled the issue of a possible productivity spill-over for neighbor productive units. The paper aims at the exploration of the sources of TFP growth in Egypt with a special interest to the assessment of any possible spill-over between firms located at the same industrial agglomeration. In a first time, TFP is decomposed into its three components: Technological change, Technical Efficiency and scale efficiency using The Data Envelopment Analysis Techniques. The individual efficiency is estimated using Farrell (Farrell, 1957) output oriented technical efficiency (TE). Productivity growth is then measured by Malmquist Output-Based Productivity Index and decomposed using Simar and Wilson (1998) methodology assuming a multiplicative scheme. In a second step, TFP growth, Technical efficiency and scale effect are set conditional on a set of covariates describing the internal and the external environment of the firm along with the performances of other firms sharing the same industrial agglomeration in as suggests a spatial lag model (Anselin, 1989). Data used for this paper is based on the World Bank enterprise surveys which is an excellent company-level data in emerging markets and developing economies. Three enterprise surveys where held in Egypt: in 2004, 2007 and 2008. The choice of Egypt for this study is widely influenced by the quality of data provided for this country especially concerning the firms localization. Two variables provide the geographic localization of the firm in the survey. A variable indicating the industrial area to which the fir belongs (for firms that are in an industrial agglomeration) and a variable indicating the Kism/markaz (the administrative subdivision in Egypt equivalent to a county) where the firm operate for all firms. Based on the surveys of 2007 and 2008 it was possible to construct initially an unbalanced panel of 4 years (from 2004 to 2007) and 1227 firms belonging to 8 manufacturing sectors which are: garments, textiles, machinery & equipments, chemicals, metal industries, non metal industries, agro industries and other industries. Preliminary

analysis of the final database shows a significant difference between firm located in an industrial agglomeration (IA) and other firms. This result is based on a preliminary regression where belonging to an IA is proxied by a dummy variable equal to 1 if the firm belongs to an IA and 0 else. It was found also that there was a slight difference in Technical Efficiency scores between firm belonging to an IA and other firms.

Quality of life experienced by human capital: an assessment of European cities

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Agglomeration and Productivity

The economic literature focusing on urban aspects has been attributing a growing importance to issues related to quality of life. Being a multidimensional and multidisciplinary concept, quality of life has also been increasingly discussed from the perspective of competitiveness of cities, in an international environment characterized by creativeness as the drive of development. Quality of life is an important factor to explain why cities are considered attractive by some segments of the population. Particularly important is to understand this attractiveness in what concerns highly educated and productive people, as they can be the key factor to promote urban economic growth and development. The identification of the cities with better conditions to attract this human capital, and thus investments, is a useful tool to politicians and, in an European perspective, an important asset to justify the allocation of funds in order to assist economic development. The main aim of this paper is to provide a picture of the quality of life of European cities from the perspective of highly educated people. For this purpose, we propose an assessment of the European cities quality of life (QoL) by means of a composite indicator obtained using Data Envelopment Analysis (DEA). This indicator was computed based on data collected by the European Urban Audit project, taking into account the preferences that human resources give to different aspects of quality of life according to a worldwide well-known consulting firm, Mercer. The cities' ranking based on the composite indicator of QoL is then compared with the ranking that Mercer provides every year based on its own data. Given the urban diversity of Europe, we also propose to characterize benchmark cities and non-benchmark cities concerning the contextual factors that may influence cities QoL in the perspective of highly qualified human resources. This approach involved the use of a decision tree, where the target variable is the DEA performance score, used to classify each city as benchmark or non-benchmark. The exploratory variables correspond, among others, to the geographical location of the cities within Europe, their importance within the country (i.e, capital or not) and demographic conditions (i.e., population density).

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Profiting from agglomeration?

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Agglomeration and Productivity

Agglomeration effects or external returns have received substantial attention for more than a decade. Many studies investigating the presence of agglomeration effects have been based on a production function approach, where one shows that industrial clusters increase productivity due to scale economics caused by external factors. The external scale economics then increase the competitiveness of an area, as the firms located here presumably have higher productivity than firms located outside the area. While benefits to the firms within a cluster then shows up as higher output per unit of inputs, the specification does not capture several economically relevant aspects of industrial agglomeration. For this reason, cost function specification has also been used. By accounting for economic factors like input prices and capacity utilisation, the cost model approach provides understanding of factors underlying the cost-output relationship. Furthermore, using a cost function approach the extent of agglomeration externalities can be more directly estimated, as the benefits show up not only as higher output per unit of inputs, but also as lower production cost at locations where the externalities are present.

However, cost reduction as the main benefit of agglomeration, does not fit well with all observed industrial clusters. For example, casual inspection suggests that many celebrated clusters are located in high cost areas. This is the case e.g. for the IT cluster in Silicon Valley and the financial clusters in N.Y. and London. In these areas cost of living is relatively high, and the cost for several factors is therefore also high to compensate them for being located in such high cost area. Higher productivity in the primal sense or lower cost for the firms in question are then just pieces of the puzzle that can be important, but that may not tell the full story. In this paper we will investigate the impact of agglomeration on profits. This allow us to account for revenue effects in addition to productivity and cost advantages, which can be important particularly in high cost clusters since it also enables firms to cover higher costs. Further support for this notion in relation to agglomeration, can be found in the managerial economics literature, where one also focus on the revenue effects from agglomeration through higher rates of innovation, and in the urban economics literature where one recognizes that there are both economies and diseconomies related to agglomeration.

We specify a model allowing for agglomeration effects for a profit maximizing firm. Our empirical analysis focuses on Norwegian salmon aquaculture production. The empirical analysis uses a translog specification, and as we have access to firm-level data, we can test for intra- as well as inter industry effects.

The results indicate that agglomeration economics are present within the industry, between the industry and the fisheries sector, but not from processing industries and local industries in general.

How confident can we be about confidence intervals for firm specific inefficiency scores from parametric Stochastic Frontier Models?

Phill WHEAT, Andrew Smith, William Greene

Advanced SFA

Stochastic frontier models have the attractive property that the unobserved residual component of the model is comprised of both noise and inefficiency. Point predictors for firm inefficiency are common in the literature and follow the methodology of Jondrow et al (1984). The question then remains, how precise is the prediction of firm inefficiency especially when the Jondrow type estimates are known to be inconsistent in many cases? With this in mind and the general desire of practitioners to understand uncertainty in their estimates, it is perhaps surprising that interval predictors are not commonly reported in the empirical literature.

While a body of literature exists on such intervals, overall it is not clear as to what the properties and limitations are with respect to each innovation. The purpose of this paper is to clarify the existing literature that has developed on the subject over the last two decades and to propose a method to incorporate uncertainty from parameter estimation within the intervals. We start with the intervals proposed by Horrace and Schmidt (1996) (HS intervals). Importantly we conclude that these intervals are not confidence intervals, but are instead prediction intervals for firm inefficiency, ignoring any uncertainty due to parameter estimation. We also discuss that the intervals cannot be considered confidence (or otherwise) intervals for E[u(i)|e(i)] as asserted by Bera and Sharma (1999), since

var[u(i)|e(i)] is not the variance of E[u(i)|e(i)]. The important implication is that the HS intervals cannot be used for hypothesis testing as outlined in Bera and Sharma.

We discuss that the HS intervals do not represent minimum width intervals for and as such are not optimal interval predictors. We discuss how to compute minimum width intervals and highlight their attractive property that the lower bound equals zero if the probability mass of inefficiency is close to zero, otherwise it is greater than zero. This is useful in providing information as to the likely presence of inefficiency for a given firm.

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How does the choice of the scaling function in BC92-type models affect inefficiency estimates? Observations and generalisations

Andrew SMITH, Phill Wheat
Advanced SFA

The model developed by Battese and Coelli (1992), later extended by Cuesta (2000), has numerous desirable properties in the context of economic regulation and more widely.

This model is written as: U-it = U-i * exp (eta-i * (t-T)), t=1...T.

Where firm-specific etas are incorporated, the model allows inefficiency to vary over time, whilst permitting firm-specific time paths of inefficiency. It also enables the unrealistic assumption of independence in inefficiency over time to be relaxed (see Alvarez et. al., 2006), which is important in a regulatory context. Lee (2010) notes that this model is particularly useful when it is applied to a panel dataset with a small N and a large T; small N being a particular problem faced by economic regulators.

A key issue, however, is that the particular functional form selected by BC92, incorporating the constant T, in the (t-T) term, is essentially arbitrary. Using this formulation, combined with firm-specific time paths for inefficiency, we have observed that frontier firms drop sharply away from the frontier in the final year of the sample (year T); this phenomenon also being observed when (repeatedly) restricting the sample to take out the final year's data. Importantly, the same is observed in the original Cuesta (2000) paper, though it was not commented upon there. We also observe very large eta-i coefficients with large standard errors for frontier firms. Again a similar problem is evident though not discussed in Cuesta, 2000.

For frontier firms it therefore appears that the model produces an unpalatable pattern of inefficiency scores, particularly for economic regulators, as these firms all drop sharply away from the frontier in the final year of the model. The final year scores are often the most relevant for economic regulators as they form the basis for the setting of regulatory efficiency targets. More widely, inclusion or not of the T term, or selecting different values for this constant, impacts on the inefficiency estimates.

In this paper we demonstrate the above problem using an empirical example, and propose a solution, namely a more general model of the form:

U-it = U-i * exp (eta-i * (t-alpha-i)), t=1....T.

Our proposed model addresses the arbitrary nature of the BC92-type specification by turning the constant T into a parameter, alpha-i. This more general model nests the Cuesta (2000) where alpha-i = T for all firms and likewise the BC92 model if, additionally, there is a common eta parameter across all firms..

We show that for our empirical application, permitting greater flexibility in the inefficiency scaling function removes the problems noted above, whilst nevertheless producing highly plausible frontier parameter estimates and inefficiency results. We also explore the application of a restricted form of our model for the case of a common eta parameter (BC92) for the case unbalanced panels, where a similar problem may occur.

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Omitted Relevant Variables and Stochastic Frontier Efficiency Rankings

Shelton Schmidt

Advanced SFA

Stochastic frontier efficiency rankings are of interest to researchers, administrators, and others. These rankings, however, may be questioned if relevant variables were omitted from the estimation of the stochastic frontier. Two published studies include evidence on the effect of omitting a relevant variable on efficiency rankings calculated using cross sectional data: John Ruggiero, "Efficiency Estimation and Error Decomposition in the Stochastic Frontier Model: A Monte Carlo Analysis," European Journal of Operational Research, 1999; and Uwe Jensen, "Misspecification Preferred: The Sensitivity of Inefficiency Rankings," Journal of Productivity Analysis, 2005. One of the findings of these studies is that the omission of a relevant variable (from the estimated model of the production function) reduces the average of the correlation between the true and estimated efficiency rankings. My research replicates and extends the work done by Ruggiero and Jensen by performing additional Monte Carlo experiments using an omitted relevant variable with an assortment of degrees of kurtosis. I will use three-dimensional graphs to visualize the effects of multicollinearity in the inputs on the efficiency scores when relevant variables are omitted. Some of the ideas draw on Seth J. Chandler, "Cobb-Douglas Production Functions" The Wolfram Demonstrations Project, http://demonstrations.wolfram.com/CobbDouglasProductionFunctions/.

A Distribution Free SFA Model

Aljar Meesters

Advanced SFA

This paper develops a distribution free Stochastic Frontier Analysis (SFA) Model. The developed model is especially useful for estimating profit functions since it allows for negative values of the dependent variable, an issue that has not been addressed in the literature so far. The idea behind the suggested model is an additive error component and additive mean in a multiplicative function. The paper shows that the model behaves well on simulated data. Moreover, the suggested model is applied and compared with a standard SFA model one European bank data. The obtained efficiency estimates from both models are in line with each-other.

Assessing measurement error in stochastic frontier analysis

Mike Tsionas

Advanced SFA

Errors in the variables plague applied econometric practice yet they have been given practically no attention in the stochastic frontier literature or applied production economics. In this paper, we propose practical Bayesian procedures that can be used to estimate the stochastic frontier model with errors in the variables and deliver proper inefficiency measures. We consider both Cobb-Douglas and translog frontiers. In the second case we have a nonlinear random effect model. The new methods are applied to many well known datasets in the literature. Moreover we apply the techniques to a large panel for the U.K manufacturing sector and show the dramatic changes in inferences that can result.

Global efficiency and environmental protection's effects: evidence from Italian polluting industries

Alessandro Manello
Eco Efficiency

In Europe environmental regulation (in particular referring to IPPC Directive) is continuously rising and also the number of industrial sectors involved is increasing. Firms and institutions are forced to take into account pollution in their decisions then classical productivity analysis miss important dimension. A lot of global productivity indexes were proposed in non-parametric framework as Scheel (2001) and Zhou et al.(2008) summarize. In particular an asymmetric treatment of good and bad outputs is needed in order to discredit firms which increase their emissions. One of the most reliable concept of productivity proposed in non-parametric literature is based on Directional Distance Function (Chambers et al., 1996; Chambers et al., 1998; and Färe et al., 2000). This framework is applied in environmental field since its introduction (Chung et al., 1997; Boyd et al., 2002; Domalizlicky and Weber, 2004; Färe et al., 2006, Picazo-Tadeo and Prior, 2009; Bellenger and Herlihy, 2010; Macpherson et al., 2010) to create global efficiency measure. The aim of the paper is to extend previous literature on directional distance function (DDF), concentrated on small sample of homogeneous firms which produce limited number of pollutants, to an Italian sample of heterogeneous firms. A huge number of pollutants different in toxicity have been considered for industrial sectors which are subjected to the same normative framework. After classical efficiency measures and regulatory costs estimates, a second stage analysis have been proposed to understand some determinants of previous results. From a methodological point of view DDF is applied in non-parametric way using economical data from balance sheet and environmental data for each DMUs. Two databases were merged: E-PRTR European Pollutions Release and Transfer Register that collects data on air and water pollution at plant level and AIDA database from Bureau Van Dijk that contains economical variables derived from balance-sheets at firm level. Value added has been used as good output, capital stock and labor costs as inputs, air and water environmental damage as bad outputs by weighting chemicals for their toxicity. After estimating mixed environmental-economical performances via DDF assuming bad outputs as weak disposable, a proxy of IPPC's impact has been derived by comparing efficiency results under free disposability of undesirable outputs following Färe et al.(2007) and Picazo-Tadeo et al. (2005). As Simar and Wilson (2007) demonstrate, previous estimated indicators could be analyzed in a second stage phase using non-parametric technique. My paper tries then to extend what Watanabe and Tanaka (2007) or Kumar (2006) have done for environmental productivity growth to the case of efficiency scores and regulatory costs, by investigating determinants of both. Results show significant explanatory power for firms' structure indicators and other individual characteristics. The analysis also underline which firms have suffered much from normative stringency and it could suggest how to leverage, from a policy-making perspective, in order to increase environmental performances and to reduce regulatory burden. Key references: Picazo-Tadeo and Prior (2009); Watanabe and Tanaka (2007); Färe et al.(2007)

The impact of local air pollution on airport efficiency assessment: evidence from Italy

Gianmaria Martini, Davide SCOTTI, Nicola Volta

Eco Efficiency

Airport efficiency has been the subject of many contributions (Lozano and Gutierrez, 2009; Pels et al. 2001, 2003): technically efficient airports are those that maximize their outputs with their given inputs. However, even though airports that increase passengers, cargo and flights bring significant economic and social benefits to the local communities, there are some environmental externalities (such as noise annoyance and pollutants' emissions) associated to airport activities, that should be considered in evaluating their performances to avoid problems of (1) biased efficiency estimates and (2) overestimation of the benefits created by airport activities. In particular, the quality of the air nearby the airports is an increasingly important issue for airports managers, particularly in the European Union, where environmental directives and strategies have been approved.

The aim of the present paper is to evaluate airports' technical efficiency using a parametric approach allowing the inclusion in the efficiency estimation of both desirable and undesirable outputs. More in details, we focus our attention on the production of Local Air Pollution (LAP) created by aircraft movements: some contributions have shown that the social costs of aircraft pollution are relevant (Dings et al., 2003; Givoni and Rietveld, 2010). To the best of our knowledge, no previous study regarding airport efficiency has considered LAP as undesirable output. Moreover, there are no parametric studies about airport efficiency that take into account the simultaneous production of desirable and undesirable outputs. The only four contributions that have considered undesirable outputs in airport efficiency analysis (i.e., Yu (2004), Yu et al. (2008), Patomshiri et al. (2008) and Lozano and Gutiérrez (2010)) adopt a non-parametric approach.

Following the approach of Cuesta et al. (2009), we estimate a stochastic production frontier using a hyperbolic distance function model that is both parametric and stochastic. In this way, it is possible to represent the proportion by which desirable outputs can be expanded and undesirable outputs and inputs can be reduced in a multiplicative manner. Efficiency scores are estimated by a standard maximum-likelihood technique (Battese and Coelli, 1992). The econometric model is applied to a dataset of 33 Italian airports for the period 2005-2008.

We show that, when undesirable outputs are ignored, airport efficiency scores are totally different and can therefore be misleading. Specifically, the results indicate that airports tend to be more efficient, on average, when negative externalities production is included in the analysis. More in details, "inefficient" airports get closer to the environmental frontier thanks to the low number of movements realized. Furthermore, when airports with similar number of movements are considered, we clearly identify the presence of a fleet effect: more environmentally friendly fleets reduce the emissions and make airports more efficient.

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Environmental efficiency and Sustainability in Manufacturing Industry

Heike Wetzel, Yan LI

Eco Efficiency

There has been increasing salience for being more eco-efficient and more sustainable in industrial operation due to, for example, public pressure and environmental legislation at both national and international levels. However, it

is difficult to benchmark efficiency environmentally and sustainability in a production process. Our study exerts to contribute to literature by addressing this issue through examining a unique dataset (i.e., manufacturing industry in the EU27 over the period 1995-2006) that links greenhouse gas emissions with economic figures at an industry level. By using a directional distance function approach, we calculate a Malmquist-Luenberger productivity index that measures productivity change in the presence of environmental constraints such as air-pollution regulations. We further decompose the productivity index into its components and using a variety of socio-economic and industry structure variables, we analyze different sources of productivity growth, namely efficiency change and technical progress, and investigate whether country-specific differences in the development of productivity exist. A SFA model in alignment with a Bayesian approach is also developed to analyze environmental efficiency change separately from technical efficiency change to check for robustness of the measurement results obtained from our directional distance function approach.

Combining Field Research, GIS and DEA to Guide Ecosystem Management

H. K. Millington, J. E. Lovell, C. A. K. LOVELL

Eco Efficiency

Aquatic ecosystems are vulnerable to threats from human activity. Urban stream ecosystems are especially vulnerable to urbanisation of surrounding land use. Many scientists, government organisations and local volunteer groups are interested in improving the health of urban streams. We study thirty sites along two highly urbanised streams in Brisbane, Australia. A suite of water quality and stream health indicators were collected at each site during field research (e.g., macro invertebrate signal score, maximum water temperature, dissolved oxygen range). Geographic information system (GIS) techniques are being used to determine metrics of nearby land use that put stress on stream health at each site (e.g., distance-weighted impervious surface area, directly connected impervious surface area, tree and vegetative land cover). Population density is also considered as a stressor. Data envelopment analysis (DEA) is applied to individual health indicators (one at a time) and multiple stressors to construct a suite of stress/health frontiers. Calculated elasticities quantify the relative impacts of alternative stressors on stream health. DEA is also used to aggregate stream health indicators into a stream health index for each site, and to aggregate land use stressors into a land use stress index for each site. A second round of DEA is then applied to the two indexes to create a holistic stress/health frontier, which identifies best practice sites and dominators of laggard sites. Early empirical findings show a correlation between indexes of land use stress and stream health, significant deviations beneath best practice, and numerous dominators for some laggard sites. Each of these findings should provide guidance to those responsible for allocating scarce resources in an effort to improve the management of the health of Brisbane's urban streams.

Investment Decisions and Dynamic Efficiency Measurement under Uncertainty

Grigorios EMVALOMATIS, Spiro Stefanou E.

Dynamic Efficiency

The efficiency measurement literature focuses largely on a static view of the firm where the optimality of decisions is measured without any connection to the forces associated with time. On the other hand, dynamic models of firm behavior appear as early as 1970. Estimation of these models is, most often, based on dynamic duality and assuming static expectations. Furthermore, with the exception of Rungsuriyawiboon and Stefanou (2007), the possibility of inefficiency at the firm level is not considered.

We introduce a structural model of firm behavior that explicitly allows for suboptimal decision making with respect to, among other factors, investment. The model has origins from Pindyck and Rotemberg (1983), although it is a generalization of it in terms of functional form. The restrictive assumption of static expectations is dropped in favor of rational expectations.

The proposed model is applied to a panel of food-manufacturing plants from Mexico. The data cover a period of great economic instability in the country, with high and very volatile inflation and interest rates. In such an economic environment uncertainty is expected to reduce efficiency. The rational expectations assumption is crucial for measuring inefficiency net of this volatility.

Estimation is proposed within the framework of the Generalized Method of Moments and the approach of Ahn, Lee, and Schmidt (2007) is used to measure inefficiency in a system of equations. The system consists of a variable cost function, the derived variable cost-share equations and the implied Euler equations from the dynamic model. Cost minimization is assumed in the long run and the optimality of decisions with respect to investment levels is assessed against this objective. The direct estimation of the Euler equations avoids the necessity of explicitly solving for the long-run equilibrium point. Instead efficiency is measured in a period-by-period basis, at the point where the decisions are made. Additionally the observed streams of output are used to evaluate the efficiency scores, avoiding in this way to infer what the optimal level of output should be in the path towards the long-run equilibrium.

Three types of possible inefficiency are identified and estimated: (i) variable-cost inefficiency, (ii) allocative inefficiency with respect to labor and materials inputs, and (iii) dynamic inefficiency with respect to capital input.

The results suggest that firms in the industry are on average about 53% efficient with respect to variable input use. Under-employment of labor is observed during the period of economic instability, but allocative efficiency improved as the economic environment started stabilizing. With respect to capital input, the industry is found to be overinvesting on average. The price of capital that would rationalize the observed behavior is about 3.6%; a value that does not even cover depreciation.

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Dynamic Efficiency and Machine Replacement: A Discrete Choice Approach

Jorge CERDEIRA, Elvira Silva

Dynamic Efficiency

Dynamic efficiency measurement at the firm level has been developed in the context of models in which firms decide over continuous variables [e.g., Silva and Stefanou (2007), Nemoto and Goto (1999, 2003)]. In this paper, dynamic efficiency is investigated within a dynamic discrete choice model, in which firms decide over discrete rather than continuous variables. We analyze a dynamic programming machine replacement model - in which firms have to decide whether to replace their machines or not in order to minimize intertemporal costs - and develop a measure of dynamic cost efficiency at the firm level. In our model, we allow for the existence of firm heterogeneity as well as efficiency heterogeneity across firms by including random parameters in the analysis. Using a dataset with yearly information on 290 Portuguese textile and clothing firms from 2001 to 2008, we estimate our model for all the firms in our dataset, as well as for subsamples on big and small firms. We use the Bayesian estimation method proposed by Imai et al. (2009), which allows simultaneously for the solution of the dynamic programming problem and the estimation of the parameters. This method includes in each iteration two steps: one solves the dynamic programming model and the other employs the Markov Chain Monte Carlo (MCMC) algorithm to draw values from the posterior distributions of the parameters. We find out that the estimated efficiency is very similar for big and small firms as the average efficiency across firms is around 1.4 for both types of firms, meaning that, on average, big

and small firms' actual costs are 1.4 times their minimum costs. Our estimation results also reveal that different types of firms have different cost structures: on average, while big firms have significant maintenance costs and negligible learning costs, small firms bear important learning costs and statistically insignificant maintenance costs. We perform counterfactual experiments to know what would be firms' optimal choices and compare them with the actual choices. The counterfactuals results suggest that different types of firms should react differently in order to be fully efficient: big firms should do more replacements and small firms should replace less in order to be fully efficient.

Efficiency Measurement in a DSGE Framework

Camilla MASTROMARCO, Ulrich Woitek

Dynamic Efficiency

Pioneered by Aigner et al. (1977) and Meeusen and van den Broeck (1977), stochastic frontier analysis is a possibility to address the issue of cyclical factor utilization by estimating a single equation production frontier. The idea of our paper is to extend this approach and incorporate inefficiency in a dynamic stochastic general equilibrium (DSGE) model. It is straightforward to replace the production function in the standard Ramsey model by a stochastic frontier function. Linearizing the first-order conditions of the model, we end up with a state space space representation, which allows to estimate the structural parameters either by maximum likelihood or by Bayesian methods using the Kalman filter (e.g. Harvey, 1992). Assuming an AR(1) process for the log of efficiency. Following Duecker (2006), it is straightforward to adjust the prediction equations of the Kalman filter allowing the stochastic term to follow a truncated normal distribution. The approach can be interpreted as an extension of Ireland (2004), who estimates the parameters of a DSGE model adding a VAR structure for the measurement error. By allowing the possibility of inefficient production in addition to the VAR component, we are able to be more specific about off-model dynamics.

What is the role of environmental factors in the cost efficiency of Swiss water distribution utilities?

Andrea Baranzini, Anne-Kathrin FAUST

Water Management

Climate change, water scarcity and growing political concerns about the performance of network industries are putting pressure on Swiss water distribution utilities. An efficient management of the resource is thus fundamental to answer the challenges that lie ahead. The aim of this study is to contribute to the ongoing debate concerning the definition and the comparison of the performance of Swiss water utilities by analysing their costs and efficiency, taking account of the influence of environmental factors. This study uses a new and unexploited database of the Swiss Gas and Water Industry Association (SGWA). The SGWA database spans over ten years (2000-2009) and counts about 2600 observations. It offers information on the type of water production process, customers, the characteristics of the network and the cost of water supply for over 300 utilities. The water distribution utilities differ widely in terms of size, structure, water resources, geological characteristics of the distribution area, production processes and customer demand and are situated all across Switzerland. We use parametric panel data stochastic cost frontier estimation to elaborate alternative measures of efficiency. We apply those measures to benchmark the utilities with respect to each other and to highlight possible sources of inefficiencies in water supply. To explore the determinants of water supply costs and efficiency, the cost frontier does not only include output and input prices,

but further integrates environmental and climate related factors to be able to assess their impact on the costs and performance of water distribution utilities. This approach thus differentiates factors that are outside the control of the distributors (e.g. type of available raw water, customer density, precipitation) from those that can be managed (e.g. production factors). References: Filippini M., Hrovatin N., Zoric J. (2007). Cost efficiency of Slovenian water distribution utilities: an application of stochastic frontier methods. Journal of Productivity Analysis, 29: pp. 169 - 182. Greene W.H. (2005) Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. Journal of Econometrics, 126: pp. 269-303. Renzetti, S. and Dupont D. P. (2009). Measuring the technical efficiency of municipal water suppliers: the role of environmental factors. Land Economics, Vol. 85 Issue 4, p627-636, 10p.

Benchmarking local regulatory authorities: the case of integrated water services in Italy

Clementina BRUNO, Fabrizio Erbetta
Water Management

Italian water service has undergone an important reform (Galli's reform) starting from 1995. The main introduced changes were related to privatization and mergers of the existing operators, in order to reduce their number (and increase their dimension), with the target of having a single firm providing the service in each territorial unit (OTA, Optimal Territorial Area), hence allowing it to operate there as a monopolist. In order to protect users from potential monopolist's abuses, a regulatory authority was established in each OTA, to the amount of 92 authorities in the whole national territory. Although examples of authorities performing similar tasks exist in Europe (e.g. in the United Kingdom), in no other European Country it was possible to find as many water service regulators as in Italy. Recently OTAs have been eliminated by law and Italian Regions have now to choose how to reorganize the regulatory structure. For these reasons, an empirical analysis providing support to such policy choices seems particularly useful.

While the empirical analysis of the performance of firms providing water services is a broadly discussed topic in the literature, scarce attention is devoted to the performance of the regulator, which is a relevant issue as well, since the authority is a public body that uses resources whose cost is ultimately borne by households. This work is aimed to analyse the efficiency performance of Italian water authorities, by means of a Data Envelopment Analysis. The study, on top of detecting the presence of inefficiency, will show whether Italian Water Authorities were sub-dimensioned and whether, in a reorganization perspective, some adjustment in terms of dimension should be considered.

As often highlighted in the literature, when dealing with the evaluation of public entities performance, the choice of variable is a difficult task. In this study we use financial data (costs) as inputs, while environmental variables seem to be the best proxies of the output. We apply an input-oriented Data Envelopment analysis.

Empirical national or international literature related to the performances of public authorities is still scarce, and to the best of our knowledge there is no study investigating such issues for regulatory authorities. Initial estimates suggest the existence of relevant inefficiencies, where the impact of the scale effect is not negligible. This is not surprising, given the small average dimension of Italian water regulatory authorities. This would suggest, as a policy implication, that a dimensional reorganization could be useful in term of resource savings.

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Measuring efficiency in the Italian water management sector: an empirical analysis

Corrado lo Storto

Water Management

Measuring efficiency in the water management sector is a major issue for policy makers (Bruggink 1982). Since the 1994 Galli Law, the Italian water management sector has undergone a number of reforms that had the aim to improve efficiency and service quality, reducing the local fragmentation of local operators and networks. These reforms would heavily impact the structure of the sector, both on the demand and the supply side. Particularly, water services were organized on the basis of optimal territorial areas (ATO), key actors in the restructuring process. In the new framework, one single company has to be in charge of the whole water cycle, with the separation between the planning and regulation role assigned to public authorities from the management and investment role assigned to specialised companies. Furthermore, the law indicated a new formula to calculate water supply services that includes all foreseen expenditures, the underlying principles being the total coverage of costs and rate increases subject to limitations typical of Price Cap systems. Even though the restructuring of the sector is at an advanced stage of implementation, results are very different, and the role of ATOs as a means to achieve efficiency has been debated. The objective of this study is to carry out an empirical analysis of efficiency in the Italian water supply sector and investigate the following major questions: 1) does water tariffs correlates to ATO efficiency measures? 2) are different ATO efficiency measures associated to different ATO characters (i.e, organizational forms, business agreements established with companies, size, etc.)? This study adopts Data Envelopment Analysis to measure ATOs efficiency. The adoption of DEA has been used in literature to purposely measure efficiency in the water management sector (Estache, Rossi 2002; Garcia-Valiñas, Muñiz 2007). Thirty-eight ATOs are included in sample(the total number of ATOs is 91). Two models have been developed to measure ATO efficiency, the first including 6 inputs and 5 outputs, the second one including 5 inputs and 3 outputs. These are based on technical (i.e., network length, water amount), economical (i.e., operational costs), and management data (i.e., number of employees). Scale returns are also investigated. Statistical analysis is implemented to explore relationships between efficiency rates and some variables identifying ATOs characters. A preliminary analysis of results has showed that more than half of ATOs of sample are efficient. There is no correlation between tariff and ATOs efficiency. Some ATOs characters are associated to efficiency.

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Persistent and region-specific maintenance cost inefficiency in European and North American rail infrastructure: a panel data stochastic frontier approach

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Transportation

The European rail liberalisation packages have contributed to the separation of infrastructure activities from train operations. Cost efficiency in rail infrastructure management, which is a monopolistic activity, is subject to regulatory scrutiny in Britain, and will become subject to similar scrutiny elsewhere in EU member states as new rail regulatory bodies are set up and gain increased powers.

However, a key problem facing economic rail regulators is the lack of comparators. Most countries have a single rail infrastructure provider, thus ruling out domestic comparisons. Even for international comparisons, the number

of comparator firms is likely to be small. The lack of data points for econometric or other benchmarking work is therefore a major problem in the sector.

In common with other network industries, rail infrastructure managers are, for either structural or historic reasons, often organised on the basis of regional branches. This has two important implications. Firstly, it offers a possible solution to the problem of lack of comparators, since regional data from several countries can be pooled together, possibly also over time. Secondly, it raises the question as to where inefficiency resides within organisations. The main research issue when looking at the relative efficiency of branch-based organisations is the possibility of separating persistent inefficiency that applies across all regions in the same firm, from residual (region-specific) inefficiency. Smith and Wheat (2009) have analysed this issue using an unbalanced panel of European rail infrastructure managers. The present paper extends their work by looking at an expanded data set, incorporating both European and North American observations, over a multiple-year period. The data set has been collected by the British railway regulator (ORR) in 2010.

The method is the one adopted in Smith and Wheat (2009), which adapts the models developed by Kumbhakar and Hjalmarsson (1995), making the same distinction between persistent and residual inefficiency, but in this case across sub-companies within an organisation rather than over time.

We expect that this dual-level efficiency study will highlight significantly different levels of regional inefficiency, both within and across rail infrastructure operators. We expect these inefficiency levels to be separable from firm-persistent inefficiency. Previous work has also suggested that failing to account for the dual-level nature of inefficiency may cause overall firm inefficiency to be underestimated. We certainly expect that the differentiation between region-specific and persistent inefficiency will spark a constructive debate amongst regulators, policy-makers, and the management of regulated firms about the treatment of sub-company effects in regulatory proceedings, as well as the likely consequences to be faced in terms of industry design and reform.

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Measuring Input Congestion for Rail Transport with Consideration of Environmental Factors

Erwin LIN, Chun-jia Chiang

Transportation

Rail transport has long played an important role in the economic development for a country and enhancement of its operating efficiency is important to be sustainable in a competitive context. Many researchers have endeavored to rail transport performance measurement in the past several decades but one of common drawback is that they did not take the input congestion effects into consideration. In practice, the "congestion effects" do exhibit in the railway transport due to the difficulties of disposing unnecessary input factors (e.g. overstaffing). Thus, it would be helpful if one could identify the possible sources of input congestion so as to propose more specific improvement strategies for any specific railway company. As such, evaluating input congestion effects for rail transport deserves in-depth investigation.

In this study, we attempt to evaluate the output-oriented technical efficiency and then investigate the strong and weak congestion for some selected European Union (EU) member states' 24 rail companies in 2007 and 2008. We choose passenger-km per kilometer and ton-km per kilometer as outputs, and number of employees per kilometer, number of passenger cars per kilometer, and number of freight cars per kilometer as input factors. It is hypothesized that there may exist strong and/or weak input congestions in some railways and the main objective of this study is

to test this hypothesis. Based on previous literature, we note that at least three methods for measuring the input congestion have been developed: Färe-Grosskopf-Lovell (FGL) method by Färe et al. (1985), Cooper-Thompson-Thrall (CTT) method by Cooper et al. (1996), and Tone-Sahoo (TS) method by Tone and Sahoo (2004). However, these three methods do not take into account environmental factors, thus the interpretation of results could be misleading. In practice, the output shortfall could be decomposed into three components: environment, inefficiency, and congestion effects. To rectify this study investigates strong and weak congestions with some influencing factors such as gross national income per capita (GNI) and population (POP). More specifically, the methodology for measuring input congestion in this study can be divided into three stages. At first-stage we evaluate the output-oriented technical efficiency by using BCC DEA model and substituting adjusted data which has been adjusted by some influencing factors. At second and third stages we then investigate input slacks as well as strong and weak congestions by adopting Tone and Sahoo (2004) method. For comparison, we also investigate input congestion by raw data. Our results indicate that measuring input congestion with consideration of environmental factors seems more reasonable and reliable than those measured by conventional DEA models. The major contribution of this study is that we extend the DEA method by identifying the sources of input congestion in the railway transport performance measurement, from which one could propose more practical strategies in improving the railway operating performance.

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How Efficiently Do U.S. Cities Manage Roadway Congestion

Anthony Glass, Karligash Kenjegalievay, Robin SICKLES

Transportation

We estimate efficiency and productivity for roadway congestion and its associated monetary value for 88 contiguous U.S. cities over the period 1982-2007. Using Stochastic Frontier Analysis we find that congestion efficiency and value efficiency are both time-invariant. Congestion efficiency is higher than value efficiency for 66 cities. The productivity results suggest that average productivity growth for congestion is cyclical over the entire study period, whereas average productivity growth for the monetary value of congestion increasing trend. We conclude that there is scope for more efficient management of the monetary value of congestion in the 66 cities where congestion efficiency is higher than value efficiency. This can be achieved by: (i) placing increased emphasis on project selection according to the findings of rigorous cost-benefit studies and (ii) by following the example set by better performing cities with similar characteristics (income, population size etc.) in terms of the type of projects they select.

How Effective is the Knowledge Transfer of a Public Research Organization? Evidence from Spain

Gian Carlo Cainarca, Cinzia Daraio, Elba MAULEON

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE II

Universities and Public Research Organizations (PROs) more in general are increasingly called to abandon their ivory tower and to assume an entrepreneurial format which encompasses a "third-mission" of economic development

in addition to their traditional research and teaching missions. This shift arises from both the internal development of PROs and external influences on public research structures associated with the emergence of 'knowledge-based' innovation (Etzkowitz et al. 2000). However, for all European countries, the exploitation of public research results is still an open issue that requires new approaches and more investigations. This is because it is related to how the knowledge produced by PROs is transferred to the economy and more generally to the society. In this sense, it is important to analyse not only the appropriable codified knowledge that may be transferred to the economy by means of patents, licences, spin offs and so on, that we call the transfer of "technology in the narrow sense", but is important also to take into account the non codified knowledge that is not appropriable and can then be considered as a public good, which is transferred by PROs to the society more in general, which we call transfer of "technology in the broad sense". In the literature, most of the studies have analysed the process of technology transfer in stricto sensu, analysing the commercialization of technology because it directly impacts on firms and more general on the economy and on the innovation system and in particular because it is easier to measure it by means of consolidated and comparable quantitative indicators proposed by international organizations such as OECD. However, the process of technology transfer in stricto sensu even if very important is not the only channel of knowledge transfer: it is complemented by the transfer of not codified knowledge that spurred from PROs to the society. Furthermore, the process of knowledge transfer is also influenced and depends strictly from knowledge produced by PROs. The way by means knowledge is produced and the complementarities and trade-offs between codified and not codified knowledge produced by PROs have an impact on the knowledge which PROs are able to transfer to the economy and/or more generally to the society. At this purpose, it is interesting to analyse also how knowledge is produced and its interdependencies with the transfer of knowledge operated by PROs. It is more likely that a PRO that is more efficient in the production of knowledge (in its two aspects of appropriable and not appropriable knowledge) will be also more efficient in the transfer of it. However the impact of the production of codified and not codified knowledge on its transfer is less easy to understand. There may be substitution effects in the production of codified and not codified knowledge because the human resources at work to produce both forms of knowledge have limited time and energy and have to choose the allocation of their resources to one of the two forms: this is the classical trade off between teaching and publishing, publishing and patenting and so on. On the contrary, there may be complementary effects because the more you teach, e.g. at post-graduate level, the more you publish, the more you publish the more you patents, and so on. In the literature also variable relationships have been found, where two activities carried out from PROs up to a threshold are complementary and then after that become substitutes (see e.g. Bonaccorsi, Daraio and Simar, 2006). Larsen (2011) by reviewing the expanding empirical studies on the implications of academic enterprise for public science, states in her conclusions that "the question of the nature and direction of causality in the relationship between enterprise and performance or research orientation in academia remains an open question. Does an academic researcher for instance publish more articles because he is active in patenting, or does he patent more as a result of his high degree of scientific productivity? Or, is the correlation, as suggested in some of the studies reviewed, spurious, explained by the benefits of collaboration with industry partners?" It is interesting to note that firms could not assimilate and apply the codified knowledge successfully without greater technology absorptive capacity, based on non codified knowledge. By analyzing Taiwanese electronic and chemical manufacturing firms, Lin, Chang and Chang (2004) found that diverse organisational cultures, organisational interactions, R&D resources and technology absorptive capacity will result in a different technology transfer performance. Bishop, D'Este and Neely (2011) show that firms' R&D commitments, geographical proximity to and research quality of university partners have a distinct impact on the different types of benefits from interactions with universities. Most of previous studies, on the one hand, have analysed the university systems as the main actors in the production and diffusion of knowledge and have assessed the effectiveness of Technology Transfer Offices (TTOs) by using efficiency analysis techniques, focusing mainly on the technological activities approximated by number of patents. This field of studies, analyses mainly the US case whereas studies on European TTOs are limited and concentrated in the most recent years, including Chapple et al. (2005) for UK TTOs; Caldera and Debande (2010) for Spanish TTOs, Muscio (2010) for Italian TTOs and Curi, Daraio and Llerena (2010) for French TTOs. This may be due to the fact that in Europe technology transfer is not as developed as in the US (Siegel et al., 2008; Conti and Gaule, 2011); moreover, the lack of micro data is another important limitation (on this see Bonaccorsi, et al., 2007; Bonaccorsi and Daraio, 2007). On the other hand, there have been very limited qualitative case studies that tried to analyse transfer activities of informal knowledge carried out by individuals (e.g. Link et

al. 2007). See Phan and Siegel (2006) and Siegel (2007) that critically review the literature on the effectiveness and efficiency of knowledge transfer. There is still a gap in the literature concerning the analysis of PROs as a whole and investigating both formal and informal channels of knowledge transfer. As a matter of fact, 'third mission' activities of PROs, in Europe, have received very little attention and there is a lack of robust empirical evidence based on knowledge transfer activities including formal (codified) and informal (not codified) channels (results), necessary to correctly assess their overall impact. At this purpose, the Spanish National Research Council (Consejo Superior de Investigaciones Cientificas - CSIC) offers a unique opportunity to analyse a complex state-owned, multisectoral, multidisciplinary, public research body, articulated into different research areas, that is active both in the production and in the diffusion of knowledge. Interestingly, the CSIC accounts for 3% of the human resources spent on R&D in Spain and is responsible for 20% of the Spanish international production in international databases (Bordons and Gonzalez-Albo, 2008; Gomez et al. 2010). The CSIC is also the leading Spanish entity in the Patent Cooperation Treaty ranking of patent holders, which is something unusual, as in all other OECD countries big companies are further up the rankings than public research organisations (CSIC, 2006). The comparative analysis among CSIC research institutes allows to shed lights on interesting aspects of the management and organization of knowledge thanks to the possibility to explore the role that "internal" components (i.e. the specific characteristics of the areas/centers) and "external" components (i.e. of the environmental conditions in which the centers operate in) have on the performance in terms of scientific and technological production and diffusion. At this purpose, an interesting research question that arises is the following. How is the CSIC performing in terms of knowledge transfer? Is the performance of CSIC concentrated in specific institutes or equally distributed across research areas and centers? In addressing this issue, we consider the efficiency of knowledge production as an input in the knowledge transfer activity. In particular we will analyse partial models of knowledge production, including only technological production (i.e. patents) or scientific production (i.e. international and national production) and a comprehensive model including both technological and scientific activities. We will then use these different partial and total knowledge production efficiency to model how knowledge transfer activities are carried out by CSIC institutes and to look for improvements that CSIC institutes may realize in order to increase their performance. Another interesting question concerns complementarities and substitution effects between the production of "technology in the narrow sense" and production of "technology in the broad sense" and how the resulting composition effect impacts on the efficiency of the comprehensive knowledge transfer activity carried out by CSIC institutes. References Bordons, M. González-Albo, B. (2008). La investigación del CSIC a través de sus publicaciones científicas de difusión internacional (1981-2007). Madrid: IEDCYT. CSIC. (2006). Plan de actuación 2006-2009. Madrid: CSIC. Daraio, C. and Simar L. (2007), Advanced Robust and Nonparametric Methods in Efficiency Analysis. Methodology and Applications, Springer, New York. Etzkowitz, H., Webster, A., Gebhardt, C., Regina, B. and C. Terra (2000) The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm, Research Policy, 29, pp. 313-330. Laredo P. (2007), Revisiting the Third Mission of Universities: Toward a Renewed Categorization of University Activities?, Higher Education Policy, 20, pp. 441-456. Siegel D.S. (2007), Quantitative and Qualitative studies of University Technology Transfer: synthesis and policy recommendations, in Handbook of Research on Entrepreneurship Policy, edited by Audretsch D.B., I. Grilo and A. R. Thurik, pp.186-199.

Ownership and impact of European university patents

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SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE II

Universities contribute to innovation both indirectly, through fundamental research and teaching, and directly, by providing industry and services with technical solutions or devices, often as a result in applied research activities. These two contributions coexist since the nineteenth century, sometimes as complements, sometimes in competition (Rothblatt and Wittrock, 1993). More recently, however, the "direct" contribution has been given special emphasis by governments and large sections of the public opinion and universities have been encouraged to take an active

role in the commercialization of their scientists' inventions (academic inventions), also through the creation and management of intellectual property rights (Slaughter and Leslie, 1997; Yusuf and Nabeshima, 2007; Lissoni et al., 2008 and 2009). In this paper, we explore to what extent the potential value of academic inventions as a technology transfer tool, source of revenue, and bibliometric indicator, is associated to the property regime of the related patents. All of these issues can be usefully investigated through citation analysis. At a general level, counting and classifying the number of citations a patent receives from other patents sheds light on the economic value of the patent itself, as measured, for example, by the stock market evaluation of its owner (Hall et al., 2005). More specifically, citation analysis has been applied to patents filed by universities in order to assess whether they differ from patents filed by business companies in terms of novelty and scope of the invention, thus representing an irreplaceable addition to the stock of technological knowledge (Henderson et al., 1998; Sampat et al., 2003; Bacchiocchi and Montobbio, 2009). This paper analyses the impact of European university patents using a unique database of European academic vs. non-academic patents, which encompasses five countries (Denmark, France, Italy, the Netherlands, and Sweden) and all scientific, medical, and engineering universities therein. The database is an elaboration of raw data on patent applications at the European Patent Office (EPO). It contains 115,185 EPO applications, from 1995 to 2001, and related information on inventors, applicants, technology, and citations (backward and forward). Our econometric approach is based on event history analysis applied to patent citations. In particular we apply a duration model to patent citations and estimate a semi-parametric Cox model stratified according to the cohort of the cited patent. At the descriptive level, we find that academic patents are structurally different from the non academic ones: they are more general, and more original. They have on average more applicants per patent, more foreign inventors and a broader scope, as measured by the number of claims. Moreover, citations to academic patents appear sooner than citations to non-academic ones, suggesting that they impact faster on technological change. More importantly, we find that company ownership matters: it is company-owned academic patents that receive more citations than average, while academic patents owned by individual scientists or their universities receive fewer citations than non-academic ones. As for generality, university- and government-owned academic patents tend to be more general than non-academic ones; company-owned academic patents also do, but to a lesser extent. We also find important differences across countries, which we explain with the different legislations affecting the property of IPRs over academic research, as well as with the different institutional profile of the public research system.

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Industry Funding of University Research and Scientific Productivity

Hanna HOTTENROTT, Susanne Thorwarth

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE II

Research conducted by university researchers for industry constitutes one of the main channels through which knowledge and technology are transferred from science to the private sector. Since the value of such inputs for the innovation performance of firms has been found to be considerable, it is not surprising that firms increasingly seek direct access to university knowledge. In particular, industry funding for public sector R&D has been steadily increasing in most OECD countries. The growing amount of industry funded research, however, spurs concerns regarding possible long-run effects on scientific output. While some policy makers argue that the potential of universities to foster and accelerate industrial innovations is not yet fully exploited, others are concerned with the distraction of academics from their actual research mission. Whereas from a private-sector perspective, the benefits from collaborating with academia are found to be unambiguously positive, the effects on the scientific sector are not as clear cut. Science may benefit from the initiation of new ideas from industry or the use of industry funds for hiring additional researchers or investing in lab equipment. On the other hand, traditional incentives in scientific research characterized by knowledge sharing and rapid disclosure of research outcomes may be distorted. Moreover, commercial interests may induce scientists to select research projects on the basis of their perceived value in the private sector and not solely on the basis of scientific progress. Previous research has provided little empirical evidence on the effects of industry funding for university research on scientific productivity at the level of the individual researcher. This study aims at filling this gap by studying the effects of industry sponsoring on professors' scientific productivity. Our data contains information on laboratory and funding characteristics as well as on publication and patent output for 678 professors at 46 different universities in Germany covering a broad range of research fields in science and engineering. The results show that a higher budget share from industry reduces the publication output of professors in terms of both quantity and quality in subsequent years. In turn, industry funding has a positive impact on the quality of applied research if measured by patent citations. Industry funding may thus still have beneficial effects by improving impact and quality of more applied research. We believe the results from this study are provocative for policy analysis and public funding authorities. An increasing reliance on industry funding compared to stagnating core funding may indeed affect the development of science in the long run if publication output is reduced. On the other hand, industry funding may be very valuable for professors' applied research and the success of their patenting activities.

Determinants of Scientific Production: An Empirical Study of the World's Top R&D Companies

Michele CINCERA, David Dratwa

SPECIAL SESSION. Science and Technology Research in a Knowledge-based Economy - STRIKE II

This paper aims at assessing the determinants of scientific publication's activity by the largest R&D companies over the recent period (2000-2009).

Among these determinants we consider the firms' own R&D stock; the size of the firm; its profitability; the share of co-authorships with national firms; foreign firms; national universities; foreign universities; other national public research institutions and other foreign public research institutions; the number of citations received. As control variables we take into account the distribution of the firm's publications across scientific fields, the main industry sector where the firm operates as well as country and year dummies.

The dataset used in the empirical analysis consist of two main data sources. The first data source is the last edition of the EU industrial R&D scoreboard released in 2010 by the JRC-IPTS of the European Commission. The R&D scoreboard has been issued every year since 2004 and provides data at the firm level for the top 1,000 R&D-active firms in the EU-27 and the top 1,000 outside the EU-27. In order to have firms of comparable sizes, only the largest 400 EU companies are considered together with the top 1000 spenders outside the EU. The information available in the R&D scoreboards is consolidated at the group level and includes, among others, R&D investments, net sales, number of employees, capital expenditures, the country where the MNE has its registered headquarters and the main business sector, based on the Industry Classification Benchmark (ICB) at the two digits level, i.e. 45

industry and services sectors. The period covered by the 2010 R&D scoreboard is 2006-2009, but previous R&D scoreboards allow us to extend the observed period for the firms from 2000 to 2009. This sample of 1,400 top R&D companies is representative of about 80

The Elsevier's Scopus online database is the second main data source. The information concerning the scientific publications of each of the 1,400 top R&D firm has been retrieved manually from this database. Until March 2011, these companies have published about 1,280,000 papers.

The paper presents several descriptive statistics which illustrates by means of a series of figures and tables the main trends and facts about scientific publication activity of the largest R&D companies worldwide:

* The number of scientific publications by country; by industrial sector; by scientific field and over time; * The number of scientific publications per R&D by country; by industrial sector; by scientific field and over time; firms' sizes and R&D intensity; * The share of co-authorships with national firms; foreign firms; national universities; foreign universities; other national public research institutions and other foreign public research institutions.

The empirical findings are obtained by means of several econometric models for count data in the context of panel data. These models are implemented to estimate the impact of the various determinants of firms' scientific production. Another question investigated is whether firms that are more engaged in these activities exhibit a higher growth performance.

Environmental efficiency and vegetable production in Pakistan's Punjab: Implicationsfor sustainable agriculture

Abedullah ABEDULLAH, Asjad Tariq, Shahzad Kouser, Khalid Mushtaq
Agriculture and Ecology

Pesticides (insecticide, fungicide and weedicide) and fertilizers are playing a vital role in vegetable production since many decades, but their adverse affects on the sustainability of natural resources are absolutely ignored. The reduction in environmentally detrimental variables such as pesticides and fertilizers in vegetable production not only help to provide safer vegetables for consumption but it also helps to improve the environmental quality. The cleaner environment contributes in improving agricultural productivity (Wahid et al, 1995). Previous study estimated environmental efficiency indices in vegetable sector of china (Zhang, and Xue. 2005) but did not compare environmental efficiency estimates across vegetable production technologies. The contribution of present study is not only to estimate the environmental efficiency indices of pesticides and chemical fertilizers in two vegetable production technologies (grown with wastewater and freshwater) but also to compare their indices. The development of such indices helps to quantify the possible reduction in these inputs in the respective production technologies. An interview based survey of 140 freshwater and 135 wastewater vegetable growers is undertaken in two major vegetable producing districts (Gujranwala and Faisalabad) of Pakistan's Punjab in 2010. Translog stochastic production frontier approach is employed to estimate environmental efficiency indices for wastewater and freshwater areas. The environmental efficiency indices reflect that substantial reduction in active nutrients of fertilizer use (86 percent) in wastewater areas and pesticide cost (more than 50 percent) in both wastewater and freshwater areas is attainable with higher level of output. The reduction in value terms in pesticide cost and active nutrients of fertilizer are Rs.568 and Rs.1850 per acre in wastewater area while in freshwater area they are Rs.451.5 and Rs.1525.2 per acre, respectively. However, total saving at the province level from the reduction in pesticide cost in both wastewater and freshwater areas is Rs.314.5 million but from active nutrients of fertilizer it is Rs.1060.9 million. The saving from the reduction in fertilizer use is more than three times than the saving from the reduction in pesticide use. Our empirical findings demonstrate that safer vegetable production (with fewer chemicals) together with reduction in environmental pollution and higher level of profitability is achievable. This indicates a win-win situation. However, such reduction in poisonous chemicals is possible through institutional arrangements. Hence, extension department of the province needs to strengthen with dedicated and knowledgeable workers to give site-specific recommendation to farmers about the safe use of pesticide and chemical fertilizers in the targeted areas. References Wahid, A., R.

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Eco-efficiency assessment of olive farms in Andalusia (Spain)

Jose Antonio GOMEZ-LIMON, Andrés Picazo-Tadeo, Ernest Reig-Martínez
Agriculture and Ecology

Olive groves represent an important source of income and employment in rural areas of Andalusia (Spain), which is the most important olive oil-producing region in the world. Unfortunately, they also exert important environmental pressures with regard to the use of potentially polluting inputs, excessive water consumption, soil erosion and biodiversity reduction. The core of our research in this paper lies in the joint assessment of both economic and environmental issues of olive farming by using the eco-efficiency concept.

We follow a stream of research that has employed Data Envelopment Analysis (DEA) to compute eco-efficiency scores of production units (Kuosmanen and Kortelainen, 2005). This paper uses DEA and environmental pressure distance functions to analyse eco-efficiency at farm level, using a sample of 292 farms belonging to five randomly chosen districts in the region of Andalusia. We distinguish two components in the aggregate eco-efficiency measure of individual farms: managerial inefficiency and program inefficiency (Charnes et al., 1981). Program inefficiency is associated in our case to the different natural conditions prevailing in the three main olive cultivation systems in the region: traditional rain fed mountain groves, traditional rain fed plain groves, and modern irrigated intensive groves.

Our findings are the following. First, we show that low levels of aggregate eco-efficiency are widespread across these systems, offering substantial room for obtaining better economic returns and simultaneously exerting less environmental pressures. Secondly, we have ascertained that farms belonging to the traditional plain cultivation systems enjoy, as an average, the best levels of program (farming system-specific) eco-efficiency. It means that traditional plain groves offer the best trade-off between economic and environmental concerns, which is important from the point of view of agricultural policy, because opting for this system lessens the opportunity cost of promoting more environmental-friendly olive production systems. This offers a new insight with regard to the conventional view that considers traditional mountain systems as the best option from the viewpoint of agro-environmental policy. Thirdly, we also find that managerial eco-efficiency increases as land productivity rises, but eco-efficiency improvements are only achieved at decreasing rates. Using this result we are able to determine separate managerial eco-efficiency-maximizing land intensification levels for each of the analyzed cultivation systems.

Finally, we have analyzed the influence of agricultural subsidies on olive farms' managerial eco-efficiency. For this purpose, we have carried out a correlation analysis. We obtain evidence that in the three olive systems considered, eco-efficiency levels and CAP's subsidies (farm single payments) are positive and significantly correlated. Other variables, like farmers' age have proved to be statistically significant, but only for some olive growing systems

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Sustainable Value in Italian agricultural field: parametric and semi-parametric frontier efficiency models

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Agriculture and Ecology

Importance of the topic (and related literature) Measuring corporate contributions to sustainability has attracted increasing attention in the recent years and many different practical approaches have been suggested. One of the most promising developments is sustainable value (SV), introduced by Figge and Hahn that in recent years has developed a lively theoretical debate. SV is a systematic economic approach for measuring sustainable value creation of firms and measures the overall efficient use of a set of economic, environmental and social resources. SV approach may be considered the first value-based approach to the measurement and management of sustainability and appear, also, very closely appropriated to agriculture field where productive, ecological and social aspects are very closely related. Contribution of the paper (main research questions) From an applied point of view, our study is one of the first empirical applications in Italy of the recently developed stochastic nonparametric envelopment of data (StoNED) and SFA methods, respectively. Thanks to INEA (National Institute of Agricultural Economics) micro-data, covering about 10,000 farms throughout the territory, we were able to map, for the first time in Italy, the level of sustainability split by economic sector and size production. We focus also on verification of the causes of differentials in territory for sustainability, environmental and morphological characteristics and by sector and the subsequent evaluation of potential information needs to implement, in the coming years, a standard approach for the analysis of sustainability of farms and agricultural policies. Applied methodology Whereas the need highlighted also by Coelli that suggests to use the stochastic methods because measurement error, missing variables and weather play a significant role in agriculture economy, we follow two approaches that allow to separate stochastic noise from inefficiency: Stochastic Nonparametric Envelopment of Data (StoNED) [Kuosmanen and Kortelainen] and Stochastic Frontier Analysis. Summary of obtained (or expected) results Results of the two methods will be compared and used to study the geography of production efficiency in Italian regions. From the point of view of results we expect to find high regional differences due to both morphological characteristics and climate, but also related to differences in technology and linked to the presence or absence of integrated production chains. References r- T. J. Coelli. Recent developments in frontier modelling and efficiency measurement. Australian Journal of Agricultural Economics, 39(03), 1995. - F. Figge and T. Hahn. The cost of sustainability capital and the creation of sustainable value by companies. Journal of Industrial Ecology, 9:47 - 58, 2005. - T. Kuosmanen and M. Kortelainen. Stochastic nonparametric envelopment of data: Cross-sectional frontier estimation subject to shape constraints. Technical report, University of Joensuu, Economics DP No. 46, 2007. - S. V. Passel, G. V. Huylenbroeck, L. Lauwers, and E. Mathijs. Sustainable value assessment of farms using frontier efficiency benchmarks. Journal of Environmental Management, 90(10):3057 - 3069, 2009.

Incorporating heterogeneity into productivity and efficiency analysis.

Robert Chambers G., Iosif KAFKALAS

Heterogeneity II

This paper develops a systematic approach to incorporating technically-based heterogeneity into productivity and efficiency analysis with a special emphasis on DEA models. We first develop a specification of a production technology, which we refer to as event-specific, that recognizes potential sources of heterogeneity across the production conditions that different producers face. Then following Caves, Christensen, and Diewert (1982), we specify a productivity index for that technology and decompose that productivity index into an efficiency index, a technical-change index, and a heterogeneity or event index. A data envelopment analysis representation of the event-specific

technology is then developed, and it is applied to a panel data set for Cretan olive-oil producers who must deal with an insect pest peculiar to olive production. The empirical results are then thoroughly discussed, and the paper concludes.

On Evaluating Efficiency of Groups of Observations

Rui MARQUES, Pedro Carvalho

Heterogeneity II

In the efficiency analysis there is often the need to analyse the efficiencies of certain groups of observations and compare them to other groups in the same sector or industry, with the primary purpose of identifying the groups of more efficient observations. A classic example of such research is the comparison of efficiency between public and private companies. In studies of efficiency measurement that have applied non-parametric methods, this type of investigation has been often conducted through statistical tests. However, many of these tests have proved, at times, to be little powerful, partly because the efficiency scores used are influenced by the curse of dimensionality in finite samples. This research aims to contribute for the improvement of the literature that compares efficiencies of different groups, proposing the comparison of a-order efficiencies obtained from more robust methods than the full frontier methods, like the data envelopment analysis (DEA). These more robust methods are known as partial frontier methods and are not influenced by the curse of dimensionality. Thus, we propose a procedure for testing our statistical test (adapted from Li et al., 2009) to compare distributions of the a-order efficiencies. Using a Monte Carlo simulation, we observed that our proposed statistical test (adapted Li statistical test) has an acceptable power and may be an additional test to the test the one proposed by Simar and Zelenyuk (2006) who use the data envelopment analysis (DEA) method.

Identification of Efficiency Bands: An Application to the English Water Industry

Melvyn Weeks

Heterogeneity II

Despite the recent increase in the use of comparative efficiency analysis by economic regulators in a large number of countries, there still exists a considerable gap between the manner in which policy-driven comparative efficiency analysis is undertaken, and the type of analysis promoted by academic experts. In the case of the English and Welsh water and sewerage industry the gap between best practice and the approach used by the regulator is particularly acute. In this paper we consider whether conditional on a given model, it is possible to identify a distribution of both firm-specific efficiencies and rankings with precision. The motivation for this analysis is prompted by the manner in which prices are set by the regulator. In recognition of a number of dimensions of uncertainty inherent in the estimation process, firms are grouped into a number of categories based upon the distance from the benchmark firm. Firms which are allocated to the same category then receive the same price cap. Our analysis will therefore determine to what extent it is possible to discriminate across firms based upon a given distribution of efficiencies, and as a result the type of inference that can be undertaken. Given both the small sample size and the need to determine the degree of precision with which both efficiency estimates and rank distributions of efficiencies are estimated, we adopt a Bayesian approach to inference.

Cost effiency of farms with heterogenous production : Application of non convex, scale restricted, partial cost frontier.

Philippe Vanden Eeckaut, Jean Philippe BOUSSEMART

Heterogeneity II

The main question of this paper is how to measure adequately efficient cost when we are dealing with farms with heterogeneous production. We use a sample of 1300 farms operating in the Eure et Loir department of France. This sample was observed over a 3 years period (2005-2007). As technology, we assume non convexity as proposed in Briec, Kerstens and Vanden Eeckaut (2004) and local returns to scale as in Mairesse and Vanden Eeckaut (2002). The heterogeneity observed in the 25 observed production will be summarized by an index which will be used to define a partial frontier. This approach shares some similarities with the order-alpha robust frontier proposed by Aragon, Daouia and Thomas (2002)

Determinants of labor productivity growth across Italian regions

Simone GITTO, Paolo Mancuso

Manufacturing and Regional Differences

Italy represents one of the most interesting case of regional divide. In particular, while the northern part of the country exhibits labor productivity levels comparable to the most industrialized high-income economies, in the southern regions labor productivity is similar to the one of upper-middle-income countries. In recent years, the empirical literature on the analysis of the Italian regional growth has been equally divided between parametric and nonparametric models and despite the relevant number of papers, there is no general consensus on the major research questions. Further, the role played by total factor productivity (TFP), technological catch-up, technological change, physical and human capital accumulation as determinants of economic growth remains unclear (Piacentino and Vassallo, 2010). This paper examines changes in productivity, efficiency, and technology experienced by Italian regions between 1980 and 2006 in order to assess the effects of capital and human capital deepening. Parametric specification of the production function is rejected by data, so that nonparametric methods are used to estimate Malmquist indices. Following Henderson and Russell (2005), labor productivity is decomposed into efficiency change (change of the distance from the best-practice frontier), technological change (shifts of the frontier), physical and human capital deepening (movements along the frontier due to changes in the level of physical and human capital). However, departing from all the previous studies on the Italian regions, the above components of labor productivity changes are statistically tested in order to determinate whether indicated changes are real or are an artifact of sampling noise (Simar and Wilson, 1999). The results suggest that in the northern and in the central area of the country, both physical and human capital accumulation produces a positive and statistically significant impact on labor productivity growth. Instead, in the South, the contribution of the total factor productivity to the growth is comparable to that one of physical and human capital accumulation. This implies that the southern regions increase significantly their efficiency in the use of the productive inputs. Furthermore, TFP growth is mainly driven by efficiency gains and high-income regions are unable to support economic growth of the country by improving technology.

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Three keywords Total factor productivity (TFP), Regional convergence, Human capital.

Regional productivity differentials in manufacturing in Brazil in the 21st Century

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Manufacturing and Regional Differences

Production functions and stochastic production frontiers are estimated with manufacturing production across Brazilian regions in the period 2000-06. A 2 digit classification (22 sectors) and a 4-sector classification based on technological intensity were used. The results indicate that the concentration levels observed in the beginning of this Century replicates the levels traditionally observed. The evidence does not suggest any important changes in regional concentration in Brazil after the economy was stabilized and the degree of openness increased in more recent years. However, some interesting cases of high productivity outside the core manufacturing area, related to agribusiness activities, are identified.

Are formal firms more efficient than informa firms? Evidence from India manufacturing

Vinish Kathuria, Rajesh RAJ, Kunal Sen

Manufacturing and Regional Differences

Conventional wisdom about the informal manufacturing sector take it that firms in this sector are generally less efficient than firms in the formal manufacturing sector. But there is a lack of substantive empirical evidence to support this view. We use unit record data for the informal and formal manufacturing sectors combined from four repeated cross-sections over the period 1989-2005 and use stochastic frontier analysis applied to twenty-two industries to calculate absolute and relative efficiency at the firm-level for the Indian economy to examine whether formal firms are more efficient than informal firms. We use a novel econometric methodology proposed by Greene (2010) to correct for selection bias in the firm's decision to be in the informal or formal sectors in the estimates of efficiency. A comparison of industry specific means of absolute and relative efficiency and kernel density plots of absolute and relative efficiency show that there is significant variation both in levels and changes in efficiency across formal and informal firms in the same industry, and over time. However, our regression analysis suggests that on average, formal firms are more efficient than informal firms, both for absolute and relative efficiency. Our regression results also show that absolute efficiency has increased since the 1991 economic reforms, but that relative efficiency has fallen. We find a decline in the absolute efficiency gap and an increase in the relative efficiency gap between more efficient formal firms and the less efficient informal firms since the 1991 reforms.

Productivity differentials across EU-15 countries: a decomposition analysis within a convergence framework

Rosa Bernardini Papalia, Silvia BERTARELLI

Manufacturing and Regional Differences

The Lisbon European Council set an objective for the European Union to become "the most competitive and dynamic knowledge-based economy in the world". As a result, changes in productivity have become one of the central indicators for measuring competitiveness and a strategic parameter. The issue of the economic performance of a sector or the entire economy and the direction in which it is moving have considerable relevance for economic policy. Cross-country productivity differentials are influenced by the industrial structure (Kruger, 2008) and by the sectoral productivity differentials (Duarte and Restuccia, 2010). The industrial structure and its evolution over time might influence the impact on productivity levels of physical and human capital and of the technological change in terms of innovations and transmission of ideas. Several contributions point to a significant role of sector composition to the growth process. However, much of the empirical analysis has been devoted to the performance of countries, slightly neglecting their differences at industry level. In this view, the connection between growth and its determinants is analyzed by disentangling differences in productivity levels due to differences in sector composition from differences in productivity levels that are uniform across sectors. A methodology for identifying and analyzing sources of inequality in aggregate per hour productivity across EU15 countries is proposed within the growth framework by combining a shift-share based technique (Esteban, 2000) and a SUR model specification for the conditional-convergence analysis. The role played by three identified components (structural, sectoral and allocative) in explaining the country differential in productivity - that is the gap between logs of country and EU15 average productivities - are explored by specifying a system of three equations where the effects of physical capital, human capital and technological progress on the country specialization and on the uniform productivity gaps are evaluated in a simultaneous way. To study the process of structural transformation across agriculture, industry and services sectors, the analysis also considers the convergence process from this disaggregated perspective. The use of data on industries over time enables us to examine the disaggregated forces underlying country-level growth performance. The proposed methodology is employed to analyze inequality in aggregate per hour productivity levels in EU15 over the period 1990-2004. Our main finding is that differences in per hour productivity are explained in large part by the existence of country specific sectoral productivity differentials, although they have been decreasing over time. The industry mix component also plays a non-negligible role in explaining the convergence process. From a more disaggregated perspective, productivity differences uniformly distributed across sectors are more important than other components within manufacturing, while structural, sectoral and allocative components are equally important in shaping cross country productivity differentials in services. In the convergence analysis, several variables are considered as determinants of the growth process through their effects on the three decomposed components of per hour productivity levels. We find that the role of physical capital, human capital stocks, innovation and technological spillovers is heterogeneous along two dimensions: across the three components and across agriculture, manufacturing and services.

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Applying Efficiency Analysis to Fisheries Management

Manuela M. Oliveira, Ana S. CAMANHO, Miguel B. Gaspar

Fisheries

Artisanal fisheries have great social and economical importance in coastal areas, where they often constitute part of the culture of the different regions. Artisanal fisheries in Portugal account for more than fifty percent of the fish production and almost eighty percent of the fresh fish trade, generating thousands of jobs either directly or indirectly. Despite their importance, artisanal fisheries have been constantly neglected by governments, given the

low contribution to the Gross Domestic Product (GDP). As a consequence, knowledge on artisanal fisheries and on the stocks they exploit is scarce, hindering the sustainable management of these fisheries. The unbalance between the resources available and the fishing effort has lead to the decline of many stocks and to the decrease of profits. This fishery is one of the most important artisanal fishery in Portugal mainland. It comprises 85 vessels, with an overall length ranging from 5 to 16m, an engine power between 20 kW and 128 kW, and a crew composed of one to five fishermen. The fishery is managed by a closed season and a regime of daily/weekly quotas per boat and species. From a management point of view the Portuguese coast is divided into 3 main areas (the North, Western-South and the South areas). Although most of the legislation that regulates the fishery in those areas is similar, differences may be observed in the daily/weekly quotas which are set on a yearly basis depending on the status of the exploited species. While the bivalve dredge fishery in the North area is monospecific, in the other two areas it is multispecific, targeting four species. The present study aims to identify and understand the contribution of the technical characteristics of the vessels, fuel consumption, crew size and harvesting strategy adopted by fishermen to enable the maximization of captures of dredge fishery vessels. The results obtained for each fishing area are compared and discussed, in order to promote management measures that can help the inefficient vessels to improve their operation. With this purpose, data envelopment analysis (DEA) models were developed to measure technical and revenue efficiency by trip and by vessel, using data from 2005. Non-parametric tests and linear regression were also applied to measure the contribution of each variable to the technical efficiency. The preliminary results showed that the economic return and the technical efficiency differ significantly between areas, being higher in the South and Western-south areas and lower in the North area. This result is mainly explained by the mono-specificity of the North fishery and the higher amount of fuel consumed by this fleet. In periods when the demand of this species is low, the amounts landed decrease, contributing for the low efficiency of the vessels. Therefore, one of the options to increase efficiency is to diversify catches. This can be achieved with low investment, since the vessels only have to adapt the fishing gear to catch different species. New management measures are also suggested aiming at contributing for the sustainability of this important fishery.

Decomposing Economic Inefficiency in a Revenue setting: The Norwegian Ground Fishery

Kristin Helen Roll
Fisheries

In the literature inefficiency is traditionally modeled by the use of a cost- and profit function, whereas very little attention is paid to revenue efficiency (Kumbhakar and Lovell 2000). Even if the econometric techniques used to estimate cost efficiency could be modified to estimate revenue efficiency, there are several differences between the estimation of input-oriented cost efficiency and output-oriented revenue efficiency. By using revenue function as basis for measuring inefficiency, the model and estimation technique presented in this paper are slightly different from previous studies. An empirical example of Norwegian cod trawl fisheries is used to illustrate the approach. The rationale for choosing revenue maximization to best describe a fishing firm is that fisheries are generally multiproduct, and that the inputs are largely fixed and proportional to the size of the vessel. By the time the captain has decided when to make a fishing trip, the crew size, gear type, and likely the fishing areas may already have been decided. Thus, the captain's option for changing the levels of inputs can be severely limited. Given the fixity of capital in the short run, a vessel will be optimizing its behavior by optimizing species mix and by selecting highly abundant, highly valued species along with keeping the boat engaged in fishing throughout a year. Skipper skill is regard as the main source of economic inefficiency (Kirkley, Squires and Strand, 1998). Technical efficiency will therefore reflect how well the fishers catch fish, while allocative efficiency will reflect how well they catch the most valuable combination of fish. Measurement of efficiency in fisheries is important for several reasons. Declining fishery resources and excessive economic waste have become increasing global concerns, and from a fisheries managers perspective, knowledge of the efficiency level at both the firm and the fleet level and its' determinant

factors, would be valuable information to come to grips with the overfishing problems. To estimate efficiency, a shadow revenue model, with are based on a system constituted by a short-run translog revenue function and its factor share equations are applied. The results reveal large inefficiency among the sample vessels. Sample average technical inefficiency is found to be 55%, and sample average allocative inefficiency 46%. Thus, on average the industry could have increased their revenue by more than 100% by simply using their exiting inputs more efficient and produce a more "correct" output mix in light of the prevailing output prices. Although both technical and allocative inefficiency is found to vary substantially between farms, the results indicate that they are positively correlated. Thus, a technically inefficient farm often exhibits a high degree of allocative inefficiency as well. This might indicate the existence of managerial skills, whereby some farmers are better managers than others, both at adopting and using state-of-the-art production technologies, and at adjusting their output production to the prevailing output price vector. References: Kirkley J, Squires D and Strand I (1998) Characterizing Managerial Skill and Technical Efficiency in a Fishery. Journal of Productivity Analysis 9, 145-160. Kumbhakar SC, Lovell CAK (2000) Stochastic Frontier Analysis. Cambridge University Press

Monitoring the productivity change of retailing stores

Clara VAZ, Ana Camanho S.

Sectorial Analysis I

The purpose of this paper is to evaluate the productivity change of stores from an European retailing organisation. The Malmquist index, complemented with bootstrapping, is used to measure the changes in store productivity between the years 2002 and 2004. It also investigates the differences between two distinct store formats (supermarkets and hypermarkets), and the impact of scale size on productivity change.

This paper describes a case study of the application of the Malmquist index and bootstrapping to retailing stores. From a methodological point of view, it describes an enhanced approach to explore the relative position of frontiers from two different time periods, which enables determining if the frontier of one period dominates the other, or if the frontiers are crossed. The analysis of performance changes over time should take into account two effects: the variation of technical efficiency of each store and the change in the position of the best-practice frontier. The Malmquist index correctly captures these two effects. The variation in technical efficiency measures changes in the ability of each store to approach the best performance levels observed in the reference units. The changes in the frontier reflect technological developments in the practices of the best shops.

The results of the case study showed that hypermarkets had a more favorable performance than supermarkets between 2002 and 2004. The stores improved overall productivity levels, mainly due to improvements in the productivity levels of the frontier. There were some supermarkets which moved further away from the best-practice frontier (both technical and scale efficiency levels declined), leading to a decrease in their overall productivity levels. Concerning the relative position of the frontiers, we concluded that for some regions of the production possibility set there is statistically significant evidence that the frontier of 2004 is more productive than the frontier of 2002. Nevertheless, for other input-output mixes the frontiers of 2002 and 2004 are equally productive, such that in those regions the frontiers may crossover.

The Relationship Between Technical Efficiency and Industrial Concentration : Evidence from the Indonesian Food and Beverages Industry

Maman SETIAWAN, Grigorios Emvalomatis, Alfons Oude Lansink

Sectorial Analysis I

The food and beverages sector is one of the important economic sectors which contributes significantly to the Indonesian GDP and employment absorption. However, this sector is characterized by a tight oligopoly structure, with the concentration ratio for four firms (CR4) being about 66% in the period 1995-2006 (Setiawan et al., 2010). On the other hand, given that the food and beverages industry plays such an important role in Indonesian economy, the firm-level efficiency of transforming inputs into outputs is necessary to ensure a competitive price and product quality for the consumers. Nevertheless, the high industrial concentration in the sector may influence the firm-level efficiency (see Hicks, 1935 ; Demsetz, 1973).

The first objectives of this paper is to calculate the industrial concentration and technical efficiency in 33 sub sectors of the Indonesian food and beverage industry in the period from 1995 to 2006. The second objective is to find the direction of causality between technical efficiency and industrial concentration, verifying whether the Quiet-Life or the Efficient-Structure hypothesis applies to the Indonesian food and beverages industry.

This study uses firm-level survey data provided by the Indonesian Bureau of Central Statistics (BPS) classified at five-digit ISIC (KBLI) level. Industrial concentration is measured by the combined market share of the 4 largest firms (CR4) and the Herfindahl-Hirschman Index (HHI). Firm-level technical efficiency is estimated using Data Envelopment Analysis (DEA) and bootstrapping. Sector-level efficiency scores are obtained by averaging the estimated firm-level scores by subsector. To investigate the causality between the technical efficiency and the industrial concentration, this research uses Granger-Causality test and panel data analysis taking into consideration possible endogeneity which may be newly applied in this topic. Furthermore, since both technical efficiency and industrial concentration are restricted in the unit interval, we apply the logistic transformation for the both variables.

The results show that the food and beverages industry has a high industrial concentration and that the industry is inefficient. The Granger causality test suggests a one-way direction of causality, with industrial concentration having a negative impact on technical efficiency, at the sector level. This suggests that the Quiet-Life hypothesis, rather than the Efficient-Structure hypothesis, applies to the Indonesian food and beverages industry.

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FDI productivity spillover and technological gap in small versus large establishments in the Malaysian manufacturing sector

Noor Aini KHALIFAH, Salmah Mohd Salleh

Sectorial Analysis I

The Malaysian government provides fiscal incentives to multinational corporations (MNCs) in the hope of technology transfer to local enterprises. However, studies on the direct and indirect impact of foreign direct investment (FDI) in the form of productivity spillovers to indigenous enterprises in Malaysia are limited. This study examines the issue of technology transfer through both horizontal and vertical spillovers from FDI. We distinguish between horizontal and vertical spillovers from FDI for large versus small and medium enterprises (SMEs), by type of industry (electrical and electronics (E&E) versus non-E&E) and level of technological gap. Combining both input-output data for 2000 and a balanced micro-panel data set for the period 2000-2004 based on the Annual Survey of Manufacturing Industries, conducted by the Department of Statistics, Malaysia, we estimate total factor productivity (TFP) of establishments as a function of the different extent of foreign presence within industries and across industries; amongst other explanatory variables. The TFP is estimated using the semi-parametric approach suggested by Levinsohn and Petrin which corrects for endogeneity in determining inputs. All measures of forward

linkage from FDI presence negatively affect TFP for the overall domestic establishments. But when establishments are categorized by size and industry type; negative forward spillovers are significant for enterprises in the non-E&E sector only. For the overall sample of domestic establishments, backward linkages from FDI presence are not significant. But when we take a nuanced view of the establishments, positive backward spillovers are associated with large establishments in the E&E sector whereas negative backward spillovers are associated with large establishments in the non-E&E sector. In the sub-sample of SMEs, TFP of establishments in the non-E&E sector are positively associated with backward spillovers whereas productivity spillovers from FDI, both vertically and horizontally for SMEs in the E&E sector are not significant. There is a positive and significant effect of backward and forward linkages for the large domestic establishments in the large technological gap industries for all proxies of foreign presence on TFP. This supports Findlay's hypothesis that spillovers increase with a larger technology gap for the large domestic establishments. The effect of positive and significant horizontal spillovers when foreign presence is measured in terms of capital for the overall domestic establishments can be attributed to the establishments in the non-E&E industries. However, horizontal spillover when foreign presence is measured in terms of capital is negative and significant for domestic large establishments with large technological gap. The measure of market concentration (Herfindahl-Hirschman Index, HHI) is significant and negative for the domestic large establishments but when establishments are classified by size and industry type; HHI is positively associated with TFP for the sub-sample of SMEs in the E&E sector. Market share is positively related to domestic SMEs' TFP. Labour quality is positively associated with TFP in SMEs in the non-E&E sector but negatively associated with TFP in large establishments in the E&E sector. The estimates on the presence or absence of spillover effects from FDI is sensitive to size of establishments; that is, large or SMEs; type of industry, whether E&E or otherwise; absorptive capacity measure by technological gap as well as different weights used to measure the extent of foreign presence.

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JEL classification codes: D24, O19, O33

Technical Change vs Efficiency Change: How do Food Industries Evolve over Time

Christophe BONTEMPS, Céline Nauges, Vincent Requillart, Michel Simioni

Sectorial Analysis I

The food-processing industry is the largest manufacturing sector in France with a turnover estimated at 147 billion Euros (about 193 billion USD). Meat processing and dairy products are the two most important activities, gathering about one-third of all firms in the sector and contributing to about one-third of its value added.

In a recent article, Bontemps, Maigné and Réquillart (forthcoming) applied an index approach to a panel dataset of French firms from the food-processing industry and found that productivity has decreased over the last two decades. The aim of this paper is to adopt a different approach to provide some further evidence on the dynamics of productivity using firm level data over the years 1996-2006. Studying this particular period is interesting for at least two reasons. First, there has been an increased concentration in the food-processing sector. Second, this period has witnessed a number of food scares following outbreaks of BSE (mad-cow disease), dioxin-contaminated chicken, and listeria and salmonella contaminations. These raised consumers' concern and induced a reinforcement of food safety regulations with more stringent quality management and food safety norms put in place.

Because more stringent regulations may have, in some cases, shrunk the set of firms' production possibilities, we propose an original methodology in order to identify technical change using panel data and to allow for both technical progress and technical regress. We develop an iterative testing procedure that is based on the comparison of the distributions of efficiency scores for firms in the latest period of observation (2006), computed (using DEA techniques) from two different sets of sequential production possibilities: the Forward Increasing Production Set (or FIPS) and the Backward Increasing Production Set (or BIPS). The FIPS at any year t is constructed from the observations in the base period (1996) up until period t, while the BIPS in year t is built from the observations in the latest period of observation (2006) back to period t. We construct as many FIPS and BIPS as they are time periods covered by the data. Formal (non-parametric) testing of all pairs of distributions is then performed in order to assess whether firms have experienced technical change in all sub-periods between 1996 and 2006. Once periods in which technical change occurred have been identified, we compute the respective contribution of technical change and efficiency change in total factor productivity.

Illustration is made on two sectors: Poultry and cheese. In the poultry sector our testing procedure indicates that this industry has experienced a downward shift in the frontier in 1997, 2000, and 2003, while no significant change was identified in the cheese industry. In the latter the index of total factor productivity is estimated at 0.97 over the 1996-2006 period.

This paper adds to the rather small literature on the measurement of efficiency and productivity in the food-processing sector including among others Buccola, Fujii and Xia (2000), Morrison (1997), and Fischer and Schornberg (2007).

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Estimation and Inference in Parametric Deterministic Frontier Models

Christine AMSLER, Michael Leonard, Peter Schmidt

Parametric Advances

In this paper we consider parametric deterministic frontier models. For example, the production frontier may be linear in the inputs, and the error is purely one-sided, with a known distribution such as exponential or half-normal.

The literature contains many negative results for this model. Schmidt (1976) showed that the Aigner-Chu (1968) linear programming estimator was the exponential MLE, but that this was a non-regular problem in which the statistical properties of the MLE were uncertain. Richmond (1974) and Greene (1980) showed how the model could be estimated by two different versions of corrected OLS, but this did not lead to methods of inference for the inefficiencies. Greene (1980) considered conditions on the distribution of inefficiency that make this a regular estimation problem, but many distributions that would be assumed do not satisfy these conditions.

In this paper we show that exact (finite sample) inference is possible when the frontier and the distribution of the one-sided error are known up to the values of some parameters. We give a number of analytical results for the case of intercept only with exponential error. In other cases exact inference is still possible but simulation is needed to calculate critical values. We also consider some asymptotically valid methods. Finally, we discuss the case that the distribution of the error is unknown. In this case asymptotically valid inference is possible using subsampling.

We provide simulation results that support the relevance of our theory. We also give some applications.

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A State Contingent Approach to Estimating Efficiency under Production Uncertainty

Teresa Serra, Robert G. Chambers, Spiro E. STEFANOU

Parametric Advances

Chambers and Quiggin (2000) provides a compelling case for the state-contingent production framework as providing a realistic and tractable representation of problems involving production under uncertainty. With the state-contingent framework being more general than other approaches, estimation of production technologies and operator efficiency in the presence of production risk allows us to more accurately separate out the contribution of uncertainty from technical inefficiency. Several empirical efforts at econometric estimation of the state contingent production have appeared in the literature in the last several years with O'Donnell and Griffiths (2006) addressing efficiency estimation. All of these studies employ established data series which require stochastic assumptions for the construction of production states.

The focus is on estimating the production technology as we present a genuine application of the state-contingent production and efficiency measurement. A survey of 100 Catalonian arable crop farmers has been designed specifically for this project. Prior to the growing season, we collected information on farmers' planned input decisions, the range of outputs and output prices for different states; i.e., yields were solicited for bad, normal and ideal growing conditions and the range of prices were collected for different market conditions (also characterized as bad, normal and ideal). These same farmers are contacted at the end of the season to record the actual outputs and output prices. Consequently, nine production states can be specified; where i= yield state, j=price state and state yij, i,j = bad, normal ,ideal). The estimates of inefficiency are uncoupled from production uncertainty.

Estimation is undertaken with a stochastic representation of the directional distance function for the state-contingent technology. Defining as the directional output distance function associated with the safe asset. In the context of inefficiency, all feasible input and state-contingent output combinations are assumed to satisfy . To make this econometrically stochastic, we can add an error structure where , and is symmetric around zero. In this sense, we can say that we are estimating the frontier technology and that is the mean inefficiency. Estimation involves specifying the directional distance function parametric form, and using the translation property allows us to generate a normalization on one of the states. Two candidate forms being explored: a) the quadratic specification and b) the previously unexplored logarithmic-exponential form proposed by Chambers (1998).

At this point, we have been exploring the estimation strategies in terms of functional forms, error specification and normalization approaches. We expect to have presentable material well before the Workshop date.

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Expected Ranks in Parametric Frontier Models

William HORRACE, Seth Richards-Shubik

Parametric Advances

In the parametric stochastic frontier model firm-level technical efficiencies are typically reported as ranked conditional mean functions, E(u|e), and the implied goal is to infer which firms are the most and least efficient in the sample. Alternatively, one can calculate the multivariate probability that a firm is most or least efficient following Horrace (2005). We extend the multivariate probability statements of Horrace (2005) to calculate the probability that a firm is ANY rank in the sample. From this we construct the posterior expected rank for each firm. The firm-level expected rank represents another measure of firm-level performance that may be useful to empiricists.

Monte Carlo simulations are presented to show: (a) how the posterior distribution of firm rank (conditional on the residuals) changes with the variance of the noise term; and (b) the amount of variation in expected rank across samples. An empirical example is provided.

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Estimation and Decomposition of Inefficiency when Producers Maximize Return to the Outlay

Subal C. KUMBHAKAR, Frank Asche, Ragnar Tveteras

Parametric Advances

This paper deals with estimation of production technology where endogeneous choice of input and output variables is explicitly recognized. In particular, we assume that producers maximize return to the outlay. For simplicity and tractability we first start with a Cobb-Douglas transformation function with multiple inputs and show how the first-order conditions of maximizing return to the outlay can be used to derive an estimating equation which is nothing but a productivity equation. The unique feature of this productivity function is that it does not suffer from the econometric endogeneity problem although the output and input variables are endogenous. First, we consider the case where producers are fully efficient allocatively but technically inefficient. The model is estimated using a single equation stochastic frontier approach. The model is then extended to allow allocative inefficiency and it is estimated as a system using generalized method of moment (GMM). Algebraic expressions are derived to decompose the effect of technical and allocative inefficiencies on return to the outlay. We also consider translog specifications that are estimated as (i) a single equation frontier model as well as (ii) a system. We use a panel of Norwegian fishing trawlers data to estimate the model. Outputs are different species caught while inputs are labor and vessel size. We also control for number of days of operation, age of the vessel and year effects. Empirical results show that the average rate of return to the outlay is reduced by around 20to 30% due to technical inefficiency. On the other hand, average allocative efficiency is found to be about 78average overall efficiency is found to be around 60

Common sets of weights as summaries of DEA profiles of weights

Nuria RAMON, José L. Ruiz, Inmaculada Sirvent

Advanced DEA II

We propose a DEA approach aimed at deriving a common set of weights (CSW) to be used to the ranking of decision making units (DMUs). The idea of this approach is to minimize the deviations of the CSW from the DEA profiles of weights without zeros of the efficient DMUs. This minimization reduces in particular the differences between the DEA profiles of weights that are chosen, so the CSW proposed is a representative summary of such DEA weights profiles. We use several norms to the measurement of such differences. As a result, the CSWs derived are actually different summaries of the chosen DEA profiles of weights like their average profile of their median profile.

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On the uniqueness issue of the slacks-based network DEA efficiency scores

Miki TSUTSUI, Kaoru Tone

Advanced DEA II

This paper proposes a strategy for determining divisional efficiency uniquely in the slacks-based network DEA, in which uniqueness of slack values is not assured, and thus divisional efficiencies are subject to change even though the overall efficiency is unique. As extensions of ordinary DEA models, Network DEA and Dynamic DEA models have been developed in order to reveal the influence of internal structure of organizations and to gauge the efficiency change over time. In our previous papers [1] and [2], we proposed the SBM version of the above models, called Network SBM (NSBM) and Dynamic SBM (DSBM). In these models, we first evaluate the overall efficiency of DMUs which is determines as the optimal objective function value of the models. This optimal value is decomposed into divisional or term efficiencies via the optimal slack values thus obtained. However, these efficiency scores are not always determined uniquely in these models. In this paper, we propose a measure to determine them uniquely. Activities of internal divisions are interdependent, and thus divisional efficiencies should be evaluated simultaneously in the NSBM model. In contrast, intertemporal activities are time-independent, and thus term efficiencies could be sequentially evaluated in the DSBM model. Focusing on the difference between two, we propose different procedures for them. In the current paper, we explain the case of the NSBM model. In order to determine the divisional efficiency uniquely, we follow through with five steps. (1) We order the divisions by their importance. If the weight to divisions is supplied externally (beforehand), we follow the ranking of divisions by their weights. (2) We evaluate the overall efficiency of DMUs as in the NSBM model. (3) Keeping the overall efficiency value fixed, we evaluate the efficiency of the most important division using the NSBM. The connectivity of link values between divisions is also held. This divisional score is uniquely determined. (4) We evaluate the efficiency score of the second important division fixing the overall efficiency and the efficiency of the most important division. (5) In this way, we repeat the process until the least important division. All divisional efficiencies are uniquely determined as the optimal objective function values for the respective divisions. We will present numerical experiments at the Workshop. References: [1] Tone K. and Tsutsui M. Network DEA: A slacks-based measure approach, European Journal of Operational Research, 197 (2009) 243-252 (doi:10.1016/j.ejor.2008.05.027). [2] Tone K. and Tsutsui M. Dynamic DEA: A slacks-based measure approach, OMEGA, 38 (2010) 145-156 (doi:10.1016/j.omega.2009.07.003).

Choosing weights of extreme efficient DMUs in DEA: A comparison of some proposals with application to the Spanish banking sector

Begona GONZALEZ-PEREZ, Enrique Lopez-Gonzalez, Cristina Mendana-Cuervo

Advanced DEA II

This paper is focused on the analysis of one limitation of the Data Envelopment Analysis (DEA) and the effects of some proposals which try to solve it. The extensive use of DEA has demonstrated that it has a lot of advantages but it also has some limitations. An important drawback is related to the Decision Making Units (DMUs) which generate the efficient frontier, the extreme efficient DMUs. They have alterative optimal sets of weights or multipliers for their variables and only one set should be chosen. Although few authors have dealt with this question, there are some proposals which try to solve it. In this sense, we analyze the problem along with some of the formulations proposed to solve it and we apply two of these proposals in order to shed light on their effects on the weights of extreme efficient DMUs and compare them. The extreme efficient DMUs are the vertices of the efficient frontier, so they have infinite supporting hyperplanes which define infinite alternative sets of weights in the multiplier formulation of DEA. However, the efficiency measurement and other utilities of DEA, like a benchmarking tool, a ranking methodology or a method for identifying groups, require choosing only one set of weights. Many authors have ignored this problem and have opted for the first solution of the DEA model, while other researchers have tried to solve the previous limitation by means of different DEA formulations. In this paper we focus on two of these proposals. On one hand, Adu (2001), who uses the cross efficiency concept and the geometrical interpretation of DEA, proposes a DEA model to choose the set of weights associated to the supporting hyperplane which differentiates the specific extreme efficient DMU as much as possible from the rest of the closest extreme efficient DMUs. She tries to select the weights by which the extreme efficient DMU is better than the other ones, i.e., she emphasizes the best different performance of each extreme efficient DMU. On the other hand, Cooper et al. (2007) also select the optimal weights set according to the geometrical interpretation of the multiplier DEA formulation. They propose a two-stage mixed integer linear programming to choose the weights which are associated with the face of the frontier of higher possible dimension to which the extreme efficient DMU belongs, i.e, they select the coefficients of the supporting hyperplane which contains the maximum number of extreme efficient DMUs. In this paper, we apply both formulations to the Spanish Banking Sector in order to know the effects of the two previous proposals but before it, we use the super efficiency DEA model (Andersen y Petersen, 1993) in order to differentiate between efficient an inefficient DMUs and get the first combination of weights of every extreme efficient DMUs. Finally, we compare the weights which have been obtained in the three formulations by means of non-parametric tests and we can observe that the differences among them are statistically significant.

On the non-oriented epsilon-based measure of efficiency in DEA

Kaoru TONE, Miki Tsutsui

Advanced DEA II

In this paper, we present the non-oriented (i.e. both input- and output-oriented) version of the epsilon- based measure of efficiency (EBM) in DEA and point to a strange property of the model that the constant returns-to scale model and the variable returns-to-scale model yield the same efficiency score. We clarify this phenomenon and demonstrate how to get rid of such inconvenience. The unique features of this paper are (1) unification of radial and non-radial models in a single framework called EBM and (2) extension to the non-oriented case which is suitable for measuring both input-side and output-side inefficiencies simultaneously. In DEA, we have two typical measures of technical efficiency with different characteristics: radial and non-radial. Historically, the radial measure, represented

by the CCR model, was the first DEA model, whereas the non-radial model, represented by the SBM model was a latecomer. For instance, in the input-oriented case, the CCR deals mainly with proportionate reduction of input resources that can produce the current outputs. In contrast, the non-radial models put aside the assumption of proportionate contraction in inputs and aim at obtaining maximum rates of reduction in inputs that may discard varying proportions of original input resources. The main shortcoming of the CCR model is the neglect of non-radial slacks in reporting of the efficiency score. So, if these slacks have an important role in evaluating managerial efficiency, the radial approaches may mislead the decision when we utilize the efficiency score as the only index for evaluating performance of DMUs. Since models such as SBM capture the non-radial slacks directly, the optimal efficiency value accounts for the non-radial slacks which are not considered in the radial models. The SBM-projection to the efficient frontier is defined by subtracting or adding the slacks. Thus, the projected DMU may lose the proportionality in the original data. If the loss of the original proportionality is inappropriate for the analysis, then this becomes a shortcoming for non-radial models. In Tone and Tsutsui [1], we proposed an epsilon-based measure of efficiency (EBM) in DEA as a third pole of technical efficiency. This model integrates radial and non-radial models in a unified framework through a newly defined affinity index between inputs/outputs. A new principal component analysis (PCA) is applied to determine the epsilon (the radial vs. non-radial ratio) and the weights for input/output items. In the EJOR paper, we mainly presented input/output oriented EBM models. In this paper we observe the non-oriented version of this model and show that the variable returns-to-scale case yields the same score as the constant returns-to-scale case. To prevent such inconvenience we need to add some other constraints on the model. These include constraints on the radial reduction rate of inputs or the radial expansion rate of outputs. We discuss this subject in this paper. Reference: [1] Tone K. and Tsutsui M. An epsilon-based measure of efficiency in DEA: A third pole of technical efficiency, European Journal of Operational Research, 207 (2010) 1554-1563.

Bounded Radial Models

Jesus T. PASTOR, Mette Asmild, Juan Aparicio, Javier Alcaraz

Advanced DEA II

The assumption of Constant Returns to Scale (CRS) in Data Envelopment Analysis (DEA) implies that the identified benchmarks might be located outside of the range of observed values for the variables, which might be problematic when we deal with, for example, percentages or ratios. It may also, in these situations, be desirable to specifically only allow CRS since the nature of these variables implies an absence of information about the size of the assessed units. Regarding the related literature, Hollingsworth and Smith (2003, Applied Economics Letters) and, recently, Cooper et al. (2010, Journal of Productivity Analysis) have studied these situations. In this paper we introduce the Bounded Radial Models (BRM) in DEA which can accommodate the aforementioned considerations in a suitable way, without resorting to the sometimes overly conservative Variable Returns to Scale (VRS) assumption. In particular, this aim is achieved by adding input and output bounds to the model. Regarding the main results, we will show that the BRM require a double set of slacks in order to properly characterize the bounded technology. After showing several interesting properties of the new model, we implement and illustrate how it performs through a numerical example.

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Benchmarking countries environmental performance

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Energy, Environment and Eco-Efficiency

Environmental concerns have increased dramatically in the past few years and are now among the most serious challenges affecting people's well-being. Countries are facing new challenges to control their waste production and to reduce the consumption of natural resources, in order to achieve the environmental targets. In this context, it is imperative that countries become able to monitor their environmental performance in order to understand how they are doing compared to others and to identify potential for improvements. Environmental performance assessments are often conducted using environmental indicators, individual or composite, that are able to measure the pressures on the environment, to evaluate the state of the ecosystem and the impacts on human activity resulting from changes in environmental quality. Although these indicators provide a starting point for performance assessments, they do not provide guidelines that countries should follow to improve performance. The purpose of this paper is to develop an enhanced composite indicator (CI) that can be used to benchmark the environmental performance, and suggest peers that countries should look in order to search for the best practices. The CI developed in this paper used the data from the indicators underlying the construction of the Environmental Performance Index (EPI). The EPI 2010 (Emerson et al., 2010) provides data for 25 environmental indicators grouped in 10 categories, in 163 countries. From a methodological perspective, this study involved three stages. First, an exploratory analysis was conducted, using descriptive statistics and the Co-plot multivariate analysis method, to identify the existence of extreme values and strongly correlated indicators that can introduce bias in the results. The second stage consisted on the use of Cluster Analysis to group the countries in homogeneous clusters prior to the performance assessment. This was followed by the use of Decision Trees to identify the main characteristics of each cluster. The final stage of the analysis consisted on the construction of a CI to reflect the performance of countries within each cluster. It was developed an enhanced DEA model for the assessment of environmental performance. Besides the possibility of assigning a summary measure of performance for each country, the model can be used for benchmarking purposes, as it provides for each inefficient country a set of peers whose environmental practices are examples to be followed. In addition, it is possible to include in the assessment information concerning the relative importance of the different environmental dimensions. This required the specification of a new type of virtual weight restrictions that in fact work as assurance regions type I. These restrictions have the advantage of being identical for all countries, and reflect, in percentage terms, the relative importance of the environmental categories underlying the construction of the EPI. Using fixed weights for each indicator, it is possible to obtain a complete ranking of countries performance, whilst allowing some flexibility in the weight restrictions it becomes possible to identify the strengths and weaknesses of each country. This can guide decision makers in the definition of environmental policies to improve the performance of countries.

Measurement of environmental productivity and efficiency in the steam power generation of the Japanese electric utility firms

Jiro NEMOTO, Akiko Okamoto
Energy, Environment and Eco-Efficiency

This paper aims to examine environmental performance of the steam power generation of the Japanese electric utility firms in relation to productivity and efficiency. We estimate the output oriented hyperbolic distance function proposed by the recent work of Cuesta, Lovell, and Zofio (2009). By employing a weakly disposable production technology rather than strongly disposable one, the hyperbolic distance function represents the environmental production frontier that reflects technological trade-off between producing desirable outputs and reducing undesirable

outputs. This enables us to measure the marginal abatement cost of undesirable outputs by the amount of desirable outputs sacrificed for a reduction in emission of undesirable outputs. Since desirable outputs have the market values, it becomes possible to evaluate the shadow prices of undesirable outputs that serve as a reference to which the level of economic incentives for reducing pollutant is set by the environmental regulation authority. The shadow price of CO2 emission in particular receives much attention from policymakers in Japan pursuing carbon emission trading system. The hyperbolic distance function model is also used to measure the impacts of environmental restrictions on productivity and efficiency. The Japanese electric utility industry has been on the process of liberalization of the retail market since 2000. Although some studies including the review by the government discuss the performance of liberalization during this decade referring productivity and retail price level, all of them fail to take account of the aspects of environmental concern. We thus measure productivity using the Malmquist and Hicks-Moorsteen indexes and decompose them to efficiency and the other factors along with isolating the impacts of undesirable outputs. Our results will retrieve the net changes of productivity and efficiency that would be observed if undesirable outputs were kept constant. In comparison with the gross productivity and efficiency changes, we have the magnitude of lowered productivity and efficiency due to reduction in pollutant emission. We also see whether the emission control has become more costly in terms of productivity since 2000 to clarify the relationship of liberalizing the retail market to environmental performance. The data employed in this study is an unbalanced panel on the steam power generation of the nine Japanese electric utility firms after 1990. The parametric approach is taken to estimate the hyperbolic distance function. The translog stochastic frontier model is applied for the hyperbolic distance function with carbon dioxide (CO2), sulfur oxides (SOx), and nitrogen oxides (NOx) as undesirable outputs.

Eco-efficiency and convergence in OECD countries

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Energy, Environment and Eco-Efficiency

The objective of the paper is the assessment of eco-efficiency of a group of 22 OECD countries at both country and pollutant-specific levels; furthermore, the existence of convergence in eco-efficiency is evaluated for the period 1980-2005.

The economic-and-environmental efficiency or eco-efficiency has been broadly defined in the literature as 'the efficiency with which ecological resources are used to meet human needs'. The concept of eco-efficiency has been adopted and popularized as a way of encouraging companies, sectors, regions or countries to simultaneously achieving higher levels of competitiveness and environmental responsibility. Thus, assessing eco-efficiency can provide firms managers and policy-makers with relevant information to make strategic choices. From a practical point of view, we take the definition of eco-efficiency proposed by Kuosmanen and Kortelainen (2005) as the ratio between an indicator of economic performance and a composite indicator of environmental pressures.

We use information from 22 OECD countries that covers the period 1980-2005. Economic performance is measured by real GDP in constant dollars (millions US dollar, base 2000) provided by the World Bank. The pollutants exercising a pressure on the environment are CO2 emissions (Kt), NOx emissions (Gg) and SOx emissions (Gg), with data coming from the CEIP (Centre on Emission Inventories and Projections). Finally, the countries included in our analysis are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and USA.

Scores of eco-efficiency are computed using Data Envelopment Analysis (DEA) techniques as proposed by Picazo-Tadeo et al. (2011), which allow us to assess the global eco-efficiency of the OECD countries in the sample, but also their specific eco-efficiency in the management of each particular pollutant. As a result, one of the main contributions of our research to previous literature in this field of research is the development and computation of pressure-specific indicators of eco-efficiency at macro level. Once eco-efficiency has been assessed, the existence of convergence in the period 1980-2005 is investigated. The empirical methodology applied is based on the computation

of the panel data stationarity statistics suggested in Carrion-i-Silvestre et al. (2005), which allows testing the null hypothesis of panel variance stationarity allowing for multiple level shifts and cross-section dependence. Allowing for structural breaks and dependence is crucial for the analysis of convergence. First, because considering potential shifts in the series permits to identify whether there is full convergence, common trends or catching up. Second, because cross-section dependence is frequently found among groups of countries that share similar technologies or that participate in economic integration agreements.

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Electric Utilities, Environmental Externalities and Cost Measured Productivity Growth

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Energy, Environment and Eco-Efficiency

The use of coal to produce electric power (good output) can lead to sulfur dioxide (SO2) and nitrogen oxide (NOX) emissions, which contribute to the production of acid rain. Title IV of the 1990 Clean Air Act (CAA) called for permanent reductions in SO2 emissions, with 110 power plants of electric utilities having to reduce their emissions to levels relative to their fuel use in the 1985 to 1987 time period. Reducing the emissions can be achieved through (i) producing less electric power (using less coal) (ii) installing equipment to lower SO2 emissions, or (iii) using a different input mix or technology to produce electric power. Using each method could affect total factor productivity (TFP) growth, and/or the contributions of efficiency change, technical change, and other factors, in TFP growth. Firms having to reduce SO2 emissions may try to enact policies that lead to the development of a new technology that produces electric power more efficiently and less costly, with fewer emissions. A question to ask is whether compliance with Title IV of the CAA affected the measurement and decomposition of TFP growth.

This paper uses the Malmquist Cost Productivity (MCP) Index developed by Ball, Färe, Grosskopf, and Zaim (2004) to measure and decompose (into various components) TFP growth for U.S. electric utilities when accounting for the production of good (electric power) and bad (emissions) outputs. The data sample is a panel of 34 U.S. investor-owned electric utilities from 1992 to 2000, of which some electric utilities are impacted by Title IV (having to reduce SO2 emissions). We measure and decompose TFP growth for utilities that were and were not impacted by Title IV, to analyze what affect compliance with Title IV had on the measurement and decomposition of productivity growth. A measure of investments in air pollution control facilities is utilized to analyze how installing equipment or using cleaner fuels to reduce SO2 emissions impacted productivity growth. The Malmquist Cost Productivity Index can also be used to measure productivity growth and its decomposition when not accounting for (a) production of the bad output (emissions), or (b) the installation of equipment or using cleaner fuels. Not accounting for the use of cleaner fuels, installation of equipment, or production of the bad output, can lead to inaccurate estimates of both productivity growth, and the decomposition of productivity growth into its various components.

Solow Residuals: Decomposition into Frontier and Excess Capacity Components

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Macro Efficiency

Neoclassical macro assumes that the economy is always along the efficient frontier, where output is determined by capital, labor, and technology. The residual from the regression of output on capital and labor is assumed to measure technology, i.e. the Solow residual. Since the economy is always along the frontier, shocks to the Solow residual represent shocks to the efficient frontier. The major accomplishment of real business cycle models was to show that a substantial fraction of the variance of de-trended output could be accounted for by these shocks. This left little room for the standard demand shocks of Keynesian economics in creating recessions or booms.

There are two major problems with treating shocks to the Solow residual as shocks to the efficient frontier. First, a negative Solow residual shock, which is larger than the trend, is a negative shock to technology, and we do not understand technological regress. Second, the model has no place for excess capacity, as measured by involuntary unemployment or by other measures designed to measure excess capital stock.

These problems suggest a role for the frontier methodology, in which shocks could send the economy below the efficient frontier. Shocks to the Solow residual could measure some combination of shocks to the efficient frontier and a one-sided error, moving the economy below the frontier.

We decompose the detrended Solow residuals for 11 OECD countries into a frontier component, representing technology, and a one-sided error component, representing excess capacity. We estimate the fraction of variance of the detrended Solow residual which is due to technology and the fraction due to movements within the frontier. If a significant fraction of the residual variance is due to movements within the frontier, then there is a greater role for Keynesian demand shocks in business cycles than implied by real business cycle models.

We must solve two econometric problems. First, we must decompose the detrended Solow residual into a one-sided and a two-sided error component and measure their variances. We use stochastic frontier models for this. Second, the detrended Solow residuals show strong persistence and therefore the stochastic frontier models must be adapted to allow for autocorrelated composite errors. We suggest and compare two solutions. The first approach allows the one-sided error to be autocorrelated, whereas the two-sided error is treated as Gaussian white noise. The estimation of this model is solved by using simulated maximum likelihood. The second approach incorporates the persistence by treating the detrended Solow residuals as autoregressive processes with a composite error term, i.e. by leaving the source of the persistence unspecified.

The empirical results favor the model with unspecified persistence. It outperforms the benchmark model with only a frontier shock, in 8 out of 11 cases and implies a large variance of the one-sided error relative to the two-sided one for those countries. These results imply a significant role for Keynesian demand shocks, which send the economy below the efficient frontier, in generating business cycle movements in output.

Comparative analysis of the Energy dependency, Efficiency and Productivity of the Manufacturing Industries: the case of Iran

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Macro Efficiency

Efficiency and Productivity are considered as the basis of the competitiveness and strength of an economy. The productivity level is viewed as a basic index of gauging the health and competitiveness of the industry in an economy. It forms the basis for improvements in real GNP/GDP and welfare. On the other hand, Energy sector plays a very important role in the industrial production and Economic growth. In the mean time, in comparison,

energy dependency, efficiency and productivity of the industries suppose to be meaningfully different. The purpose of this paper is to examine that the industries by having the higher energy dependency also have the lower productivity and efficiency. We examine this issue for the Iranian manufacturing Industries. The technique of efficiency measurement was originated by Farrell that takes account all of the inputs and outputs to evaluate the efficiency of a productive unit in relation to the most efficient frontier. The Decomposition approach, along with the Total Factor Productivity (TFP) changes is used to analyze the efficiency and productivity of the Iranian manufacturing industries. In finding the energy dependency we used Extraction Method of the Input Output technique as suggested by Dietzenbacher & Linden to estimate the linkages and compare these ranking with productivities and efficiencies of the industries through Spearman Rank Correlation Coefficients. The findings of this study indicate a very weak and negative relation between energy dependency and efficiency, productivity in the manufacturing industries of Iran. JEL Classification: O13, O14, O4, L6, C67

Efficiency of Factor Allocation and Aggregate Productivity: Cross-Country Evidence in Manufacturing

Addisu Abebe Lashitew

Macro Efficiency

Numerous studies in the development accounting literature have documented that at least half of the cross-country difference in income is the result of differences in aggregate productivity. While several studies explore the relevance of allocative efficiency in aggregate productivity, most of them are theoretical (Restuccia and Rogerson, 2008, Banerjee and Moll, 2010). To our knowledge, there has been no rigorous empirical work that analyzes how policy factors that affect allocative efficiency might explain cross-country differences in income. This paper tries to fill in this gap by answering the following two questions:

i) What are the productivity gains from allocating resources more efficiently in different countries? ii) What policy variables affect a country's gain from efficient resource allocation?

To answer our first question, we measure possible TFP gains from hypothetically removing factor distortions using a monopolistic competition framework developed by Hsieh and Klenow (2009). We then try to answer the second question by examining how various policy factors relate to different indicators of allocative efficiency. Measured TFP gain from our answer to question (i) can be one indicator of allocative efficiency since more distorted economies will have higher potential TFP gain from removing distortions. In addition, other indicators of allocative efficiency that measure the level of dispersion in total factor productivity (TFP), revenue productivity (TFPR) and marginal products of labor and capital will be considered. We will examine the relevance of a range of policy factors such as entry and exit regulations, labor market regulations, and financial market development.

Our analysis will be based on the World Bank's enterprises survey dataset that covers more than 21,000 firms across nearly 90 countries. This dataset is the largest available dataset that provides comparable firm-level data for developing countries. The large cross-country coverage of this dataset we will enable us to analyze the relevance of various cross-country policy differences in the efficiency of factor allocation.

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The Sources of Productivity Change in the Major Sectors of the U.S. Economy

Christopher O'Donnell
Macro Efficiency

The U.S. Bureau of Labour Statistics (BLS) reports estimates of multifactor productivity (MFP) change for each of the major sectors of the U.S. economy for the period 1987 to 2007. The Solow (1957) growth accounting methodology used by the BLS is underpinned by restrictive assumptions concerning the nature of technical change, levels of technical efficiency, the returns to scale properties of the sectoral production technologies, and the degree of competition in input and output markets. This paper uses the BLS data and the aggregate quantity-price framework of O'Donnell (2008, 2010) to estimate MFP change without any of these restrictive assumptions. These improved estimates of MFP change are decomposed into indexes of technical change (measuring movements in the sectoral production frontiers), technical efficiency change (movements towards the frontiers) and scale and mix efficiency change (movements around the frontier surfaces to capture economies of scale and scope). The paper finds that the main drivers of productivity change in the major sectors of the U.S. economy have been technical change and changes in scale and mix efficiency. The findings support the view that most U.S. firms are technically efficient, and that they rationally change the structure of their operations (i.e., scale, output mix and input mix) in response to (expected) changes in relative output and input prices.

The optimal allocation of resources for secondary education schools

Carla HAELERMANS, Kristof De Witte, Jos Blank
School

Summary This paper aims at studying technical and allocative efficiency of secondary education schools and studies the influence of different school and teacher characteristics on allocative efficiency. The methodology is applied to a rich sample of Dutch secondary schools.

Topic The estimation of productive and allocative efficiency has received an increasing awareness in education during recent years due to two reasons. First, stricter budget requirements urge schools to learn from best practices. Second, the shortage of teachers requires a better allocation of the current workforce. The contribution of this paper is that it gives insights in the effects of teacher and school characteristics on allocative efficiency scores, so that schools can maker better decisions in how to become more efficient.

Methodology This paper estimates the efficiency of schools by using a budget restricted production model (indirect output distance function; IOD). The model is inspired by Blank (2009): . where f denotes a translog specification of the production function, y is a vector of outputs (production indicators), w is a vector of resource prices, C is a vector of costs and z is a vector of explanatory variables (e.g. environmental and school characteristics). We include a Fourier function to test for the specification of functional form.

The model is applied to a rich dataset of Dutch secondary education. The data comprise school expenditures, resources and school performance (as measured by Education Inspectorate) for 448 schools over 6 years. In the multivariate efficiency analysis we take into account both school characteristics and environmental characteristics of the school. To correct for the heterogeneity between schools we use school and year fixed effects. We estimate both technical efficiency scores and allocative efficiency scores for the use of management personnel, teaching personnel, supporting personnel and material.

Conclusion Our results indicate that the average efficiency score of Dutch secondary education schools amounts to 0.93 with a standard deviation of 0.01. For obtaining the same output levels, schools could reduce expenditures by 7% if they would work as efficient as the best practice observations. Schools could thus learn from each other.

Furthermore, our analysis shows that on average schools use too many teachers and too little managers, supporting personnel and materials. If the excessive teachers would be re-allocated, the structural vacancies for teachers could decrease. Differences in allocative efficiency can in most cases be explained by teacher experience, number of branches and share of part time teachers.

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Measuring the efficiency of publicly financed schools in Spain: an unbiased comparison using propensity score matching

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School

The results from PISA 2006 Report show that Spanish students have a poor performance compared with other OECD countries. Moreover, there are significant differences between students' results attending public schools and publicly financed private schools (PFPS). The conceptual framework for estimating the educational production function are commonly based on the relationship between educational outputs and a collection of inputs such as student's family background, peer group effects and school resources (Levin, 1974; Hanushek, 1979). Another important issue across the economics of education literature is how school ownership impacts on students' results and efficiency. Although there is no agreement about its effect, a direct efficiency comparison between both school types could lead us to biased conclusions if we do not take into account the process of school choice.

The aim of this paper is to propose an alternative methodology for measuring and comparing educational efficiency by school type through a Propensity Score Matching (PSM) approach within the framework of stochastic frontier analysis. The target of PSM is to find in a large group of non-treated individuals (those attending public schools), that are similar to the treated (those attending PFPS), conditioning on a set of observable variables Z that influence school choice. After tackling the self-selection problem we compare student efficiency by school type using parametric distance functions.

The implementation of both methodologies allows us to enhance the conclusions obtained after calculating two new in the literature measurements; the Average Treatment of the Treated on the Production Frontier (ATTpf) and the Average Treatment of the Treated on the Production Frontier assuming Efficiency (ATTpfe). Up to the best of our knowledge PSM and stochastic parametric distance functions have not been jointly used in any paper about the assessment of the school efficiency.

For empirical purposes, we use Spanish data from PISA 2006 evaluation which provides us with data from 15 years old students belonging to ten regions that decided to take part in evaluation with an extended representative sample of their population. This analysis is especially interesting in Spain, where regions are fully responsible for the decision about the quantity of the educational budget and its allocation since 2000. The general pattern shows that on average students benefit more of attending PFPS although there are wide divergences in student efficiency by school type and across regions.

The efficiency of public spending on secondary education: An empirical analysis

Tommaso Agasisti
School

Recent policy suggestions from the European Community underlined the importance of efficiency and equity in the provision of education (EC, 2006). At the same time, the European countries are required to provide their educational services by minimizing the amount of public money devoted to them, given the necessity to strictly control public budgets. In this challenge, some countries emerge as able to maintain efficiency in their spending on education (that is, obtain good results in terms of educational output with a limited amount of expenditure), while others did not reach similar results. The availability of updated and comparable data at country level, allows the researchers to empirically investigate the efficiency of public spending in education, in a cross-country perspective. As a consequence, a recent stream of the literature is developing along these lines of research (e.g. Afonso & St. Aubyn, 2006). In this paper, I realize an empirical study by comparing the spending efficiency on education in 20 European countries during the period 2006-2009. The average ability of students at age-15 is considered as the output of education processes, and measured though the OECD-Pisa test scores (editions 2006 and 2009). The "expenditure per student", as defined by the OECD dataset "Education at a Glance" has been used as the input. Moreover, some robustness checks are provided to test the sensitivity of results on different inputs' choice. The efficiency scores are calculated via a bootstrap Data Enveloped Analysis (DEA) procedure (Simar & Wilson, 1998) to take into account statistical problems associated with the traditional DEA approach. In a second stage, the efficiency scores are regressed against a set of context variables, which represent the different socio-economic settings (e.g., GDP per capita, unemployment rate, etc.) to identify those factors, which are affecting efficiency of educational spending. Teachers' salaries and internet usage (as a proxy for technological "literacy") play a positive role in affecting educational performance.

Lastly, Malmquist indexes are calculated to measure the change in efficiency in the period 2006-2009. The results will show how the efficiency improved in the period under analysis, decomposing it in "pure efficiency" gains (losses) and positive (negative) "frontier shifts".

Do Central Administrators Produce Local Public Goods?

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School

School districts are effectively networks in which central administration provides overhead or shared services to the member school campuses. In assessing performance of the member campuses and of the overall school district, we typically make an assumption concerning the assignment of central administration overhead to the constituent schools. If these services are essentially private goods, then the assignment should be on some kind of aliquot basis. On the other hand, if they are truly shared they become a (local) public good in which each school receives the entire benefit of the centrally provided services. Here we set up a 'network' type model that explicitly allows us to allocate the central resources across individual schools in such a way that we maximize the performance of the sum of the school district schools. We essentially do a grid search: we solve for the optimal allocation of arbitrary shares of central administration. We seek the optimal allocation which yields the best aggregate performance for each school district. This is essentially a series of large DEA type problems. We apply this approach to Texas public schools. All of the data for this analysis come from the Texas Education Agency (TEA) and Texas' State Board for Educator Certification (SBEC). This analysis focuses on urban, public schools in Texas during the 2004-05 school year.

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On Modeling Pollution-Generating Technologies

Sushama Murty, R. Robert RUSSELL, Steven Levkoff

SPECIAL SESSION. Good Modelling of Bad Outputs

Standard models of pollution-generating technologies treat pollution either as a freely disposable input (e.g, Reinhard, Lovell, and Geert [2000]) or as a weakly disposable output (e.g., Färe, Grosskopf, Noh, and Weber [2005]). We argue analytically that each of these (reduced form) approaches has unacceptable implications for the trade-offs among inputs, intended outputs, and unintended outputs (pollution). We propose, as an alternative, a "by-production" technology-an intersection of two sets reflecting two production relationships. The first, an intended-production technology set, describes how inputs are transformed into intended outputs; it satisfies standard free-disposability properties. The second represents nature's residual-generation process; it violates standard disposability properties with respect to inputs or outputs that result in (or affect) pollution generation and exhibits "costly disposability" with respect to pollution. As a result, the overall technology violates standard disposability with respect to inputs or outputs that cause (affect) pollution generation and exhibits costly disposability with respect to pollution. We formulate DEA specifications of technologies that satisfy by-production, with or without pollution-abatement activities, and employ them to measure technical efficiency of firms. In the context of by-production, standard measures of efficiency decompose very naturally into environmental and intended-output efficiencies. However, we find that, in the context of by-production, the commonly used indexes of (in)efficiency, the hyperbolic index and the directional-distance-function index, overstate efficiency. A modification of an index proposed by Färe, Grosskopf, and Lovell [1985, pp. 153-154] (which they called the "Russell Graph Measure") corrects the flaws in the hyperbolic and directional-distance-function indexes. An empirical comparison of the values of this index with those of the hyperbolic and directional-distance-function indexes, using a database for electric power firms, supports our arguments about the inadequacies of the latter.

Keywords: Pollution, efficiency, disposability.

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Good Modelling of Bad Outputs

Finn R Førsund

SPECIAL SESSION. Good Modelling of Bad Outputs

The materials balance principle points to the crucial role of material inputs in generating residuals in production processes. Pollution modelling must be of a multi-output nature. The most flexible transformation function in outputs and inputs used in textbooks is too general to make sense in pollution modelling. Specifying bads as if they are inputs, although may be defendable on a macro level as a reduced form, hides explicit considerations of various modification activities. Applying a non-parametric efficiency approach extended to cover bads as outputs, assuming weak disposability of the bads, has serious formal weaknesses as well as not accounting satisfactorily for abatement. Factorially determined multi-output production may be used to model generation of bads by making them being functions of the same set of inputs as in the production of good outputs. A complete taxonomy of inputs as to the impact on both residuals and marketed products as joint outputs is then derived. Factorially

determined multi-output production can also be used to model end-of-pipe purification, observing the materials balance principle, thus providing detailed information for choice of policy instruments.

NETWORK TECHNOLOGIES WITH GOOD AND BAD OUTPUTS

Rolf Fare, Shawna GROSSKOPF, Carl Pasurka

SPECIAL SESSION. Good Modelling of Bad Outputs

Starting from preferences over outputs, both desirable and undesirable, we evaluate various axioms familiar from production theory. Following Shephard (1970) and our earlier work dealing with good and bad production, we relax the traditional assumption that outputs are freely disposable. The alternative notion introduced by Shephard is weak disposability.

Another assumption used to model production with good and bad outputs from earlier work is jointness. This assumption in its strict form (null jointness) may imply little or no substitution possibilities between good and bad outputs. To address this limitation we introduce a network model which includes one subtechnology devoted to abatement of bad outputs.

We include an empirical application for the electricity generation, which includes data on abatement of SO2 and generation of electricity. Data for coal-fired power plants from 1995 to 2005 are used to estimate technology in an activity analysis framework. The sample will consist of plants with flue gas desulfurization (FGD) systems and plants without FGD systems. The technology modeled in this study assumes one good output, "net electrical generation" - kilowatt hours (kWh), and one bad output - sulfur dioxide (SO2). The exogenous inputs consist of the capital stock (which is assigned to either electricity production or pollution abatement), the number of employees (which are assigned to either electricity production or pollution abatement), the heat content (in Btu) of the coal, oil, and natural gas consumed at the plant, and the fuel quality (sulfur content).

The Dynamics of Labor Productivity in Swiss Universities

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This paper analyzes the productivity of Swiss university departments between 1995 and 2007. We estimate and decompose the Malmquist productivity indexes using a parametric input distance function. This paper proposes a relatively rich panel data specification to address the unobserved heterogeneity across production units. The adopted model is a mixed-effects model that accounts for heterogeneity by individual intercepts as well as random coefficients of time trends across universities and scientific fields. While retaining the transient nature of inefficiencies, we use an autoregressive stochastic term to allow for persistency and gradual improvement through learning. The results indicate a negative trend in overall productivity measured by Malmquist index, particularly after 2002. However, the identified patterns of heterogeneity point to a few exceptions: departments in exact (e.g.mathematics) and natural sciences (e.g.biology)as well as those in newly founded universities show a considerable improvement in their productivity. The results do not provide any evidence of statistically significant productivity effect of measures for the Bologna reform or openness.

Comparing German and Italian universities: Convergence or divergence in the higher education landscape?

Tommaso Agasisti, Carsten POHL
University

In a globalized economy, higher education institutions are receiving increasing attention in the political and economic debate since a country's human capital significantly affects its (future) economic development. In many European countries, public institutions are dominating the university landscape, so that measuring and improving their efficiency remains an important issue in times of tight public budgets. Despite this importance the question of efficient allocation of public resources in the university landscape has only recently been investigated. In particular, the comparison of higher education institutions across different countries has been a rare topic for investigations, although this approach is promising in order to detect efficiency differences and similarities in alternative higher education systems (a notable exception is the research conducted by Bonaccorsi and Daraio, 2007). In addition, this kind of analysis could be used to show which structural reforms might be necessary in order to improve the efficiency of the higher education system in a particular country.

In this paper, we focus on the question whether and to what extent the comparative efficiency of universities in Germany and in Italy has developed over time. These countries are particularly interesting since both countries display similarities with respect to the university landscape as well as in economic terms. The university systems in both countries have been substantially reformed with the introduction of the Bachelor/Master curriculum due to the Bologna process. From an economic point of view, both countries display relatively large geographical differences with respect to Northern and Southern Italy as well as Eastern and Western Germany respectively. Consequently, it is interesting to investigate to what extent economic circumstances are associated with the efficiency of higher education institutions. Previous studies have shown that universities located in the economically disadvantaged regions, i.e. in the Eastern part of Germany as well as universities located in Southern Italy, represent underperformers in the university system (Agasisti and Dal Bianco, 2006; Kempkes and Pohl, 2008). Our paper is the first to compare the university landscape between Germany and Italy.

Two main questions are addressed in this paper. First, we will investigate to what extent the intra-country differences in university efficiency have developed over time. Second, we will compare the efficiency of German and Italian universities in a cross-country perspective and show how environmental factors are related to the efficiency performance in each country.

Overall, our results show that German universities are more efficient than their Italian counterparts. However, in a dynamic perspective Italian higher education institutions are improving their efficiency more rapidly than those in Germany. With regard to the external factors we find that the existence of a medical faculty and a high regional unemployment rate are negatively associated with efficiency, while a positive relationship is found for the regional share of workers employed in Science and Technology.

Dynamic analysis of productivity in higher education: Case study of Belarus

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Our knowledge of the relative performance of the institutions of the higher education and historical record of the performance change over time is crucial to understand effectiveness and relevance of management strategies and policies of the individual institutions.

In this study, productivity growth of Belarusian universities over the period 2002 to 2010 is investigated using nonparametric frontier techniques. We estimate the common technological frontier of the higher educational institutions as well as individual productivity scores of universities of Belarus human and physical capital as inputs for the technological process and research and teaching activity as its outputs. We further compute Malmquist productivity indices and applied Färe et al. (1994) approach to decompose productivity growth into technical efficiency, scale efficiency change and technological change. This allows to come up with more relevant policy implications with respect to importance of size in the institutions' efficiency, effectiveness of individual management strategies and relative changes of the institutions' efficiency over time.

We further carry out two simple but informative exercises. Firstly, we test whether public and private universities indeed share the same technological frontier, i.e. if there is a statistical difference between productivity of public and private universities, and whether these frontiers converge over time. This test is executed using the methodology proposed by Simpson (2005). Secondly, using so-called DEA peeling procedures we construct relative rankings of the universities based on the multi-output model of the technological process rather than single-output models used in most of the other rankings.

To our knowledge this is not only the first attempt to study Belarusian higher education from a productivity analysis perspective, but also the first study in productivity and efficiency analysis field in general using Belarusian data.

The papers' preliminary findings give sufficient evidences of difference between technological frontiers for private and public universities in Belarus as well as provide preliminary ranking of the Belarusian institutions of higher education.

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A Cost Constrained approach to asses Efficiency and Productivity Growth for the Mexican State Universities.

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University

In this study, we assess the efficiency and productivity change for the Mexican Public State Universities over the period 1989-2005 using the indirect (cost constrained) output oriented technology suggested by Färe, Grosskopf and Lovell (1994). During the 90's the Mexican Federal Government recovered its coordination,regulation and guidance power rebuilding the rules of the game for the entire system which was previously immersed in infructuous highly politicized negotiations on public funding. This transformation relied on the implementation of new policies intended to increase Government's influence on the development of the public universities and the whole system. Among the most relevant policies, we can mention the following: (i)an evaluation system was established as a normal practice,(ii)competition was promoted among the institutions,either public or private,(iii)the promotion of enrollment growth was endorsed while asking to maintain quality levels,(iv) scientific research and technological development were supported, (v)better management practices were promoted , and (vi)the funding rules were partially modified. (Kent-Serna et al., 2009). The implementation of the reforms was politically possible by guarantying to each institution a fixed budget to handle their current expenses that accounted for approximately 90% of the total, plus a variable budget based on performance. It is important to remark that at the same time, there were not legal restrictions for the institutions' administrators to modify their set of inputs (e.g. academic and

non-academic personnel) to produce the desired outputs (e.g. teaching and research). A DEA output indirect model provides a useful characterizations of behavior and is suitable for the public sector: it assumes that the decision-maker has a fixed budget and must choose inputs which satisfy that budget, while providing the maximum feasible services from those budget restricted resources while a revenue measure does not exist for free public services. The cost indirect output distance function seeks to maximize multiple outputs subject to a budget constraint. In contrast to the direct distance function, which takes inputs as given (and therefore not subject to choice); the indirect, is a more relaxed technology since inputs are not given but only restricted to a budget, this allows the decision-maker to better allocate those inputs to create greater potential outputs. We use the indirect version of Malmquist output based productivity indexes and provide a decomposition of the results. We also explore the existing relationship between de direct and indirect technologies as mentioned by Grosskopf, Hayes, Taylor, & Weber, (1999) to evaluate allocative efficiency.

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Knock-On Effect of Regulation on Manufacturing Sectors: a Stochastic Frontier Approach

Marco Fioramanti

Regulation I

After the almost complete failure of the Lisbon Strategy, in 2010 European Council renewed its commitment to make the Union the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion, adopting a new strategy: Europe2020. Among others, the role of pro-competitive environment is highlighted as a pre-requisite for sustainable growth. In this context, it is fundamental to analyze the effect of competition/regulation policies on economic growth in order to select the best practices and formulate policy suggestions. In particular in this paper I try to evaluate the impact of (indirect) regulation on manufacturing sectors, in a panel of advanced countries, aver the 1975-2007 period. The analysis is carried-out using the EU-KLEMS database together with the OECD Regulation Impact Indicators (RegImpact). The EU-KLEMS database is the main source for Value Added, Labour and Capital contribution, while RegImpact measures "knock-on" effects of the regulations in one sector on the other sectors according to the extent of anti-competitive regulation in a particular sector, and the importance of this sector as supplier of intermediate inputs in other sectors (Conway and Nicoletti - 2006). I use the Stochastic Frontier Analysis, and in particular the Battese and Coelli (1995) specification to model the effect of RegImpact over production efficiency. Once the model has been estimated, given the detail of the EU-KLEMS database I can recompose Total Factor Productivity (TFP) change in its main components: technical change, technical efficiency change, scale component and allocative efficiency. Within this framework I can model the technical (in)-efficiency as a function of "knock-on" effect of regulation (and country/sector unobserved heterogeneity) and evaluate the contribution of each components in TFP dynamic. I choose a flexible functional form for the production function: Translog. The econometric techniques and this specific functional form together permit to test a series of hypothesis: Translog vs Cobb-Douglas; No technical change; Non-neutral vs neutral technical change etc. Preliminary results show that the production function exhibits slight increasing return to scale; inefficiency is present and highly significant; technical progress is non-neutral; Translog production function is preferred to the Cobb-Douglas. Furthermore, I found that regulation Impact Indicator has negative and highly significant impact on efficiency, and hence, the greater the burden of regulation, the lower the TFP growth. I'm actually considering whether to extend the paper with a counterfactual analysis. That is, given the results of the (country/sector) best performer in terms of TFP growth

(the benchmark), which would have been the results for a specific (sub-optimal) country/sector in the case the level of competition/regulation would have been the same as the benchmark?

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Impact of regulatory standards on the eco-efficiency of firms

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Regulation I

One of the most striking challenges in (environmental) economics is the internalisation of negative external effects. Various concepts and models try to deal with this issue. Our paper enters into the discussion as we refer to implementing environmental standards in evaluating the eco-efficiency of different firms in a particular industry in order to give incentives for less pollutant production. By doing this, it is possible to measure the regulatory impact on firms by comparing eco-efficiencies before and after a fictive introduction of an environmental standard. This can provide support for the environmental policy makers in choosing appropriate instruments and intensity of regulation.

In this paper we propose one approach to implement environmental standards into the data envelopment analysis (DEA) framework and thereby to measure the regulatory impact on eco-efficiency. As it is rather difficult to quantify pollution, emissions or other undesirable outputs in monetary units, we apply DEA, a non-parametric approach for multilateral productivity comparisons. With this approach, which is extended in several ways, it is now possible to ascertain the eco-efficiency of firms. As one basic feature of DEA models lies in the exogeneity of inputs, outputs and emissions, it is not possible to introduce environmental constraints for these parameters directly into existing DEA models. Therefore, a two-step method is introduced initially to illustrate our basic idea which refers to assessing the regulatory impact as difference in eco-efficiency scores before and after a fictive introduction of environmental standards. Subsequently, we develop extensions to common DEA models, incorporating environmental standards via the idea of bounded variables which allows for constraints on efficiency-frontier projections. Herein weak disposability of undesirable outputs (see Färe et al. 1989) is taken into account, also establishing an extension to common DEA models with slack-based-measure (SBM) techniques. Similar research can be found in Yang & Pollitt (2010) and Lozano & Gutierrez (2011).

By using contemporary DEA-models and common software, it was not possible to properly account for weak disposability of undesirable outputs in the context of implementing environmental standards. Therefore, our proposed model framework comprises huge flexibility for researchers, regulatory authorities and environmental policy makers. As the regulator can choose between two general SBM model frameworks, three types of environmental standards and two weak disposability versions the model can be adopted to a wide range of industries. Moreover, assessing the regulatory impact of environmental standards in advance and thus choosing appropriate instruments and a reasonable intensity of regulation could help to follow the principle not to regulate firms to death.

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Service deregulation, competition and the performance of French and Italian firms

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Regulation I

We use firm-level data for France and Italy to explore the impact of service regulation reform implemented in the two countries on the mark-up and eventually on the performance of firms between the second half of the 1990s and 2007. In line with some previous studies, we find that the relation between entry barriers and productivity is negative. This relation is intermediated through the firm's mark up and is very different in the short and the long run.

By contrasting the experience of two regulation-riddled countries such as France and Italy, we aim to provide two-step empirical evidence on whether reform in the service industries - the least exposed to globalization winds - has affected firm performance, and notably total factor productivity. In the second half of the 1990s through the early 2000s both France and Italy have been swept by a wave of product market reform measures. Yet aggregate data indicate that this wide-ranging set of reforms has not been paralleled by faster growth and not even by positive productivity developments in either country.

We proceed in two steps. We first investigate whether changes in regulation - in most cases deregulation - has changed the mark-up of firms in the industry where reform took place and in the expected direction (deregulation bringing about less rent). In the second stage, we ask ourselves whether the originating changes in mark-ups have translated into TFP and labor productivity's change. Our data set spans from 1998 to 2007.

We find that barriers to entry are associated to higher mark-ups, and in turn higher mark-ups are statistically related to economic performance as proxied by total factor productivity. Whether the relation between rents and productivity is a negative relation or an inverted U is slightly more controversial.

keywords: deregulation, productivity, service sector

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Application of the StoNED method in the regulation of electricity distribution in Finland: The regulator's perspective

Matti Ilonen

SPECIAL SESSION. Regulation of Local Monopolies in Electricity Distribution

The Finnish regulatory model of electricity distribution networks can be described as a hybrid of the traditional revenue cap and cost plus models. The reasonable rate of return for electricity distribution operators (DSOs) is determined with the WACC-model. Finnish Energy Market Authority (EMV) has applied efficiency improvement targets in the regulation of DSOs since 2001. The initial method for estimating the efficiency improvement targets was Data Envelopment Analysis (DEA) and it was not applied to all DSOs. In 2005 EMV started applying ex ante regulation with a fixed regulatory period of three years (subsequently four years). In the first regulation period (2005-2007) DEA-method was applied to all DSOs. For the second regulation period (2008-2011) EMV introduced Stochastic Frontier Analysis (SFA) to complement the DEA-method in efficiency measuring. To accommodate both DEA and SFA, EMV has applied the average of the efficiency scores estimated with these two methods.

EMV is committed to continuous development of the regulatory model, including the efficiency analysis, for every regulation period. The Finnish environment is challenging due to a large sparsely populated area and heterogeneity of DSOs. Thus, it is difficult to find a model and parameters that treat all DSOs equally. There are 86 DSOs in Finland operating in different environments (urban, suburban, rural, different soil and climate conditions). The DSOs have sued EMV several times to the Market Court. The court cases concerning efficiency analysis have dealt with such questions as how "equal" the DEA/SFA-model is considering the heterogeneity of DSO's operating environments. Using the average of two efficiency scores has also been challenged. There has also been critique towards variable selection in the model, the function form used in the SFA-method and separating the inefficiency and error terms.

For the third regulation period (2012-2015), EMV has responded to the critique by replacing DEA- and SFA-methods with semiparametric StoNED-method (Stochastic Non-smooth Envelopment of Data: Kuosmanen and Kortelainen, 2011). There has been analysis of variable selection and as a result of this the composition of input variable has been changed. A new environmental variable, the degree of underground cabling of medium voltage network (1-70 kV), was introduced. The efficiency improvement target will be directed to total expenditure included in the input variable (TOTEX) instead of part of it as previously has been done. The variation in efficiency of DSOs is wide and in order to take into account the efficiency improving potential of all DSOs a transition period of eight years is introduced. During this time period all DSOs should achieve the efficient cost frontier. The initial proposals for the methods of determining reasonable return during the next regulatory period 2012-2015 were introduced in January 2011 and the first comments from DSOs will be received in March 2011. Before summer, there will be information about DSOs responses and possible further actions that EMV might take to develop the regulatory model.

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Cost efficiency analysis of electricity distribution networks: Application of the StoNED method in the Finnish regulatory model

Timo Kuosmanen

SPECIAL SESSION. Regulation of Local Monopolies in Electricity Distribution

Electricity distribution network is a prime example of a natural local monopoly. In many countries, electricity distribution firms are regulated by the government. In Finland, the regulator estimates the efficient cost frontier using the data envelopment analysis (DEA) and stochastic frontier analysis (SFA) methods. This paper reports the main results of the research project commissioned by the Finnish regulator for further development of the efficiency estimation in their regulatory model. The key objectives of the project were to integrate a stochastic SFA-style noise term to the nonparametric, axiomatic DEA-style cost frontier, and take into account the heterogeneity of firms and their operating environments. To estimate the resulting stochastic semi-parametric cost frontier model, a new method called stochastic non-smooth envelopment of data (StoNED) is proposed (Kuosmanen and Kortelainen, 2011). Based on the insights obtained in the empirical analysis using real data of the regulated networks, replacing the currently used DEA and SFA methods by the StoNED method is recommended.

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Implementation of Stochastic Frontier Models in Regulation: Some Lessons from the Finnish Regulatory Model of Electricity Distribution

Timo Kuosmanen, Sami PAKARINEN

SPECIAL SESSION. Regulation of Local Monopolies in Electricity Distribution

Electricity distribution companies are natural local monopolies. In Finland, the electricity distribution sector is regulated by the Finnish Energy Market Authority (EMV). The Finnish regulatory model is a hybrid of the traditional revenue cap and cost plus models. To estimate the acceptable cost level, EMV has applied estimation methods from productive efficiency analysis since 2001. The first method introduced was Data Envelopment Analysis (DEA). For the second regulation period (2008-2011) EMV introduced Stochastic Frontier Analysis (SFA) to take into account a stochastic noise term. To accommodate both DEA and SFA, EMV has applied the firm-specific efficiency improvement target that is based on the average of the DEA and SFA efficiency estimates.

For the third regulation period (2012-2015), EMV is going to implement some major reforms. The purpose of this paper is to describe and discuss the reforms regarding the implementation of efficiency analysis that are particularly relevant for the stochastic frontier models that assume a noise term. As regulators in several countries already apply or plan to apply SFA or other stochastic frontier methods such as StoNED (Kuosmanen and Kortelainen, 2011), the lessons from the Finnish Regulatory Model are relevant for regulators that have adopted or are planning to adopt stochastic frontier methods. This is valid not only in electricity distribution but in regulation of local monopolies and network industries in general.

In the second regulation period (2008-2011) the Finnish regulator specifies each firm an efficiency improvement target based on the average of the DEA and SFA efficiency estimates. However, the estimation of firm-specific efficiency levels is a notoriously challenging task. In the noisy environment of the SFA model, the conditional expected value of the firm-specific inefficiency (Jondrow et al., 1982) is known to be inconsistent (e.g., Greene 2008): the precision of the firm-specific efficiency estimate does not improve even if the sample size approaches to infinity. In contrast, the SFA estimator of the cost frontier is unbiased and consistent (provided that the model is correctly specified).

Another problem of the firm-specific SFA efficiency improvement targets based on the conditional expected inefficiency is that the targets are dynamically inconsistent. Even if all firms meet the stated efficiency improvement targets, efficiency differences across firms will not be eliminated. In other words, firms that successfully achieve their efficiency improvement targets do not typically reach the efficient frontier, but face new efficiency improvement targets in the next period. Thus, transition towards the efficient frontier can take an infinite number of regulation periods.

To resolve these two problems, it is recommended to specify the acceptable cost level based on the estimated cost frontier instead of using the firm-specific efficiency estimates. The cost frontier is less sensitive to random noise and outliers than the firm-specific efficiency estimates. If performance targets are needed, reaching the cost frontier can be specified as a target.

Finally, the specification of the inefficiency distribution influences the expected inefficiency and thus the acceptable cost level. We examine the method of moments estimator applied to the half-normal, exponential and gamma distribution to assess the impacts of the distributional assumptions on the expected efficiency.

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Two-stage procedure based on data envelopment analysis to evaluate the efficiency of the Italian health system.

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Explaining Health Efficiency

During last decades the Italian National Health Service has been characterized by several reforms aimed to introduce a quasi-competition mechanism and to increase the administrative and the fiscal autonomy of the Regional Government in the organisation of the health services. In fact, by these reforms, the Regional Governments are in charge for organization and administration of publicly financed health care and hold a tax-raising power which allows them to provide health services in addition to those defined by the Central Government. This new environment has originated a different way to organize and to fund health services at the regional level, so it is possible to identify three different organizational models and three reimbursement systems applied by the Regional Governments. Moreover, the reforms have introduced the right for the patients to be admitted to any local health unit, even if it is outside their district of residence (Levaggi et al).

In particular, the paper investigates the impact that organizational models and reimbursement systems, applied by the Regional Governments, produce on health efficiency during the period 2004-2005. Moreover, the paper analyzes the effects of different kinds of patient mobility on the health performance.

In this paper we use a semi-parametric two-stage procedure, based on bias corrected data envelopment analysis (DEA). The traditional DEA-estimator is biased by construction and it is affected by uncertainty due to sample variation. So, we apply a bootstrap procedure to derive the sampling distributions and to construct confidence intervals of efficiency scores. In the second stage, we run truncated regressions (Simar and Wilson, 2007) to establish the impact of the organizational models, reimbursement systems and patient mobility on health efficiency. The inputs and outputs employed in the analysis are consistent with the related literature on the argument.

Our results show that high level of decentralization in the organization of the health services produce negative impacts on health performance. As opposite the cost to deliver a care, adjusted taking into consideration local characteristics in terms of population and health organization, increase health efficiency. Finally, patient mobility might represent one of the most important drivers of health inefficiency in Italy in the future.

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Analyzing scale efficiency estimates for Greek public hospitals: A system-of-equation two stage DEA approach

Roxani Karagiannis

Explaining Health Efficiency

The paper adopts a two-stage approach to analyze scale efficiency estimates for a panel of Greek public hospitals. The first stage employs a DEA approach in which scale efficiency scores could be determined from data on observed inputs, like as the number of beds, the number of physicians or the number of other hospital personnel and outputs, like as the number of inpatient days or the number of outpatient visits. The second stage applies a system-of-equation model to explain the impact of contextual variables, like as socio-economic factors and hospital-environmental characteristics, on scale efficiency. The scale efficiency measure is usually not obtained directly, but is calculated indirectly by noting that, if one calculated the distance from the observed data point to the CRS

technology then it can be used to calculate the scale efficiency score residually as the ratio of technical efficiency scores under CRS and VRS. The main advantage of using a system of equations in the two-stage approach is that we analyze simultaneously and in a theoretically consistent way the impact of factors affecting technical efficiency and thus scale efficiency, instead of considering separately their impact on either technical or scale efficiency. The degree of scale efficiency estimated on average to be around 93% was higher than the degree of technical efficiency indicating that a greater portion of overall inefficiency was due to producing below the production frontier rather than operating at an inefficient scale. A small portion of hospitals (58%) achieved scores above 90%.

Optimal productive size of hospital's intensive care units

Hervé LELEU, James Moises, Vivian Valdmanis

Explaining Health Efficiency

Authors of past studies focusing on returns to scale in hospitals proffered mixed results. These seemingly contradictory findings have probably arisen due to different methodological approaches (parametric or non parametric), different aggregation levels of analysis (hospital/department/units), nature of data (quantity data or economic values) but also technological improvements operating in hospitals and case mix adjustment to account for the severity of patients' conditions. In this paper, we apply a new approach to determining returns to scale for multi-output homogenous technologies. Our approach is characterized by 1) a non parametric approach based on quantity data allows us to avoid assumptions on cost minimization or profit maximization behavior of hospitals, on relevancy of economic values for hospitals (costs, revenues and prices) and on a priori specification of the health care production function; and 2) an analysis of optimal productivity size at both the disaggregated level of intensive care units and at the aggregated hospital level. The methodological advantage is that we can unambiguously define increasing returns to scale which is lacking in more traditional non-parametric approaches because of the convexity assumption imposed earlier. We apply the methodology to intensive care units (cardiac care (CICU), medical/surgical care (MSICU), pediatric care (PCIU) and neonatal care (NICU) which are operating in 235 general short term hospitals of Florida state in 2005. We also consider the hospital level by analyzing the general activity of the hospitals in our population. To summarize our findings, we find that 60% of intensive care units are operating at increasing returns to scale, 10% are operating at optimal productive size and 30% are characterized by decreasing returns to scale. In average intensive care units operate 40% under the optimal size. The policy implication of this result should be an increase of the size of all types of intensive care units to meet productivity gains. The picture is completely reversed at the aggregate hospital level. Here decreasing returns to scale prevail for 65% of hospitals while only one fourth are operating at increasing returns to scale. In average hospitals' number of beds should decrease by 40% to reach the optimal productivity size. One policy solution may include reallocating resources from general beds to the more specialized beds.

A Finite Sample Improvement of the Fixed Effects Estimator of Technical Inefficiency

Daniel Wikström

Advanced Panel

The fixed effects estimator of technical efficiency proposed by Schmidt & Sickles (1984) has spawned a huge bulk of theoretical and applied studies based on both time invariant and varying technical efficiency. However, Wang

& Schmidt (2009), among others, show that the FE ('fixed effects') estimator of technical inefficiency suffers from poor small sample abilities. The estimator is seriously upward biased when, the number of firms, N, is moderate or large and/or the number of time observations, T, is small. This is an unattractive feature since panel data sets very often have a relatively large N but small T. The pessimistic implication drawn from Wang & Schmidt is that the FE estimator is merely applicable when N is tiny and T is rather large.

We propose a kernel estimator that is MSE ('mean square error') efficient to the traditional FE estimator. We derive theoretical small sample properties of the estimator which includes a proof of the MSE efficiency and the MSE optimal bandwidth. This is completed without imposing restrictive assumptions on the technical inefficiency, i.e. the proposed estimator is still a FE type of estimator. Thus, this is a possible way to overcome the pessimistic implication of Wang & Schmidt, to enable the use of FE type of estimators of technical inefficiency also when N is large.

We make use of the kernel regression estimator with discrete regressors presented by Ouyang, Li & Racine (2009). To our knowledge, this estimator has not previously been applied to estimating the firm effects ('individual effects') in a linear panel data model. By first obtaining firm effects through kernel estimation we can estimate the technical inefficiencies as proposed by Schmidt & Sickles for the FE estimator.

Besides the theoretical results we conduct Monte Carlo simulations. The Monte Carlo simulations support the MSE efficiency of the kernel estimation and also show that the kernel estimator of the technical inefficiencies has the ability to reduce both bias and MSE.

The improvements are most pronounced in cases when the traditional FE estimator performs poorly, i.e. when N is large and T is small. Thus, the kernel estimator seems to have the ability to overcome the pessimistic conclusion of Wang & Schmidt, that FE type of estimators only are useful in cases when N is tiny and T is large.

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A State-Space Stochastic Frontier Panel Data Model

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Advanced Panel

Efficiency analysis is intrinsically static and its dynamic version (productivity analysis) requires the introduction of time into the model. This further development came at a very early stage due to the growing availability of panel datasets. A first discussion of panel data settings for stochastic frontier models (SFM) was provided by the seminal paper of Schmidt and Sickles (1984). In such a context technical efficiency can be interpreted as unobserved heterogeneity and panel data estimators are available to deal with it. In a dynamic context one has to model at least two different contributors to productivity change: technical change and technical efficiency change. While the latter has been addressed widely, the former has been basically dealt by ad hoc solutions. Kumbhakar (1990, 2004) proposed a model with deterministic time varying technical inefficiency and Battese and Coelli (1992) parameterized the deterministic function of time in a different fashion. At the same time Cornwell et al (1990) proposed to accommodate for time varying technical inefficiency using quadratic time varying firm specific intercepts. Ahn et al. (2000) proposed to model technical inefficiency as an AR(1) process (stationary) and the same route was followed, with some interesting novelties, by Desli et al. (2003) and Tsionas (2006). All these specifications put emphasis on technical efficiency change with less attention given to technical change. Particularly, stationary specifications (like the AR(1)) are unlikely to perform well in modelling a structurally non-stationary phenomena like technical change. A common way of addressing technical change is introducing time as an explanatory variable in the vector of inputs and sometimes it is interacted with the inputs to provide a second order approximation typical of flexible functional specifications. This is indeed the way explicitly put forward by Orea (2002) to build the generalized Malmquist productivity index. This strategy has been also proposed by Coelli et al (2003) and Ahn et al (2000). A way forward

was proposed recently by Jin and Jorgenson (2009) using state-space modelling. Although their attempt is confined to a time series context, it is an intuitive approach that we try to develop in a more general context within SFM modelling. In this paper we propose a general strategy to deal with technical change and time-varying technical inefficiency based on state-space modelling. We first develop a general state space version of the stochastic frontier model and then show that our model nests many of the commonly used ad-hoc methods of introducing technical change as a deterministic time trend. Since we use state-space modelling, the model is intrinsically non-stationary therefore providing a much more appealing tool for productivity measurement and technical change. We present our modelling strategy in a primal setting (i.e. a production function instead of a cost function). The production function is assumed to have time-varying parameters and time-varying technical inefficiency. We provide a state-space procedure able to identify time-varying parameters of the production function. These methodological novelties are applied to the EU-KLEMS dataset, identifying the main trends in technical change and productivity growth in the period 1977-2007 for 13 countries and 29 sectors of each economy. Schmidt P., Sickles R.C. (1984), Production frontiers and panel data, Journal of Business & Economic Statistics, 2, 367-374 Jin H., Jorgenson D.W. (2009), Econometric modelling of technical change, Journal of Econometrics, 157, 205-219

Using copulas to model time dependence in stochastic frontier models

Christine Amsler, Artem PROKHOROV, Peter Schmidt

Advanced Panel

Current approaches to modeling time dependence in panel stochastic frontier models impose restrictive assumptions on the nature of dependence such as the "scaling" property or involve T-dimensional integration, with T being the number of cross-sections in the panel. Moreover, no known multivariate distribution has marginals that allow for a one-sided error term. We show how to use copulas to resolve these issues. The range of dependence we allow for is unrestricted and the computational task involved is easy compared to alternatives. We propose copula-based full maximum likelihood and simulated maximum likelihood estimators. We also point out to improved asymptotic efficiency of copula-based estimators and show how to estimate technical inefficiencies using copulas. A well-known application demonstrate usefulness of our approach.

US Residential Energy Demand and Energy Efficiency: A Stochastic Demand Frontier Approach

Massimo FILIPPINI, Lester Hunt

Energy and SFA

The promotion of energy efficiency policy is seen as a very important activity by both the International Energy Agency (IEA) and the Energy Information Agency (EIA) (e.g. see IEA, 2009). Moreover, the role of energy efficiency in reducing energy consumption and emissions remains a key policy objective for governments across the globe; and the US is no exception. In practical energy policy analysis, the typical indicator used to proxy energy efficiency at the aggregate level is energy intensity, defined as the ratio of energy consumption to GDP. However, this simple indicator is not entirely accurate since changes in energy intensity are a function of changes in several factors including the structure of the economy and energy efficiency; hence, it is difficult to make conclusions for energy policy based upon this simple measure.

The aim of this paper is to attempt to construct and measure the 'underlying energy efficiency' for the US 'states'; building on previous work by Filippini and Hunt (2010). This draws upon different strands of the energy

economics research literature; in particular, frontier estimation and energy demand modeling. An aggregate energy demand frontier function is estimated in order to isolate the measure of 'underlying energy efficiency'; explicitly controlling for income and price effects, population, weather, structure of the economy and technical progress.

It is assumed that there exists an aggregate energy demand relationship for a panel of US States, as follows: Eit = E(Pit , Yit , POPit HDDit , CDDit , Ai, ISHit , SSHit , Dt, EFit) (1) where Eit is aggregate energy consumption, Yit is GDP, Pit is the real price of energy, POPit is population , HDDit are the heating degree days, CDDit are the cooling degree days, Ai is the area size, ISHit is the share of value added of the industrial sector and SSHit is the share of value added for the service sector all for state i in year t. Dt is a variable representing the UEDT that captures the common impact of important unmeasured exogenous factors that influence all countries simultaneously. Finally, EFit is the unobserved level of 'underlying energy efficiency' of an economy which has to be estimated. To estimate the economy-wide level of underlying energy efficiency (EFit) the following stochastic frontier function approaches for panel data has been used: i) the pooled model (PM hereafter), the stochastic frontier model (SFM) in its original form proposed by Aigner, et al., (1977); ii) the random effects model (REM hereafter) proposed by Pitt and Lee (1981); and iii) the true random effects model (TREM hereafter) proposed more recently by Greene (2005a and 2005b)

The estimates for the underlying economy-wide energy efficiency using this approach show that although for a number of states the change in the simple measures of energy intensity might give a reasonable indication of their relative energy efficiency; this is not always the case. Therefore, unless the analysis advocated here is undertaken, US policy makers are likely to have a misleading picture of the real relative energy efficiency across the states and thus might make misguided decisions when allocated funds to various states in order to implement energy efficiency and conservation measures.

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Estimating the cost of improving quality in electricity distribution: A parametric distance function approach

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Energy and SFA

The frequency and the duration of power outages are the two key measures of quality that electricity distribution utilities pay particular attention to. Other than direct costs of outages, represented by opportunity costs and repair expenditures, firms operating in a regulated framework also risk penalties, generally a fixed amount for each customer affected by long duration outages. To prevent outages and these related costs, operators have two main possibilities, either to increase maintenance or to make new investments, e.g. replace overhead lines by underground lines. In this paper we are mainly interested on this issue and, more precisely, on the way electricity distribution operators anticipate and prevent potential outages by increasing maintenance activities and/or capital investments. We make use of the parametric distance function approach proposed in the activity analysis literature to deal with undesirable outputs (Färe et al., 1993). The same approach is applied here, but instead of assuming that outages are an undesirable output, we assume that they enter in the firm production set as an input, i.e., that outages are an imperfect substitute for maintenance activities and investment. Therefore, following Growitsch et al. (2005), we postulate that the corresponding distance function is input oriented. This allows us to identify the underlying trade-off faced by operators, between quality and other inputs and costs. In this study we use panel data on 92 electricity distribution units operated by EDF-DIST (Electricité de France - Réseau Distribution) in France in the 2003-2005 financial years. Compared with similar studies, we have access to very comprehensive and

comparable data, mainly on the value of capital. This database allows us to flexible translog multi-output multi-input technology. On the output side, we chose a specification that takes into account the main output dimensions of the electricity distribution activity: i) the number of customers; ii) the surface served and; iii) the number GWh distributed. On the input side, the three dimensions retained are: i) operational expenditures; ii) capital; and iii) quality, represented by the number of interruptions (longer than 3 minutes). Given the flexible nature of the translog distance function, we use for computation purposes a parametric and deterministic linear programming approach (PLP) and a stochastic frontier approach (SFA). Both approaches give similar results, on average. However, for further analysis we select the parameters and the results obtained from PLP, as this approach allows us to impose restrictions, in a very simple way, on the parameters of the distance function, such as monotonicity. . Using the computed translog parameters, several measurements are done that allow us to describe the main characteristics of the underlying production technology. Among others, the distance function elasticities with respect to inputs and outputs at each point of the boundary surface. And using these measurements, shadow prices can be derived, for the quality (outages) measures. These results are potentially useful for the operators themselves, who can learn from them about the marginal cost of reducing interruptions. They are also useful for regulators, who could use them for the design of incentive schemes that incorporate quality measures. The preliminary results show that shadow price of quality varies dramatically, particularly across different sizes of the area served: from 3.62 Euro to 8.06 Euro by customer interrupted among the operators in the lowest and the highest quintiles of the distribution, respectively.

Flexible estimation of firm production with multiple good and bad inputs and outputs

Scott ATKINSON, Dan Primont

Energy and SFA

Directional distance functions have been employed recently to estimate multiple-input and multiple-output production functions with inputs and outputs that are both good and bad. In this paper, we generalize previous approaches by deriving the restrictions that allow one to determine the effects of assuming different directions for different inputs and outputs and incorporate parameters which allow the measurement of allocative and relative output efficiency. This generalized methodology is applied to estimate the technology-oriented directional distance system for a panel data set of U.S. electric utilities, which includes data for the good outputs, bad outputs, good inputs, and a bad input. We compute technical inefficiency, productivity change, technical change, efficiency change, and allocative inefficiency. Estimation of a full set of structural and efficiency parameters requires use of a Bayesian Markov Chain Monte Carlo method. Many of our results are quite robust across a wide range of directions.

Estimation of an Endogenous Threshold

Hung-pin Lai

Heterogeneity III

Will a high capital-labor ratio firm use a production technology that differs from that of a low capital-labor ratio firm? Will the production technology of a larger firm differ from that of a small firm? Heterogeneity among firms has been an important issue in studying firms' technical efficiencies. In this paper we generalize a stochastic frontier model to accommodate the heterogeneous technologies among firms by considering a threshold stochastic frontier model. Previously, Yélou, Larue and. Tran (2010), Wang and Huang (2009), Tsionas and Tran (2007) have done

similar works, where the sample split or threshold variables are assumed to be exogenous and uncorrelated with the frontier equation. However, firms belonging to different groups may potentially contain different characteristics or input variables that may be correlated with the threshold variable. The exogeneity assumption is violated when the stochastic disturbance in the frontier equation is correlated with that in the sample split rule. We propose a stochastic frontier model with a specified sample split rule to accommodate cross-sectional parameter heterogeneity. In particular, we focus on discussing the econometric techniques appropriate for threshold stochastic frontier model with panel data. Finally, our approach is also demonstrated by an empirical example.

How to Measure the Impact of Environmental Factors in a Nonparametric Production Model?

Luiza BADIN, Cinzia Daraio, Léopold Simar

Heterogeneity III

The measurement of technical efficiency of decision making units is useful for making comparisons and informing managers and policy makers on existing differentials and potential improvements across a sample of analyzed units. The step further is to relate the obtained efficiency estimates to some external or environmental variables which may influence the production process and hence, affect the performance evaluation and explain the efficiency differentials.

Conditional efficiency measures including conditional FDH, conditional DEA, conditional order-m and conditional order-alpha became rapidly a useful tool to investigate the impact of external-environmental factors on the performance of Decision Making Units in a nonparametric framework.

In this paper, we clarify what can be learned by analyzing these conditional efficiency scores, showing that the impact of these factors on the production process can have different facets: impact on the attainable set in the input x output space, and/or impact on the distribution of the inefficiency scores. We suggest a procedure allowing to make local inference on the impact of Z on the process, as opposed to the global test of separability developed in Daraio et al. (2010). Using the optimal bandwidth selection procedure proposed in Badin et al. (2010) we provide confidence intervals for the local impact of Z by adapting the subsampling ideas from Simar and Wilson (2010).

The approach proposes statistical inference on the level of the impact, using up-to-date bootstrap algorithms for which we prove the consistency. The procedure is illustrated through simulated samples and with a real data set from the Banking industry.

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Econometric Problems in Identifying Class Switching in a Latent Class Model

Antonio Alvarez, Carlos ARIAS

Heterogeneity III

Firm heterogeneity has long been a concern in empirical analysis of production since the assumption of a common technology can cause biased estimates of relevant features of the technology. Several approaches have been followed to deal with the problem of unobserved heterogeneity. For example, using control variables that account for firm heterogeneity, the most common being the introduction of firm specific intercepts. However, firm specific intercepts can be quite restrictive in modeling heterogeneity. On the other hand, a model with firm specific slopes can be difficult to estimate and/or interpret. Middle ground can be found in a model with group-specific parameters. At least two approaches come to mind. First, a two stage estimation procedure that splits firms into two groups and then estimates different production functions for each group. Alternatively, a procedure that estimates jointly different technologies and the probability of using each technology in one step. Latent Class Models (LCM) lie in this category. LCM distribute observations among a set of classes and attributes prior probabilities of class membership for each observation. Each observation is assigned to the class with the highest probability. As usual, Panel Data provide a set of opportunities and challenges in the estimation of LCM. For one, it is reasonable to envision a firm switching classes over the sample period. On the other hand, class membership constant over time can be unattainable for long panels or for periods with vigorous technical, institutional or economics changes. However, to our best knowledge current models do not deal explicitly with this possibility. The main objective of the present paper is to estimate models that explicitly allow for changes of class over time. A better understanding of class membership over time could help answering relevant policy and management questions. For example: Do many farms switch technology over time? How does a change in some exogenous variable (policy) affect technology choice? In fact, firms switching from one technology class to other over time could be seen as an essential feature in the modeling of technical change. Switching between groups over time requires time variant probability of belonging to a class. However, the prior probability of class membership is usually modeled as time invariant. This feature of the model precludes the analysis of changing classes in the period of analysis. Things change if class membership is determined by posterior probabilities. Posterior probabilities depend on time variant explanatory variables and, as a result, allow for changes in class membership. This issue raises concerns over the interpretation of prior and posterior probabilities as well as their statistical properties and significance. Estimating a pooled sample of observations or splitting the panel in two time periods could provide some insights into the extent and nature of firms switching classes over time. In the empirical portion of the paper, we use a panel of dairy farms in Northern Spain. To our best knowledge, the possibility of switching from extensive to intensive farming during the period of analysis is not explicitly considered in previous papers. Extensive dairy farming consists of producing milk using mainly on-farm produced forage with low stocking rates. Fostering production using extensive systems has often been an explicit goal of agricultural policy. The preference for this system of production is explained by a number of features such as environmental soundness, milk quality or use of abundant resources in underdeveloped areas. However, counter to this policy setting many dairy farms in northern Spain have gone in the opposite direction. Indeed, in past years there has been an intensification of dairy farms. We wish to analyze this process of intensification focusing on farms that switch from extensive to intensive production during the period of observation.

Investigating economies of scope by robust non-parametric methods

Pedro CARVALHO, Rui Marques

Scale and Scope Economies

The existence of inadequate market structures jeopardizes the maximization of the organization's efficiency in monopolistic markets. Although the governments intervene many times to curb the market power and to correct market failures, either through regulation or policies that promote competition, the presence of scale and scope economies often remain as obstacles for the customer's protection. The scope economies exist when there are synergies in the simultaneous provision of various goods or services by the same entity. The results found in the literature are very different with regard to the existence or not of scope economies. The vast majority of studies of the literature that use non-parametric methods to examine economies of scope have been exclusively based on the

full frontier methods (such as data envelopment analysis - DEA) which are highly sensitive to outliers and extreme data. Therefore, in this research we propose a new non-parametric methodology based on the recent and robust order- method (belonging to the family of partial frontier non-parametric methods, which are less sensitive to extreme data and outliers than the traditional full non-parametric methods (Daraio and Simar, 2007)) to assess the existence of scope economies. Our proposal allows the investigation of economies of scope by comparing the efficient frontier of firms that produce two or more goods or services with an efficient frontier of firms that produce only one good or service. However, since the frontier of the partial frontier methods are discontinuous, is necessary to linearize these frontiers to make it possible to assess the dominance between efficient frontiers. Following the ideas of Jeong and Simar (2006), who suggest the linearization of the frontier FDH (LFDH), we propose a procedure to linearize the frontiers of the partial frontier non-parametric methods. The results show that our methodology is the most advantageous and robust one to find economies of scope using non-parametric methods. As a representative case-study, we analyzed a sample of 67 Portuguese water utilities for the period 2002-2008. We examined if there were savings when providing drinking water supply and wastewater services together or with other activities (e.g. urban waste). The results seem to point out the benefits (economies of scope) between the joint provision of water and wastewater and the drawbacks of including the waste activity (diseconomies of scope).

Equivalences in Measuring Returns to Scale in Multi-output-Multi-input Technologies

Valentin Zelenyuk

Scale and Scope Economies

In this article we show equivalence between the input oriented and output oriented scale elasticity measures for multi-output, multi-input technologies. We show the necessary and sufficient condition for this equivalence. We also provide a Lagrange multiplier (or shadow price) interpretation of the scale elasticity measure.

A non parametric method for decomposing economies of scope into scale efficiency and product mix effect.

Mario FORTIN, Andre Leclerc

Scale and Scope Economies

Economies of scope have been defined by Panzar and Willig (1981) as the situation where the joint production of many outputs by a single firm is less costly than the disjoint production by specialized firms. This property is important in efficiency analysis, and particularly in banking, but has been studied mostly with parametric methods such as the estimation of a flexible functional form because the non parametric Data Envelopment Analysis (DEA) method do not provide a direct measure of economies of scope. Morita (2004) has proposed to compare the input requirement sets of diversified firms and specialized firms to measure the cost savings of multi-output firms, a method which cannot be applied when the sample contains only diversified firms. Cummins et al (2010) uses a two-stage approach that is based on a regression analysis of efficiency scores.

This paper proposes an alternative method of calculating economies of scope with DEA. In a first part we show how economies of scope can be decomposed into a pure diversification effect linked to the convexity of the production set at a given input cost, and a change in the firms' scale efficiency. This decomposition is similar in substance to that exposed by Berger, Hanweck and Humphrey (1987) between ray scale economies and product mix economies

but differs on the treatment given to scale effects. Indeed, rather than relying on the cost-elasticity of output we measure the scale effect by comparing the scale efficiency of the combined firm with those of the specialized firms. Moreover, the output-mix effect on cost is measured at a constant level of inputs. This decomposition is then transposed into a DEA analysis to disentangle scope economies into product mix and scale efficiency effects. In order to apply the method to any sample, we use the hypothesis of free disposal inherent to the DEA to compare the efficient level of production of diversified firms with the projected efficient production of specialized firms. We illustrate the method with banking data to measure scale efficiency and scope economies.

Bootstrapping scale elasticities and optimal scales in DEA

Dag F. Edvardsen, Finn R. Førsund, Sverre A.C. KITTELSEN

Scale and Scope Economies

Deterministic estimates of frontiers in Data Envelopment Analysis (DEA) are characterised by piecewise linear facets which give rise to discontinuous marginal properties. Scale elasticities are not continuous nor even monotonically decreasing, and optimal scales are known to be often heavily dependent on input and output mix (Førsund et al., 2007). Determining the optimal scale can be vitally important for production planning and public policy. Podinovsky et al. (2009) provide formulas for the calculation of scale elasticities in DEA, and by implication also for the identification of the optimal scale. While bootstrapping can give bias-corrected DEA estimates of efficiency with confidence intervals, bootstrapping implicitly also gives corrected estimates of the production (or cost) function, i.e. the position and shape of the frontier of the production possibility set. Simar & Wilson (2002) provide bootstrap tests of whether the frontier as a whole is characterized by constant returns to scale (CRS) or variable returns to scale (VRS). This paper extends our knowledge of the statistical properties of scale in DEA, and examines the bootstrap estimates of scale elasticities and optimal scales, and the associated confidence intervals, as well as the monotonicity and continuity of these estimates. Results are illustrated using data on Norwegian nursing homes.

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Agricultural Productivity in the U.S. States: Catching up and the Business Cycle

Eldon Ball, Carlos SAN JUAN, Camilo Ulloa

Efficiency in Agriculture III

Several recent studies of the agricultural sector provide evidence of convergence of total factor productivity (TFP) across states. McCunn and Huffman (2000) found evidence of "catching-up" in levels of TFP (i.e., beta-convergence), although they rejected the hypothesis of declining cross-sectional dispersion (i.e., sigma-convergence). Ball, Hallahan, and Nehring (2004) also found evidence of beta-convergence after controlling for differences in relative capital intensities.

The speed of convergence and whether it is transitory or permanent in nature play an important role in characterizing regional disparities in income and, hence, have important implications for the design of agricultural policy.

According to Barro and Sala-i-Martin (1992), there is beta-convergence if states with lower levels of productivity tend to grow faster than the technology leaders, and sigma-convergence if the dispersion of their relative TFP levels tends to decrease over time. Thus, beta-convergence is a necessary but not a sufficient condition for sigma-convergence. An important implication of this result is that income inequality across states or regions may persist due to shocks (e.g., cyclical fluctuations in economic activity) that tend to increase dispersion.

This paper explores the relationship between the business cycle and convergence in levels of agricultural productivity. Two alternative explanations have been proposed in the literature to explain why convergence patterns may be related to the business cycle. The first is based on the pro-cyclical nature of the innovation process and the time lags between technological innovations and diffusion processes. According to this argument, productivity leaders tend to innovate more during periods of expansion in response to positive demand shocks. However, due to the existence of informational barriers, productivity followers, who tend to learn by imitation, postpone the adoption of innovations until economic downturns.

The second explanation is based on the relation between competition and productivity. Productivity followers have more incentive to reduce their costs during downturns when negative demand shocks increase the probability that these firms will exit the industry.

Overall, these arguments point to faster rates of convergence during contractions in economic activity and to slower rates of convergence, or even divergence, during periods of expansion. Despite these arguments, few researchers have estimated the impact of the business cycle on productivity convergence.

An exception is provided by Escribano and Stucchi (2008). Using firm level data for the Spanish manufacturing sector, the authors test the catch-up hypothesis across different phases of the business cycle. They find strong evidence in support of the innovation-imitation hypothesis. Firms tend to diverge during periods of expansion and to converge during recessions, a result of both time lags in the diffusion of technical information and the pro-cyclical nature of innovation.

In this paper, we closely follow the methodology of Escribano and Stucchi (2008). First, we test the catch-up hypothesis using a model specification that ignores the business cycle (i.e., the benchmark model). Then we investigate the possible impacts of the business cycle on the convergence process.

We find strong evidence of "catching-up" across the business cycle. Moreover, the speed of convergence was greater during periods of contraction in economic activity.

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Assessing the profit inefficiency among urban and peri-urban vegetables crop producers in the Southern Benin: a directional distance bootstrap approach

Alphonse SINGBO, Alfons Oude Lansink, Grigorios Emvalomatis

Efficiency in Agriculture III

In West Africa, the rapid population growth, infrastructure development and urbanization provide increasing opportunities for the intensification of agricultural systems in urban regions. A wide range of vegetable crops are grown, traded and consumed in urban and peri urban zones of Benin. However, the potential of urban vegetables production is limited by technical, allocative and marketing inefficiency. In addition, with the food crisis that started this last decade in Africa, agriculture has gradually returned in the global development agenda. Hence,

urban agricultural sector productivity analysis is crucial for food security and poverty reduction. By contrast, the vegetables sector traditionally received far less attention from research and extension than either industrial or staple food crops. These trends provide increasing opportunities for agricultural development and the intensification of agricultural systems around urban centers. The objective of this paper is to estimate the level of profit inefficiency among urban and peri urban vegetable crop producers in the South of Benin. We collected data from 310 producers in six cities and towns in the South of Benin during agricultural production year 2009/2010 using a two-stage stratified random sample procedure. Variables collected from the farmer survey are outputs, inputs, farm characteristics and socio-economic information of the farmer and farm household. We employed a dual approach to estimate and decompose short-run profit. This framework also accommodates multiple outputs and multiple inputs which characterises urban vegetable crops production. We adapt the (first stage) smooth bootstrap approach to the directional distance function to improve statistical inference. The bootstrap method appears to be robust and useful for investigating inefficiency in cross section data. In semi-parametric efficiency analysis, the directional distance function is becoming a more popular approach to measuring profit inefficiency. The directional distance function is derived from the shortage function which generalizes the profit function in the short-run. Since overall profit inefficiency analysis is based on difference rather than ratio in Farrell cases, the directional distance function is practical due the fact that both maximal and observed profit may equal zero. In addition, the fact that the directional distance function combines features of both an input-oriented and an output-oriented model, generally leads to a more complete ranking of the observations. The results show that although urban and peri urban vegetable crop production farming is input intensive, there is a need to reduce loss of profit of producers. We found evidence of substantial profit inefficiency among urban vegetable crop producers. The paper also provides empirical support for reducing urban agriculture inputs use inefficiency to address urban food insecurity problems in Benin.

Agricultural Productivity and Production Bias: Policy and Infrastructure in Henan, China

Bingxin YU, Fengwei Liu, Liangzhi You

Efficiency in Agriculture III

Food demand in China has expanded dramatically in the past few decades due to rapid urbanization, income growth, and steady population growth. At the same time, limited scope of land expansion has made increasing productivity the only feasible way to achieve steady agricultural growth in the long run. The government has implemented comprehensive policies to encourage domestic agricultural production, including agricultural tax elimination and subsidies. In particular, China has invested heavily over the last decade in major infrastructure such as roads, railway, airports and dams. The scale and intensity of investment in infrastructure is unprecedented in the world. There is an urgent need for knowledge on the effectiveness of policies and infrastructure in stimulating agricultural productivity, which can guide policy formulation in the process of economic transformation to ensure stable growth.

There is a vast amount of literature on the sources of agricultural productivity growth in China (Fan and Chan-Kang, 2005; Brummer, Glauben and Lu, 2003), however, these studies do not address spatial, biophysical and policy factors in a comprehensive manner. This paper contributes to the understanding of the impact of policies and investments on agricultural productivity growth in China by using detailed information on disaggregated county-level agricultural production information and distinguishing infrastructure and policy, generating a more nuanced picture of TFP evolution over time. It also captures the nature of technical change during fast economic transformation by calculating output and input bias in technical change, the shifts of the output combination corresponding to changes in farmer's output and input sets. Instead of traditional non-parametric approach, this paper addresses the statistical reference issue through parametric distance function estimation. China's experience can be useful for other developing countries facing similar food security concerns, serving as guidelines for policy planning.

Crop outputs, inputs, and other related variables in 108 counties in Henan province for 1998-2007 are compiled from Henan Statistical Yearbook. Other factors that can affect agricultural productivity include biophysical conditions (temperature, rainfall and extreme events (e.g. drought and flood) by growing season), human capital (primary school enrollment rate), infrastructure (irrigation, and market accessibility), and capital investment, and the intensity of government policies to support agriculture.

We use a parametric distance function approach to estimation the path of agricultural productivity in China, which can be decomposed into technical efficiency change, technical change, input bias and output bias. Following Fuentes, Grifell-Tatje and Perelman (2001), a translog output-based distance function with multiple outputs and inputs is used to represent the production relation. Using linear homogeneity condition of the output distance function in outputs, we can transform distance function to have an estimatable equation. We define the transformed function with two error terms, which has the same composed error structure as a standard stochastic production frontier model. One error term is standard and the other defines technical efficiency, truncated at zero from below to capture the effect of policy and infrastructure.

The Malmquist index and its components can be obtained through the parametric estimation, allowing us to measure productivity and technical bias.

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International Comparisons of Agricultural Productivity, Technical Change and Prospects for TFP growth in Developing Countries

Alejandro NIN-PRATT

Efficiency in Agriculture III

The high yields and harvests obtained today in industrial and post-industrial economies using modern technology are still the result of the same scientific principles that brought about the agricultural revolution in the late 19th century. By the end of the 20th century, with the impressive advances made in biotechnology, we witnessed the dawn of a new paradigm in agricultural research that is thought to replace the Mendelian genetics as the driver of technical change in agriculture. The transition between the old and the new paradigms in agricultural research will not occur without problems. One of these problems is the displacement of the center of gravity of agricultural R&D from the government and non-profit research institutions to the private sector. This is a result not only of changes in science and the advantages for the private sector to develop new technologies under the new innovation paradigm, but also because governments in high income and developing countries have been giving less priority to investment in agricultural R&D. What are the consequences of these changes on global rates of public investment in agricultural R&D? Is technical change in agriculture of high income countries slowing down as a result of these changes? Are developing countries falling behind or are they catching-up to the technological frontier? What are the implications for future agricultural growth in developing countries? This study analyzes the evolution of global agricultural Total Factor Productivity (TFP), looking for evidence of changes in TFP growth rates at the global, regional and country levels. This is done by estimating a nonparametric Malmquist index for 110 high income and developing countries using a Data Envelopment Analysis (DEA) approach. Because this approach is susceptible to the effect of data noise and shadow prices can prove to be inconsistent with prior knowledge on cost shares, we analyze the obtained implicit input shadow shares and set bounds to these shares introducing information on their likely value. We also decompose TFP into efficiency and technical change and focus on the evolution of technical change in different countries and regions looking for evidence of structural changes in the series. We then develop

an econometric model that explains technical change as a function of public agricultural R&D at the country level, international public investment in R&D, private R&D investment and international spillovers. The paper concludes with implications for future growth of agriculture.

Container Ports Efficiency: A Robust Non-parametric Approach

Susila MUNISAMY, Wang Danxia

Non Convexity

In the last decade, the shipping industry and the global seaborne trade has witnessed a rapid growth due to globalization of the world economy, boom in international trade and borderless investments. As competition among international ports has intensified, the evaluation of port operational efficiency has become increasingly important to enable individual ports to reflect on its current status quo and understand their strengths and weaknesses in the competitive environment. This paper analyses the efficiency of major container ports in Asia using a robust non-parametric approach.

The theory of efficiency analysis began with the works of Koopmans (1951), Debreu (1951) and Farrell (1957) who made the first attempts at estimating efficiencies for a set of observed production units. Among the non-parametric approach for estimating efficiency, the Free Disposal Hull (FDH) (Deprins et al., 1984), and Data Envelopment Analysis (DEA) (Charnes et al., 1978; Banker et al. 1984), are based on the envelopment technique. The main non-parametric methods used in previous empirical studies to estimate efficiency of ports are FDH and DEA. Because of the known sensitivity of the traditional non-parametric approaches such as DEA and FDH to extreme values or outliers, small sample size and slow convergence rates of efficiency estimates, this study employs an alternative robust non-parametric technique called order-m estimator following Cazals et al. (2002) to evaluate the efficiency of Asian container ports. This technique converges in root-n consistency, achieves asymptotic normality, and is more robust to outliers and extreme points since it does not envelop all units. In addition, for large number of inputs and outputs, the order-m estimator requires far less data to provide a more efficient estimate than FDH (Wheelock and Wilson, 2003).

In this study, we formally investigate the efficiency of 71 major container ports in the Asian region for the year 2007. We conduct two efficiency analyses comprising FDH and order-m, identify outliers following (Simar, 2003) and rank the container ports with the order-m efficiency estimates.

We conclude that the order-m estimator provides efficiency estimates that are robust i.e. less sensitive to extreme values or outliers using small samples. The arrived efficiency estimates do not suffer from the curse of dimensionality. The estimates also reflect more realistic benchmark and define an output level that is best expected among any m ports chosen randomly from the population using no larger inputs than the given port. The leave-one-out version of the order-m estimator proposed by Simar (2003) is a useful tool for outlier detection.

The empirical results reveal that the ports of Ningbo, Shanghai, PSA International Ltd. and Busan are outliers. Removing these outliers, the order-m estimator was used to rank the remaining container ports. The most efficient port was the port of Hong Kong. The results illustrate that the Asian container port's average efficiency in 2007 was 1.7502, denoting the group of ports only produced 57 percent of the maximal expected output of a random sample of 75 ports and could have handled 43 percent more traffic with the same resources.

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Nonconvex Nonparametric Least Squares Regression and its Application in Frontier Estimation

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Non Convexity

Isotonic least squares regression (Barlow et al., 1972) is a well known method in the theory of regression analysis and there are several applications of this method in statistics such as image processing, medical science and operations research. To our knowledge, this method has not been used in productivity efficiency analysis. In this paper we examine an Isotonic Nonparametric Least Squares (INLS) problem and show that INLS can be obtained from Convex Nonparametric Least Squares (CNLS) problem (Kuosmanen & Johnson, 2010) by removing the concavity assumption. We extend the work of (Kuosmanen & Johnson, 2010) to non convex technologies and show the equivalency of non-convex nonparametric least squares and isotonic regression analysis. Further, we show Free Disposal Hull (FDH) (Tulkens, 1993) model is a sign constrained case of isotonic nonparametric least squares regression problem and thus we can treat FDH as a statistical regression method. We also present the sign constrained INLS that is equivalent to the integrated FDH model. The INLS formulation can be used as another LP formulation of FDH model. Finally, we examine the INLS and the sign constrained INLS by Monte Carlo simulations for multiple regression.

Discriminating efficient units using super-efficiency FDH

Shinn SUN, Shing-Cheng Hu

Non Convexity

Free Disposal Hull (FDH) is one of the tools in the theoretical and empirical work on the measurement of productive efficiency. Excluding linear combinations of extremal observations to construct this reference technology entails that many of the observations belonging to an evaluated dataset are labeled efficient by this method. Few researchers have sought to improve the discrimination power of FDH. Van Puyenbroeck (1998) modified standard FDH method by using Andersen and Petersen (1993), referred to A&P FDH. Jahanshahloo et al. (2004) used 0-1 linear programming (LP), referred to 0-1 LP FDH to find FDH-efficient units. Recently, Sun and Hu (2009) propose an alternative FDH based upon the concept of Mehrabian, Alirezaee, and Jahanshahloo (1999). The theme of this research is on "improvement of discriminating power in FDH". The purpose of this research is two-fold: (i) to develop super efficiency FDH (SE FDH) that introduces A&P model into A&T FDH proposed by Agrell and Tind (2001); (ii) to compare SE FDH with FDH, A&T FDH, A&P FDH, and 0-1 LP FDH. Research questions include: (i) Which FDH models have the most discriminating power? and (ii) Are any results different by various models? This study shows that the SE FDH has the best result in three examples and can improve the discriminating power of FDH.

Predicting the Success of Entrepreneurial Ventures Using Order-m FDH

Harold FRIED, Loren Tauer

Non Convexity

The entrepreneur is the driving force of change. The better is our ability to identify successful entrepreneurial ventures, the higher will be our standard of living and the brighter our future.

We evaluate the success of entrepreneurial ventures. Success is measured relative to a best practice production frontier. Outputs are revenue and revenue growth; inputs are total expense and hours worked by the owners. For a startup firm, it is easy to incur expenses, it is difficult to generate revenue and even more difficult to generate profit. For this reason, we quantify successful performance in terms revenue and revenue growth, rather than profit, although by including both revenue and expense, profit is implicit in our index. The generation of revenue and revenue growth at an early stage establishes the potential for profit at a later stage.

We choose order-m FDH (Daraio and Simar 2005). The advantage of FDH is that ventures are rendered efficient or inefficient relative to operating units rather than artificial composite units derived from data points. We use order-m instead of traditional FDH to accommodate noise. The order-m efficiency score is the mean of an infinite number of efficiency scores generated from random subsamples of the data of size m, drawn with replacement. The impact of outlying observations (possibly the result of noise) is reduced since some subsamples will exclude these observations. In this respect, order-m is a smoothing technique.

In order to identify successful entrepreneurial ventures, we regress firm survival against lagged values of the index. The index is restricted to strictly production function inputs and outputs in the purest sense. It does not include other potential determinants of success such as education, gender, ethnicity, financing, age, region, although these determinants may impact the transformation of inputs into outputs. The index is designed to provide a warning that a venture is at risk and in need of intervention. It is the job of experienced consultants to dig into the specifics and determine particular operational weaknesses and to assess the likelihood of remedial efforts being successful.

We use the Kauffman Firm Survey which includes data on 4,928 start-up firms in 2004, with follow up surveys in each year of 2005 through 2008. Efficiency scores are calculated for 2006 and 2007. The categorical variable survival is regressed against lagged values of the efficiency scores. This exercise is conducted in 2007 and 2008.

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Efficiency and productivity in operational units of the armed forces

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Security and Defense

Most nations spend a considerable part of their GDP on defense. NATO has set a target for its member countries to allocate at least 2% of GDP to defense objectives. By allocating such amounts to a single sector, there should also follow a requirement for efficient utilization of those resources. However, the quite obvious absence of market prices in this sector will leave the armed forces without the means to reach an efficient allocation. We are therefore using methods to measure productivity and efficiency in the sector.

As far as we know, the productivity in the core areas of the armed forces, the operational units, has not previously been studied. Previous studies of productivity and efficiency related to the armed forces, mainly during the eighties and early nineties, have solely been concentrated around various service and support functions, like maintenance

and recruiting. A complete approach to the sector should however also cover the core area of the defense by including the operational dimension. We have studied productivity and efficiency among some operational units in the Norwegian Armed Forces.

What are the armed forces actually producing? This is the main problem in measuring productivity in the public sector. The main task for the armed forces is often related to maintaining sovereignty. Our approach to measuring output is to identify indicators at unit level for results contributing to solve the main task. In doing this we have to be able to distinguish whether an indicator of military activity, for example flight hours, is to be considered at the output or the input side of the model. In the operational part of the defense sector, dealing with this problem is of particular interest. We have therefore spent considerable time together with the Armed Forces, and made use of expert opinion to define the actual outputs of the operational units

We have studied eleven units of the Norwegian Home Guard over a period of three years by using a DEA model. The model is specified by inputs from expert opinion in the Home Guard. The Home Guard defines its production as troops at various proficiency levels as well as training and coursing of the officers. We have used an input oriented model with three inputs and one output variable. The output variable is an aggregate of troops at the various proficiency levels, where each level has a price determined by the decision makers at the Home Guard.

The number of units is rather small, but we have observations for three years so the number of observations can be increased to 33 by pooling the data. It must then be assumed that the technology remains the same for the three years. In view of the still somewhat limited number of observations it is of interest to measure the uncertainty of the point estimates of efficiency and productivity by bootstrapping, providing confidence intervals.

Environment-Adjusted Evaluation of Local Police Effectiveness: Evidence from a Conditional Data Envelopment Analysis Approach

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Security and Defense

Hard data do not suffice to evaluate local police effectiveness in the new age of community policing. Citizens can provide useful feedback regarding strengths and weaknesses of police operations. However, citizen satisfaction indicators typically fail to accurately convey the multidimensional nature of local policing and account for characteristics that are non-controllable for the local police departments. To construct a citizen satisfaction indicator that accounts for both multidimensional aspects of local policing and exogenous influences, this paper proposes the use of a multivariate conditional, robust order-m version of a non-parametric Data Envelopment Approach with no inputs. We show the potentiality of the method by constructing and analyzing citizen satisfaction indicators of local police performance in Belgium. The findings suggest that the citizen satisfaction with local police forces is highly conditioned by the demographic and socio-economic environment.

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Keywords: local police; conditional efficiency; citizen evaluation

Measuring effectiveness by Stochastic Frontier Analysis: An application to public safety in the Netherlands

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Security and Defense

Since the end of the nineties, productivity has become a keyword for budget makers of the Dutch government and so for the field of public safety, the playing field for the police. More recently, attention has changed from the production of police to the effect of police. Instead of measures as the number of fines, safety should be the objective. Therefore, there is a clear and present need for research on the effectiveness of Dutch police. An interesting analysis is done by Vollaard and Koning (2009), who however only consider the size of police forces in number of employees as an input factor for police. Moreover, their most recent data come from 2004.

Using Stochastic Frontier Analysis, this study aims to give insight in how the effect of the police on safety can be measured, and what the influence of demographical and geographical factors is on safety. The main research questions are how safety has developed in the period 2002-2009, how effectiveness of the police has evolved, and which factors play a role in the development of effectiveness. Barros and Alves (2005) used stochastic cost frontiers for the analysis of police efficiency in Lisbon. An interesting aspect of our paper is the application of Stochastic Frontier techniques to the effectiveness of public safety policy in general. The paper therefore proves that these techniques can be applied in a much broader context than the usual firm assessments.

In the Netherlands, security is being monitored through a large-scale questionnaire, which allows us to work with panel data of all 25 Dutch police regions. This information is more reliable than data on registered (and reported) crime. Data on indicators as population, surface, density, urbanisation, income, unemployment, youth and immigration are also available for the regions. Furthermore, we have data on different types of personnel and of the costs of the 25 police forces for the period 2002-2009.

Through modelling the differences over time in the panel data by a translog cost function we can obtain more insight into the influence of police and of the environmental factors on safety, and in how the effective use of means by the police varies over time and among the regions.

We show that general police expenditure has a significant crime reducing impact, but that not all investments in police pay off and that the properties of the region and its inhabitants have a substantial influence on the effectiveness of police on safety.

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Can local governments buy a good performance evaluation? Theory and evidence from the comprehensive performance assessment of English local authorities

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In 2001, the UK government embarked on an elaborate and costly evaluation exercise - comprehensive performance assessment (CPA) - to gauge how effectively its money was being spent to provide local services. From 2002 to 2008 CPA has been used to scrutinise service delivery in English local authorities (LA) across seven service blocks: education; social care; environment; libraries and leisure; use of resources; housing; benefits. Hundreds of performance indicators and a plethora of audit and inspection reports have been collected, summarised, weighted, and categorised so as to arrive at final category ratings of "excellent", "good", "fair", "weak", and "poor". Differently from previous studies on CPA, the primary goal of this paper is to study, both from the theoretical and empirical point of view, the relationship between CPA scores and LA's technical efficiency in the provision of local services in order to verify if some authorities can simply "buy" better CPA scores using their fiscal capacity. The theoretical

analysis has been built expanding the theoretical framework proposed by Revelli (2010) in order to take explicitly into account that councils' ability to provide local services can be influenced both by different level of efficiency and different degrees of deprivation. The empirical approach, instead, has been conducted in two steps. First an index of council's technical efficiency has been estimated non-parametrically through data envelopment analysis (DEA) using Simar and Wilson (1998) bootstrap approach. Subsequently, the relationship between DEA-efficiency and CPA scores has been studied using a parametric approach where CPA scores are regressed both over measures of efficiency and deprivation. A similar parametric approach has been used, then, to analyse councils' fiscal behaviour in order to verify if some authorities could "buy" better CPA scores increasing local taxes. Final results, in line with the predictions of the theoretical analysis, show that the efficiency indices are only moderately correlated with the CPA scores (Spearman correlation coefficient around 0.30). In fact, the probability of obtaining high CPA scores is positively affected both by higher efficiency in the provision of local services and by the presence of a favourable local context. Moreover, final results provide empirical evidence in support of the idea that inefficient LA favoured by a good local context can "buy" a good CPA score increasing their property tax rate above the level set by efficient local authorities. These results are important because they expose some important fallacies of CPA that, as far as we know, is the only comprehensive assessment procedure for sub-national government based on quantitative indicators of performance implemented so far. The main policy advise provided by the paper is the possibility of using the level of property tax rate as a signal to spot inefficient councils that are able to "buy" high performance scores at the expenses of efficiency. References Revelli, F. (2010). Spend more, get more? An inquiry into English local government performance. Oxford Economic Papers, 62:185-207. Simar, L. and Wilson, P. W. (1998). Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models. Management Science, 44(1).

Testing for separability in a DEA framework

Simone Pieralli

SPECIAL SESSION. A Tribute to Sydney Afriat

The importance of separability in economics has been understood for many years (Blackorby, Primont, and Russell 1978). Some authors (Banker 1996) have considered testing for separability a crucial part of production economics. A recent revival of the separability problem has occurred with the necessity of testing for assumptions that make possible estimates in the efficiency literature (Simar and Wilson 2007 and Daraio, Simar and Wilson 2010).

In this study a new test that relates two ways of defining a technology is presented. Farrell output efficiency scores characterize the technology in this part of the study. In particular Farrell output efficiency scores are taken to represent the technology in two different manners. On one hand, a Farrell output efficiency score is measured directly including all inputs distinctly in the technology. On the other hand instead the Farrell output efficiency is calculated in two steps, imposing a separability assumption as in (Blackorby, Primont, and Russell 1978). First, a measure of efficiency is calculated conditional on the other variables fixed at a certain reference level. Then another measure of efficiency is calculated including the first step measure as a strongly disposable input. The latter way of defining the technology assumes separability while the former does not.

In this part of the study, differently than in the rest of the literature, separability is assumed directly among some inputs, and other inputs and outputs. This methodology allows taking into account technologies that would otherwise be impossible to be identified. The purpose of this paper is to prove that the test proposed shows correctly when separability can be confidently assumed or not on the technology. This is done through Monte Carlo simulations. An application to a Kenyan household data set shows preliminary results of separability of the technology at difference levels of the reference variables. This also means that the technology is a rather flexible one.

Value Data and Index Numbers

Robin CROSS, Rolf Fare

SPECIAL SESSION. A Tribute to Sydney Afriat

Diewert (2003) proposes three bilateral indices, the Fisher, Walsh, and Törnqvist-Theil, to replace elementary indices used to construct the United States Consumer Price Index (CPI). Each of the proposed satisfies important mathematical properties of Fisher's (1922) Test Approach and Diewert's (1976) Economic Approach, which elementary indices do not. Bilateral indices require multi-period price and quantity (factor) data, making them relatively "expensive" to compute. Economic data is often available only in terms of values: sales, costs, profit. This is the case for some types of retail transaction (scanner) data and other tax, lending, and regulatory disclosure data. We reduce the "computational cost" of bilateral indices by deriving value-based Fisher, Walsh, and Törnqvist-Theil indices, expressed in terms of revenues, costs, and price relatives. For completeness, we also provide value-based Dutot, Jevons, Laspeyres, Lowe, and Young indices, all prevalent CPI components. When price relatives are not available, we show how they are recoverable from revenue and cost data by exploiting properties of the Weak Axiom. To evaluate the performance of these value-based indices, we conduct a Monte Carlo experiment in which price relatives are unavailable and producers respond to price changes with error (they fail to minimize cost). We compare bilateral and elementary indices under Quadratic technologies, consistent with the Fisher and Walsh indices, and Translog technologies, consistent with Törnqvist-Theil. The bilateral indices outperform overall. This is reasonable, because they average over a two-period market basket, whereas elementary indices use only a single-period (or no) market basket. Index accuracy is higher for modest price changes (50% - 100%), larger sample sizes (20 - 30 firms), and greater variation in production responses (standard deviation 0.3 - 0.4). Fisher accuracy remains bounded above and below by its Paasche and Laspeyres components, respectively.

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The role of convexity assumptions in weakly disposable DEA technologies

Timo Kuosmanen, Victor PODINOVSKI

SPECIAL SESSION. A Tribute to Sydney Afriat

The treatment of undesirable (bad) outputs in models of efficiency and productivity analysis often requires replacing the assumption of free disposability of outputs by their weak disposability. The Shephard technology is an established technology incorporating weak disposability of bad outputs. In this paper we show that the Shephard technology exhibits a particular type of relaxed convexity, the fact that appears to not have been appreciated in the literature. We further investigate the effects of other variants of the convexity assumption on the technology with weakly disposable outputs. We give complete axiomatic characterizations and programming formulations suitable for such technologies in the cases of full convexity, convexity only applicable to output sets and no convexity at all. We also give an axiomatic definition of the Shephard technology.

R&D Efficiency in Manufacturing: A Non-Parametric DEA Approach

Petra ZLOCZYSTI, Jens Schmidt-Ehmcke
Research and Development

The Lisbon Agenda for competitiveness included two targets for R&D: 1) R&D expenditures relative to GDP were expected to increase to 3% by 2010; and 2) the business sector would be responsible for about two-thirds of the expenditures. Our goals are to identify the best-performing countries and industries for benchmarking and to gain insights about the strengths and weaknesses of innovation strategies that improve R&D efficiency. Although the extant literature generally focuses only on the country level, we suggest that the industry level is more useful. In fact, neglecting the importance of industrial specialization can skew performance rankings. A country like Finland, which has specialized in information and communication technologies, will reveal a relatively high R&D intensity since this particular industry requires high R&D expenditures. In other words, benchmarking at the industry level allows a finer-grained examination of countries' domains of specialization relative to the industries that occupy the technology frontier. This paper identifies the country-industry combinations that define the world technology frontier in the manufacturing sector. It explores which countries reveal the most efficient industry-specific innovation processes. First, we derive efficiency estimates for the entire manufacturing sector at the country level. Second, we proceed to the industry level and identify those county-industry combinations that define the world technology frontier. Third, we focus on selected industries - those mainly defining the technology frontier - and conduct separate efficiency analyses to account for industry-specific production technologies. We build on the empirical literature concerning the importance of level and dynamics of R&D expenditures for economic growth which shows that countries utilizing their R&D resources inefficiently will be penalized with a growth discount. This paper analyzes R&D efficiency at the industry level in manufacturing for 13 European member and 4 nonmember countries between 2000 and 2004. We consider three inputs: knowledge stocks approximated by R&D expenditures and high- and medium-skilled labor to capture human capital. Our analysis uses nonparametric efficiency measurement methods and identifies the differences in the efficiencies on the country and industry levels using a traditional nonparametric frontier approach, i.e. data envelopment analysis (DEA). Since DEA is a deterministic approach, extreme observations can have a strong influence on the calculated efficiencies. We circumvent this problem by using the super-efficiency approach to detect and then remove extreme observations from the sample. Grouping the countries according to their average R&D efficiency score summarizes the results for total manufacturing: * high efficiency: Germany, Denmark, the United States, the Netherlands, Belgium, Ireland, Finland * medium efficiency: Italy, Sweden, Japan, Australia, France * low efficiency: South Korea, the United Kingdom, Spain, Poland, and the Czech Republic. Generally, we find electrical and optical equipment is the dominant industry when determining the technology frontier, followed by machinery, and mineral products. Conducting separate DEA analyses for selected industries corroborates the results from the pooled estimation and provides further insights about the relative position of countries in economically-important industries.

Toward an efficient use of R&D: Accounting for heterogeneity and dynamics in the OECD

Astrid CULLMANN, Petra Zloczysti
Research and Development

This paper assesses the relative efficiency of public and private R&D expenditures in the OECD. The purpose of our analysis is to highlight R&D efficiency differences among OECD countries and the underlying dynamics with an appropriate stochastic frontier model (SFA) for panel data. We thereby account for country-specific heterogeneity as

well as individual variation over time in a country's knowledge production process. Innovation becomes even more important for productivity growth when a country approaches its technology frontier, since there is less room for imitation and replication. As countries might be in different states of economic development and industrialization, e.g. transition economies in Eastern Europe, the measurement of R&D efficiency should consider differences in shape and progress of technology. The existing empirical literature on R&D efficiency so far mainly builds on a fixed or intertemporal technology frontier neglecting the importance of heterogeneity and dynamics (e.g. Sharma and Thomas 2010).

We examine systematic efficiency differences and performance changes between OECD countries using a multi-input multi-output parametric output distance function in an SFA framework. The model specification is as follows: observable measures of inputs, such as R&D expenditures and the number of researchers, are invested in the knowledge production process and directed toward producing economically valuable knowledge. As argued above, it is usually assumed that countries operate under the same knowledge production function. However, we might face different production processes within countries with different complexities (e.g. caused by the legal or political system), which are unobservable but influence the production process. It seems obvious that this is a serious issue when comparing country levels within the OECD: e.g. "old" European countries like Germany or France versus North America and transition economies. Against this background, we apply a random coefficient model capturing country-specific unobserved heterogeneity by exploiting panel data (Greene 2005, 2007; Tsionas 2002).

The analysis is based on a sample of 30 OECD member countries for the years 1995-2008. Different patent indicators and publications are used as proxies for inventive output. The European Patent Office's Worldwide Patent Statistical Database serves as the base of information on patent applications. Data on human capital and R&D expenditures, which serve as inputs, are taken from the Main Science Technology Indicators. Manpower invested in R&D equals the number of researchers per country. We further account for environmental factors affecting knowledge production such as protection of property rights or regulation taken from the world development indicators.

We find considerable variation in the estimated coefficients between countries showing that the random coefficient model is the appropriate framework for our analysis. Most Scandinavian countries are in the top third of the performance ranking, while the situation of most transition economies suggests that they are still in the phase of imitating and replicating existing technologies. Our preliminary results therefore suggest that a matured economic structure is a prerequisite for an efficient use of resources.

Efficiency analysis of knowledge infrastructure and export experience: The role of technology choice mode

Nizamettin BAYYURT, Sunil Sahadev, Mehmet Demirbag
Research and Development

In this paper we explore the linkage between internationalization performance of firms and their choice of technology acquisition modes. Most of the extant studies have focused on the impact of internationalization on important dimensions of a firm's choice of strategy - specifically in the field of R&D and innovation. They focus on the level of R&D investment or new product development success as an outcome of internationalization. The relationship between Internationalization and R&D and innovation is based on the strong belief that success in internationalization is greatly influenced by a firm's ability to innovate and manage its R&D activities effectively. However researchers have not sufficiently conceived the relation between the efficient usage of internationalization levels of firms and their preferred mode of technology development. To investigate this issue we use 1344 firm's data from 18 countries. Data Envelopment Analysis and nonparametric statistics are main tools of the study. the input variables we use in the analysis are intellectual property protection index of country where the firm is located, university business collaboration index of country, knowledge infrastructure index of country, number of employees

of firm, percent of sales exported, percent of inputs and supplies imported, and years of experience in exporting. The variable knowledge infrastructure of country is obtained from the sum of the five indicators of countries. These are; quality of education, quality of math education, local availability of specialized research and training services, availability of scientists and engineers, quality of scientific research institutions. The output variable of the model is firms' sales. Results show that firms that prefer in-house acquisition mode are significantly efficient in transforming their internationalization levels to sales than the firms prefer outsource or joint development modes. This study explores the issue in different perspectives like country groups, sectors and firms' sizes.

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R&D, ICT, and Endogenous Productivity

Nelli Valmari
Research and Development

The aim of my paper is to evaluate the distribution of productivity gains generated by research and development (R&D) and information and communication technology (ICT) investments on Finnish firm level data. Innovation and implementation of more efficient technologies are acknowledged to be the major determinants of productivity growth. At the same time remarkable productivity differences across firms undertaking these investments are observed. A potential explanation for the productivity differences are the high, nonlinear but risky returns to R&D and ICT investments. Understanding the investment - productivity -relationship is important for efficient resource allocation and enhancing productivity growth.

My contribution is to evaluate the productivity effects of ICT and R&D allowing for nonlinear and risky returns. By doing so I present a more realistic picture of the investment - productivity -relationship than the conventional knowledge capital model allows for. I take account of the following characteristics: (1) returns to ICT and R&D are subject to shocks, and these shocks may persist over time (2) the productivity effects of R&D and ICT may be nonlinear in time, (3) returns to R&D and ICT may depend on firm characteristics that are unobservable to the econometrician, and (4) ICT and R&D can be substitutable or complementary to each other. Due to these characteristics, ICT and R&D can have remarkably heterogeneous effects in different firms.

I use Doraszelski et al.'s* novel dynamic estimator that endogenizes the unobservable firm-specific productivity term to knowledge expenditures, allowing for all the return characteristics described above as well as imperfect competition. While Doraszelski and Jaumandreu endogenize productivity to R&D only, I allow also ICT to impact firms' productivity in the similar flexible manner. This is important because returns to ICT are unlikely to be a linear function of the ICT expenditures only, and, for example, ICT and R&D may have complementarities**.

The estimates allow me to characterize (1) the distribution of returns to ICT and R&D investments, (2) the magnitude of uncertainty involved with ICT and R&D investments, (3) the role of ICT and R&D, and the uncertainty involved, in explaining productivity differences across firms, (4) how persistent productivity gains obtained by ICT and R&D investments are, and (5) to what extent ICT and R&D are substitutable or complementary to each other, and in what kind of firms and industries. Importantly, I can distinguish between the physical efficiency effects and the profitability effects that ICT and R&D investments and imperfect competition yield.

Preliminary results, assuming away imperfect competition, confirm highly nonlinear and uncertain returns to ICT and R&D. Persistence of productivity obtained is surprisingly low. R&D and ICT have not only complementary but also substitutable productivity effects depending on the firm as well as the industry in question.

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Public IT Infrastructure, productivity and the Standard of Living - Implications for Advanced and Transitional Economies in the European Union

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Research and Development

Advances in Information Technology (IT) in the first decade of the Century have highlighted the role of IT as an enabling technology throughout an economy. But although the role of IT in transforming the way in which business and consumer transactions are done is clear to all participants in the production-consumption process, it is difficult to pinpoint and precisely measure the specific productivity of IT at the various stages of economic activity. As a result, the productivity of government commissioned innovations in IT is arguably seriously under-measured in official statistics. One reason for this is due to the critical role of IT in enhancing the quality of public infrastructure. The measurement of the economic value of public infrastructure has traditionally been a difficult area because of its 'public good' nature, which means that many users can benefit from use of public infrastructure at the very same time. This is especially true of 'new economy' infrastructure such as IT, which links so naturally with developments in telecommunications so that the existence of many users, far from creating congestion in use, actually enhances the value of the infrastructure through network effects. In response to the measurement problem, the approach of this research has been to utilise an economic model that looks at the end result - observations on changes in the pattern of producer and consumer spending behaviour - and econometrically estimates the extent of the link between these behavioural changes and their drivers. These drivers include the traditional economic stimuli as well as changes in the economic environment due to advances in technology and associated infrastructure - in particular, for this research, the improved provision of public sector IT infrastructure. The results, compared across economies, suggest higher productivity gains from IT advances for the more developed economies. The reasons for these differences in the relative sizes of benefits can be credited to the e-readiness of economies, the extent of sophisticated inter-sectoral linkages that extend multiplier effects, and the potential available at the margin, given the nature of the economies, for extension of proactive public sector IT outsourcing policies. This research paper, which is a companion paper to a study of Asian economices presented at APPC 2010, is primarily concerned with reporting econometric estimates and subsequent simulation experiments that examine the extent to which the productitvity and welfare of economies can be improved by targeted introduction of innovations in public sector IT as supporting infrastructure for economic and social activity. A comparison of results across a set of advanced (generally older member) and transitional (generally newer member) economies in the European Union suggest that the productivity and welfare impacts are much higher than many would have expected. They are also quite varied across economies. After allowing for differences in stages of development and in particular for each economy's orientation towards the 'new economy' - ie its e-readiness - it is apparent that most economies surveyed should be able to take advantage of innovations in major public sector IT infrastructure provision if they choose to do so.

Changes in Industrial Structure and Economic Growth in Japan

Sumio Hamagata

Previous papers compare the effects of information and communication technology (ICT) on aggregate labor productivity growth in Japan, the European Union, and the United States. For example, van Ark, Inklaar, and Mcguckin (2002) and Timmer and van Ark (2005) find that ICT effects almost fully explain the US lead in labor productivity growth over the EU. They also show that non-ICT related sources of growth are the main drivers of productivity growth in the EU and Japan. Moreover, ICT-using industry has a low growth rate of labor productivity despite of its high value-added share in Japan. That might be one of the reasons the growth of Japanese economy is sluggish.

This paper clarifies how the industrial structure has changed in Japan, what policies are used to attempt the conversion of the industrial structure, and how the changes in the input structure in each industry influence on the increase in productivity.

We then use the Japan Industrial Productivity Database 2010, which is compiled in a collaborative effort between the Research Institute of Economy, Trade and Industry (RIETI) and Hitotsubashi University. At first, we adopt the indices proposed by Wolff (2002) as measures of structural change in each industry. Wolff (2002) develops three measures of structural change: changes in occupational composition, changes in input-output technical coefficients and changes in capital coefficients. We regress the indices of structural change on the ICT intensity. We also estimate the effect of structural change on labor productivity/total factor productivity with the pooled cross-section, time-series data for 26 industries over the period from 1980 to 2005.

We find that some ICT-related industries, including computer equipment and accessories, semiconductor devices and integrated circuits, and electronic parts, has a low value-added share despite of achievement of a high labor productivity growth. Moreover, its structure has been maintained for 20 years. Growth in the IT investment had been rapid until 2000, and then its speed has decelerated. We find the ICT intensity has a positive and significant impact on the changes in capital coefficients in each industry. However, it is shown that the estimated coefficient of ICT on the degree of occupational change is significantly negative. This may mean the possibility of the inefficiency in labor market. Moreover, we find that changes in capital coefficients and changes in input-output technical coefficients have a positive and significant effect on productivity in all industries. In contrast, coefficients of the changes in occupational composition are significantly positive only in the manufacturing industry.

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Does intangible capital affect economic growth?

Felix ROTH, Anna Thum

Economic Growth and TFP Advances

Using new international comparable data on intangible capital investment by business within a panel analysis from 1995-2005 in an EU-15 country sample, this paper finds a positive and significant relationship between intangible capital investment by business and labour productivity growth. This relationship is cross-sectional in nature and proves to be robust to a range of alterations. Our empirical analysis confirms previous findings that the inclusion of business intangible capital investment into the asset boundary of the national accounting framework increases the rate of change of output per worker more rapidly. In addition, intangible capital is able to explain a significant portion of the unexplained international variance in labour productivity growth and when incorporating business intangibles, capital deepening becomes an even more significant source of growth. The relationship is

slightly stronger in the time period 1995-2000 and seems to be driven by the coordinated countries within the EU-15.

Corruption as a Source of Heteroscedasticity in Cross-Country Productivity Comparisons

Antti SAASTAMOINEN, Timo Kuosmanen
Economic Growth and TFP Advances

Total factor productivity is generally seen as the main source of economic growth. While neo-classical growth theory emphasized the role of exogenous technical progress as the source of productivity growth, the new endogenous growth theory attempts to explain the productivity growth within the model itself. Recently the role of social factors such as corruption has gained growing research attention. Estimating the effect of corruption on economic growth has emerged as a popular topic in the empirical research. The emerging use of frontier estimation techniques has shed some new light on the effects of corruption on productivity differences across countries. Unfortunately, the effects of corruption on the variance and the expected level of productivity are commonly mixed. This study aims to clarify this issue by applying a newly developed semi-nonparametric frontier estimation technique that can identify and distinguish the two effects. Our empirical results suggest that the corruption may have a more significant effect on in the variance of productivity than on its expected level. In other words, we find that corruption significantly increases the uncertainty of productivity growth, even though its effect on the expected growth rate is relatively small and insignificant. This result is in line with the common perception of corruption as a source of macro risk.

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Efficiency change over time in amultisectoral economic system

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Economic Growth and TFP Advances

In the literature two approaches of productivity and efficiency analyses can be found, namely the neoclassical approach and the frontier approach. Neoclassical analysis weights inputs by value shares, a procedure that requires data on factor input shares or prices. This approach imputes productivity growth to factors, but cannot distinguish a movement towards the efficiency frontier and a movement of the latter. In contrast, the frontier approach allows decomposing productivity growth into a movement of the economy towards the frontier and a shift of the latter but cannot impute productivity growth to factors. Ten Raa and Mohnen (2002) were the first who proposed a model to resolve these limitations. They estimated total factor productivity (TFP) growth without recourse to data on factor input prices. In their work they reproduced the neoclassical TFP growth formulas, but in a framework that is Data Envelopment Analysis (DEA) in spirit.

Another contribution to this topic is provided by Luptacik and Böhm (2010). Like ten Raa (1995, 2005) the economy is represented by the Leontief input-output model extended by the constraints for primary factors. Using

the multi-objective optimization model the efficiency frontier of the economy is generated. The solutions of the multi-objective optimization problems define efficient virtual decision making units (DMUs). The efficiency of the economy can be obtained as a solution of a DEA model with the virtual DMUs and DMU describing the actual performance of the economy. It can be proved that the solution of the above defined DEA model yields the same efficiency score and the same shadow prices as the models by ten Raa, despite the different variables used in both models. In this way the merits of both approaches can be used.

In this paper the approach by Luptacik and Böhm (2010) is extended in two directions. First, in order to ensure a Pareto-Koopmans efficient solution the slacks-based measure of efficiency (SBM) is applied. Second, the focus lies on the efficiency change over time. This model allows imputing productivity growth to individual factors without loosing the possibility to decompose productivity change into efficiency change (catching up) and technology change (frontier shift). For illustration data for Austria are used and the following questions addressed: What is the contribution of individual factors (labor, capital, etc.) to TFP change in Austria? Is TFP change caused by technical change and/or by efficiency change?

Exogenous Technical Change Modeled via Time Trend and Technology Shifters: Application to OECD Countries

Almas HESHMATI, Subal C. Kumbhakar

Economic Growth and TFP Advances

In the literature following the neoclassical model technical change is assumed to be exogenous and specified as a function of time. However, some exogenous external factors others than time can also affect technical change. In this paper we model technical change via a combination of time trend and other exogenous factors. The former are purely external non-economic while the later are external economic factors labeled as technology shifters. We define several technology indices based on the external economic factors which are indicators of aspects of technology. Our definition of production function is amended to accommodate technology shifters which are also complement to the production inputs. The technology shifters allow for non-neutral and biased shift in the production function. The model allows the rate of technical change to be decomposed into two main parts. One part is driven by time corresponding to the neoclassical model and the other part is related to producer specific external economic factors. The technology shifters are aggregated via hedonic aggregator functions into several groups of technology indices for parsimonious parametric specification. The empirical model uses panel data on OECD members, accession and enhanced engagement countries 1980-2006. We identify a number of key technology shifters and estimate their effect on technical change and TFP growth of the sample countries.

Efficiency of Non-profit Organizations: The Case of Russian Homeowners Associations

Ekaterina BORISOVA, Anatoly Peresetsky, Leonid Polishchuk

Services

Efficiency assessment of non-profit organizations remains a challenge for the third sector research. The authors have argued (Borisova et al., 2010) that stochastic frontier technique commonly used for efficiency analysis could serve as an adequate tool for such assessment, especially when dealing with numerous non-profits serving identical and clearly identified purposes. We consider homeowners associations (HOA), which are non-profit organizations

formed within apartment buildings. The objective of such associations is management of common property, which is an important ingredient of community development and welfare. HOAs face a nexus of problems typical for the third sector organizations such as collective action, participation and leadership, volunteerism, governance, resources. Assessment of their efficiency could have valuable policy implications for local community development and residential housing reform. HOAs are a de novo institution in Russia that is expected to complete the privatization of the residential housing sector initiated almost twenty years ago. Until recently common property management was a responsibility of municipal governments which is currently being transferred to homeowners. Despite the strong economic rationales and incentives in taking common property in homeowners' own hands the existing organizations often face formidable obstacles. Prominent among them is a lack of social capital, commonly interpreted as trust, norms, and networks that underpin the capacity for self-organization (Putnam, 1993). The paper reports an assessment of HOA efficiency based on a survey of 82 associations located in Russia's national capital Moscow and a large industrial city of Perm in the Northern Urals. Respondents' satisfaction with various HOA services and their payment for them used to estimate the stochastic frontier (distance function approach, translog specification, (Lovell, 1994)). Efficiency variations are explained by various factors of potential relevance for HOA efficiency, including (i) physical characteristics of buildings, (ii) social capital measures, and (iii) institutional parameters and history of HOA. Physical conditions of the housing stock and specific social capital were shown to be of primary importance. Moreover, a lack of tenants' capacity to operate HOA couldn't be made up by good governance. Significance of general social capital ingredients was less pronounced. HOAs that have been created by tenants on their own demonstrate stronger efficiency than those pre-established by developers or imposed upon tenants by local authorities. We can also see better efficiency of those HOAs in the sample that work without management companies. This allows us to make straight policy implications, which are needed in this unsteady and problematic sector of Russian economy.

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Efficiency and firm failure during the economic crisis: An analysis of the construction sector in Spain.

Magdalena Kapelko
Services

The world has been hit by a macroeconomic crisis in recent years. Spain was not an exception: according to some sources, the economic crises began in this country already in the end of 2006 when construction industry started to collapse, while it flourished in the middle of 2007 when the global crisis added its effects. The Spanish construction sector is considered to be mostly affected by the economic turmoil with many firms disappearing from the market. The sharp increase in those firms' defaults focuses the attention on the causes of those actions. The firm failure prediction and the analysis of the factors associated with defaults are of critical importance for managers, stakeholders and other parties related. In some studies firm inefficiency proved as a good predictor of enterprise's failure (Xu and Wang, 2009). But to what extent do the less efficient firms fail during the economic crisis? Almost 100 years ago the famous economist Schumpeter visualized the recession as a "creative destruction": the decrease in demand forces the least efficient firms to fail, while the best companies increase their market share. At the same time many new players appear which find the opportunities in the market. As a result when recession comes to the end, the economy renews and becomes stronger. However, the governments' actions to overcome the recession and save the firms might impede the "creative destruction" phenomenon. In such way, the inefficiency might be promoted and moral hazard created leading to the excessive risk-taking of firms in the future. Motivated by the

remarks described above, this study seeks to investigate the association of efficiency with the survival likelihood of firms in the context of current economic crisis. Our empirical analyses are conducted on the sample of firms in the construction sector that operated in Spain during the 2004-2009 time-period. Choosing this time span we are able to analyze the years before and during the economic crises in Spain.

The relation between efficiency and firm failure has been analyzed in some studies, however to our knowledge it was not investigated in the context of current economic crisis. Moreover, efficiency proved to be a useful indicator for predicting the bank's failures, but it was not researched in the industrial settings like in the Spanish construction sector.

To model the relationship between efficiency and firm failure, we use a two-step procedure. Firstly, we compute efficiency indices for each firm in the sample. We apply the Data Envelopment Analysis (DEA) model with bootstrap (Simar and Wilson, 2000), since we are able to infer the statistical properties of the efficiency measures computed. Then to address the manner in which firms evolve over time and to assess the relationship between efficiency and firm survival, we employ the survival analysis techniques by incorporating the cox proportional hazards regression. This regression is able to isolate the influence of specific variables on firm survival over time and handle censored observations in an unbiased manner (Lawless, 2003). In previous research the survival analysis techniques has been used extensively to analyze the business failures.

We expect that the analysis undertaken will show that efficiency is an important factor which impacts on the firm's probability of survival.

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Conceptualizing Service Network Productivity - A Looped DEA Approach

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Services

Modern economy is evolving into a service-oriented network society (Castells 2000). This shift has resulted from two interwoven developments. First, there is a global trend towards increased specialization and division of labor. Second, customers increasingly demand integrated solutions of physical goods, services, and software that are custom-fit to their problems. With the proliferation of corporate networks comes the need to measure and improve their efficiency. Network DEA approaches have been proposed as means to analyze the efficiency on the "inner workings" (i.e., the companies and their relationships) in a network. However, current network DEA approaches (often implicitly) presuppose that the network under investigation can be represented as a directed acyclic graph (DAG). While this assumption holds true in manufacturing scenarios in which outputs are physical embodiments that can be inventoried or routed through a supply chain, service - by definition - is built upon acts of value co-creation (Vargo and Lusch 2004). It follows that service networks inherently feature looped network topologies. In the light of the rich and diverse body of knowledge in DEA, this apparent lack of consistency with the recent Service Science literature is surprising.

Traditional network DEA approaches fall short on dealing with productions systems in which looped product flows are defined (Cook, Liang and Zhu 2010). From an Information Systems Research / Computer Science perspective, we attempt to conceptualize service network productivity as a looped DEA approach that accounts for the value co-creation properties found in service systems. We assume that discussing our ideas with OR specialists at the Ewepa Conference will stimulate progressive discussions.

We introduce service network scenarios in which companies cooperate to jointly provide integrated solutions to their customers. The scenarios are situated in the German High Tech engineering sectors, since these industries

have experienced a strong shift towards the service paradigm in recent years. After identifying bidirectional Input/Output relationships of the companies cooperating in service networks, we expect to incrementally set up a DEA optimization problem that is able to cope with looped service network topologies.

We attempt to conceptualize a looped network DEA approach that is built on the business characteristics of service networks. This contribution is innovative and worth discussing in a high-quality workshop setting such as Ewepa, since it might require considerable conceptual changes to be made to classic (i.e. built on manufacturing analogies) network DEA approaches.

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Baumol's Cost-Disease, Efficiency, and Productivity in the Performing Arts: An Analysis of German Public Theaters

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Services

This paper analyzes the productivity development in the German public theater sector for the seasons 1991/1992-2005/2006. Using a stochastic distance frontier approach that allows to decompose total factor productivity change into different sources we examine (a) whether Baumol's cost-disease hypothesis is valid in this sector and (b) if so, whether its negative influence on productivity can be compensated by efficiency gains. The findings indicate an increase in real unit labor cost as a result of rising wage rates and, thus, support the cost- disease hypothesis. Furthermore, increasing returns to scale are observed for the majority of the theaters which implies that significant efficiency gains can be realized by the exploitation of scale economies. However, because of the increasing unit labor cost and an increasing scale inefficiency we find an overall decrease in average productivity of about 8 percent within the sample period.

Efficiency analysis and integration in European banking

Ioannis Samantas

Efficiency of European Banks

The aim of the paper is to contribute to the literature of Stochastic Frontier Analysis (SFA) regarding the identification of the efficiency frontier determinants that control for the adverse environmental conditions and the inherent correlates of bank-specific inefficiency scores. The employed model is the one-stage conditional mean approach of Batesse and Coelli (1995) that utilizes Fourier flexible specification of the cost/profit function, and half-normal distribution for the inefficiency error term. Moreover, the paper comprises the estimation of scale and scope economies over the examined period.

Of special interest will be the effect of European integration in the estimation of bank-level efficiency scores. In particular, several factors are employed to capture the key constituents of integration, as set out by Walkner and Raes (2005), namely the cross-border growth of M&As, branches and subsidies, and provision of banking services. To the best of our knowledge, it is the first attempt that deals with that matter.

The sample is going to cover the whole region of the European Union, that is both the developed and transition economies allowing for particular dummies to disentangle the explicit impact of different degrees of economic development. Policy ramifications are identified in terms of contemporary competitive issues.

Noise, inefficiency, and nonparametric bank branch evaluation

Marijn Verschelde, Koen SCHOORS, Paul Gemmel

Efficiency of European Banks

The banking industry experienced recently (de)mergers, acquisitions and corporate restructuring. To facilitate strategic decisions, both policy makers and bank managers rely on a detailed understanding of bank efficiency at the branch level. But how to properly measure this branch-level efficiency remains unclear: there is no consensus in the literature on how to decompose noise and inefficiency. Particularly in the banking sector it is not clear whether (locally) imposing distributional assumptions on noise and inefficiency is less problematic than ignoring noise altogether. We propose to use combined information from a deterministic conditional robust frontier approach and a nonparametric stochastic frontier approach to allow a full understanding of (1) the effectiveness of resources and (2) the efficiency levels while allowing for heterogeneity, nonlinearities, environmental variables and uncertain noise. We demonstrate our approach in a study of market efficiency of 579 bank branches of a large bank in Belgium. The findings suggest that bank branch performance is highly affected by market potential.

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A Non-Neutral, Non-Monotonic Inefficiency Effect Model Applied to Greek Banking Sector

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Efficiency of European Banks

We propose and estimate a non-neutral, non-monotonic inefficiency effect model which combines Huang and Liu (1994) non-neutral production frontier model with Wang (2002) non-monotonic inefficiency effect model and in addition incorporates the "environmental" variable in the deterministic kernel of the frontier in the way suggested by Coelli, Perelman and Romano (1999). This generalized stochastic frontier model contains also a special case, the monotonic inefficiency effect model of Battese and Coelli (1995) and Good et all (1993) model. The proposed model, under particular parametric restrictions, is reduced to Wang (2002) model, to Huang-Liu (1994) model and finally to the Battese - Coelli (1995) model. We apply the proposed model to a panel data set of Greek banks for the period 1997-2006 and we formally tested for all possible nested models.

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Efficiency in the banking systems of the European Union: a Bayesian hierarchical approach

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Efficiency of European Banks

Stochastic metafrontier models are useful models to investigate the technical efficiencies of firms in different groups that may not have the same technology (see Battese et al. (2004) and references therein). Following these authors, we consider that the inputs and outputs for firms in a given industry are such that stochastic frontier production function models are appropriate for different groups within the industry. The metafrontier production function can be defined as a deterministic parametric function such that its values are no smaller than the deterministic elements of the components of the stochastic frontier production functions of the different groups involved, for all groups and time periods. As is usual in this kind of models, the estimation of the parameters is the natural way for approaching the corresponding efficiencies (for firm, industry, and period).

In this work we propose the use of Bayesian methods for estimation. The Bayesian reasoning is not new in the Stochastic Frontier Analysis literature (see for instance Kim and Schmidt (2000) and works by Koop et al.). The main advantages of its use (easy inference on efficiencies, easy incorporation of prior ideas and restrictions such as regularity conditions and optimal treatment of parameter and model uncertainty) also apply in the context of metafrontier models, specially Bayesian hierarchical modelling. In this work, we model the stochastic metafrontier model via a Bayesian hierarchical model which takes into account the different sources of variability in the problem. As usual in these models, the estimation of the parameters and hyperparameters is not easy and so numerical integration is needed. In particular, we use Monte Carlo Markov Chain (MCMC) methods to do so.

We apply these models in a particular banking setting. More precisely we analyze differences between banks of different types (private commercial banks, savings banks, and credit unions) in different countries of the European Union during a period of five relevant years (2005-2009) which includes the beginning of the international financial crisis.

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A Three-Stage DEA-Approach for Analyzing Drivers of Inefficiency in Business Processes: An Application to OTC Derivatives Settlement and Clearing

Anne Dohmen

Efficiency of other Financial Industries

For banks it is a pivotal objective to enhance efficiency. Banking inefficiencies are often rooted in the bank's production processes like back-office operations. This paper focuses on the efficiency in the manual and automatic cycle time of a highly standardized production process in banking: settlement and clearing of over-the-counter

(OTC) derivatives. Despite being standardized, settlement and clearing processes show high performance variation in practice (Burger and Moormann, 2010). Mainly, the obstacle of reducing this inefficiency is that the reasons for this process inefficiency are unknown. This paper analyzes the efficiency of securities settlement and clearing by measuring the current state of process efficiency by Data Envelopment Analysis (DEA) and further presents and applies a method how to identify the drivers of the measured process inefficiency. Most commonly applied approaches for analyzing reasons of inefficiency in combination with Data Envelopment Analysis (DEA) are one-step approaches and two-step approaches. However, these approaches require a priori assumptions about what factors possibly could influence the efficiency score. Due to huge amounts of possible factors that influence process inefficiency and due to many possibilities of combining these factors, both approaches cannot deliver satisfying results (Dohmen and Sottocornola, 2010). My paper presents a novel approach for identifying drivers of inefficiency in business processes by combining Data Envelopment Analysis with data mining. It is a three-stage-approach which combines DEA, cluster analysis and an association analysis. This methodology does not require a priori knowledge about potential drivers of inefficiency, but identifies from a large database structural associations between process instances' characteristics and their efficiency scores measured by DEA. An empirical study of the derivatives settlement and clearing process of a major European bank demonstrates how this three-stage-approach can be applied. The results deliver these factors and combinations of factors which have been associated with different levels of inefficiency. This enables operations managers to identify drivers of process inefficiency, to quantify their impact on overall process efficiency and to support them in their decision of prioritizing business process improvement projects.

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Assessing the Adverse Effects of Interbank Funds on Bank Efficiency through Using Semiparametric and Nonparametric Methods

Ahmet Faruk AYSAN, Gürdal Ertek, Seçil Öztürk

Efficiency of other Financial Industries

This paper investigates the relationship between interbank funds and efficiencies for the commercial banks operating in Turkey between 2001 and 2006. Data Envelopment Analysis (DEA) is executed to find the efficiency scores of the banks for each year, and fixed effects panel data regression is carried out, with the efficiency scores being the response variable. It is observed that interbank funds (ratio) has negative effects on bank efficiency, while bank capitalization and loan ratio have positive, and profitability has insignificant effects. Our study serves as novel evidence that interbank funds can have adverse effects in an emerging market.

Ownership structures and Cost Advantages: Evidence from the Italian Leasing Industry

Marta DEGL'INNOCENTI, Claudia Girardone

Efficiency of other Financial Industries

Using Greene's (2005) random parameter cost frontier model and a unique recent dataset, this paper provides novel evidence on the cost advantages of Italian leasing companies with alternative ownership structures and distribution channels. Results suggest that bank-owned counterparts are more able to control costs compared with their counterparts. Interestingly, technological progress is found to be a key factor in driving the leasing companies' economies of scale. Evidence also shows that domestic leasing companies are more cost efficient than their foreign competitors. Finally, it appears that the type of distribution channel chosen by the leasing companies is crucial in determining the cost effectiveness of specialized financial intermediaries.

Efficiency and Productivity of Microfinance Institutions

Suthathip Yaisawarng

Efficiency of other Financial Industries

In the past five years, the number of microfinance institutions has increased substantially. These institutions are located around the globe, especially in less developed countries. Microfinance institutions provide small loans to the poor who do not have access to mainstream financial resources. These poor individuals could potentially be productive assets to the society if they have assets and tools needed to explore their entrepreneurial capability. The main goals of microfinance institutions are to alleviate poverty and to maintain financial sustainability. This paper evaluates efficiency and productivity of microfinance institutions in terms of their ability to achieve the goals through outreach, operation, and transparency.

Limited empirical evidence on the performance of microfinance exists. A few studies use case study approach to analyze the performance of microfinance institutions. Others use either DEA or SFA to measure efficiency and/or productivity in a given country or regions. Some of these studies focus on the role of subsidy on efficiency or relationship between size and efficiency. Past studies include outreach and/or financial performance in their analysis; none has included all three dimensions that reflect reasons why microfinance exists in the first place. This paper uses DEA to analyze efficiency and productivity of microfinance institutions. Our sample includes microfinance institutions from 2005 to 2009 that are located in countries with large microfinance sector (i.e., a country that has at least 30 microfinance institutions). We complement our efficiency analysis with case studies where we attempt to understand operating environments that are favorable to the success of microfinance.

We use output-oriented DEA model to calculate efficiency scores for individual microfinance institutions. Our tentative model includes three inputs and three outputs. Our input variables are total assets, operating cost and number of staff. Our output variables are number of women borrowers (outreach), operational self-sufficiency index (operational sustainability) and diamond (transparency). We calculate efficiency scores for individual microfinance institutions relative to the frontier constructed from all microfinance institutions in the sample for a given year as well as to the respective country frontiers. Difference in efficiency scores between these two frontiers reflects level of inefficiency due to operating environments in that particular country. We also calculate Malmquist indices for the grand sample as well as country subsamples. A small number of microfinance institutions will be selected to further analyze their efficiency and productivity patterns as they relate to the country profiles. The latter will enable us to provide insight regarding the environmental attributes that would lead to successful operations of microfinance institutions.

We expect a large variation in efficiency and productivity scores across microfinance institutions as well as across countries. However, we expect a greater variation across countries due to different competition, regulation, and political conditions.

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The Shape of Aggregate Production Functions: Evidence from Estimates of the World Technology Frontier

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Comparing Methods

Estimation of aggregate production functions is notoriously difficult due to multiple empirical issues. We carefully address one of them. Notably, the production function is a purely technological concept, but country-level productivity may also be affected by various non-technological variables. We control for differences in non-technological conditions across countries and time thanks to the World Technology Frontier approach.

Knowing the actual shape of the aggregate production function is of crucial importance in numerous fields of macroeconomics.

We estimate the aggregate, country-level production function as a relationship between countries' aggregate inputs and their maximum attainable output, computed on the basis of the World Technology Frontier – the best-practice frontier at each moment in time. We then use these estimates in analyses aimed at deriving this function's crucial characteristics and discussing which parametric form agrees most with the available empirical evidence.

As crucial features of the estimated aggregate production function, we consider its implications for the cross-country distribution of technical inefficiency, the pattern of dependence of its (variable) partial elasticities on factor endowments, (variable) returns-to-scale properties, and its implied (Morishima and AllenUzawa) elasticities of substitution.

We apply:

a) the nonparametric Data Envelopment Analysis (DEA) approach (see e.g., Kumar and Russell, 2002), augmented with the Simar and Wilson (2000) bootstrap procedure.The advantage of this approach is that it does not require one to make a priori assumptions on the functional form of the aggregate production function – and yields testable predictions instead;

b) the Stochastic Frontier Analysis (SFA) methodology (see e.g., Koop, Osiewalski and Steel, 1999) which allows us to estimate the production function directly, under certain predefined (parametric) functional specifications. Such parametric models are estimated with Bayesian techniques, relatively robust under collinearity and measurement error. The advantage of the SFA approach is that it allows to test several parametric specifications directly. It is also useful for drawing precise conclusions on the aggregate production function's elasticities of substitution.

We obtain the following principal results:

a) the Cobb-Douglas production function fails to reproduce the important properties of our data,

b) the (non-parametric) bootstrap-augmented DEA frontier is also markedly different from the translog specification, even though the latter can be fitted to the data relatively well,

c) partial elasticities of the aggregate production function are correlated with inputs both in the DEA and in the translog case, and they vary substiantially across countries and time, lending support to the skill-biased technical change hypothesis,

d) tests of returns to scale based on the DEA, Cobb-Douglas and translog representations of the frontier provide mixed evidence on this property,

e) unskilled and skilled labor are not perfectly substitutable,

f) elasticities of substitution vary largely across countries and time, staying in broad agreement with the hypothesis of capital-skill complementarity.

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A Monte Carlo Study of Old and New Frontier Methods for Efficiency Measurement

Jens Krueger

Comparing Methods

Until recently estimation methods for frontier production and cost functions widely in use could be divided in two broad groups: parametric-stochastic (like SFA) and nonparametric-deterministic (like DEA or FDH). Both groups have their own advantages and disadvantages. Recently two approaches, the so-called order-m (Cazals, Florens and Simar 2002) and order-alpha (Daouia and Simar 2007) approaches, appeared which have the potential of combining the advantages of the parametric-stochastic and the nonparametric-deterministic approaches. These nonparametric-stochastic approaches require no functional form or distributional assumptions and are robust with respect to measurement errors. In contrast to earlier nonparametric-stochastic methods these approaches have a sound theoretical foundation. See also Daraio and Simar (2007) for a book-length exposition.

This paper reports the results of an extensive Monte Carlo study with scenarios containing different production functions, returns-to-scale regimes and the introduction of outliers in addition to the general presence of measurement errors. Considered are a wide range of efficiency measurement methods, including SFA, DEA and FDH as well as the order-m and order-alpha approaches which are not considered in such comparisons so far. It is not clear a priori that the conceptual advantages of the nonparametric-stochastic methods also materialize in small-sample situations with different extents of measurement errors and outliers. Including these methods in a unified Monte Carlo experiment is thus important for evaluating their properties in a direct comparison with the more traditional methods.

The simulation results show a good performance of SFA even in the presence of outliers. Although we have to be cautious with this statement since the experimental design is quite favorable for SFA, we can say that the criticism raised against this method (i.e. that it is not able to separate inefficiency and measurement error) can not be confirmed by the present study. The performance of DEA and FDH is also quite remarkable even for larger measurement error variances and in the presence of outliers. Overall, we have the ranking of SFA dominating DEA, which itself is dominating FDH and order-m and order-alpha are dominated in general. Nevertheless, order-m becomes better at larger measurement error variances and for larger extents of outliers. When outliers are induced, order-m and order-alpha are rather stable and sometimes even slightly better compared to their performance in the baseline scenario. Moreover, order-m performs better than the theoretically more robust order-α approach.

Compared to that the performance of the robust nonparametric-stochastic methods, the order-m and order-alpha approaches, appears not to be very advantageous in well behaved settings. At the bottom line it can be said that it is not appropriate to use order-m and order-α routinely in situations which are characterized by smooth well behaved production environments with no outliers or limited extents of outliers. Even with the induction of additional outliers it depends much on the values of other parameters in the Monte Carlo setting whether these methods become better than more traditional methods of efficiency analysis. Thus, it is always wise to cross-check the results with other methods to asses their validity.

Productivity change using growth accounting and frontier-based approaches - Evidence from a Monte Carlo analysis

Dimitris Giraleas

Comparing Methods

Productivity growth is on the forefront of European Union (EU) policy making. The Europe 2020 strategy's primary goal is to pursue "smart, sustainable and inclusive growth", by assisting the member states in achieving their productivity potential. With such increasing emphasis being placed on achieving productivity growth, it is crucial to first understand how productivity growth can be accurately measured. There are various approaches that can be used to measure productivity growth; the most widely adopted approach is growth accounting (GA). GA is relatively easy to use and does not require information from outside the country or the sector examined, but it also requires the adoption of a number of simplistic assumptions, most notably those relying on the existence of perfect competition. If these assumptions are violated, GA could produce unreliable estimates. An alternative to the more traditional GA approach is to adopt one of the so-called frontier-based approaches. Such approaches relax the stringent assumptions required by GA and also allow for the decomposition of productivity growth, which could be of great interest to the users of productivity change estimates. However, despite the theoretical advantages offered by frontier-based approaches, there has been very little research on whether these advantages do in fact affect the accuracy of the productivity growth estimates and by how much. This study presents some quantitative evidence from a number of simulation experiments on the accuracy of the productivity growth estimates derived from growth accounting (GA) and frontier-based methods (namely DEA-, COLS-, and SFA-based Malmquist indices) under various conditions that diverge from the assumption made under perfect competition. These include the presence of technical inefficiency, measurement error, misspecification of the production function (for the GA and parametric approaches) and increased input and price volatility from one period to the next. The study finds that the frontier-based methods usually outperform GA, but the overall performance varies by experiment. Parametric approaches generally perform best when there is no functional form misspecification, but their accuracy greatly diminishes otherwise; in such cases, both DEA and GA produce more accurate estimates. The results also show that the deterministic approaches perform adequately even under conditions of (modest) measurement error and when measurement becomes larger, the accuracy of all approaches (including SFA) deteriorates rapidly, to the point that their estimates could be considered unreliable for policy purposes.

A metanalysis of agricultural productivity

Giannis Karagiannis, Suzanna-Maria PALEOLOGOU, Vangelis Tzouvelekas

Comparing Methods

In this paper we use meta-regression analysis to examine the results of previous empirical studies on measuring productivity in the agricultural sector. We survey a total of 124 papers published in 45 different scientific journals during the period 1963 to 2009. Based on this sample we have a total of 1,307 observations as some authors report results from more than one methods or for more than one countries. We attempt to account for this in the econometric estimation by using appropriately specified dummy variables. We also examine the statistical significance of author's dummies. Moreover, in the econometric analysis we control for the impact of (a) different types of productivity measures (i.e., partial versus TFP), (b) different productivity indices (i.e.., Tornqvist, Fisher, etc), (c) different levels of aggregation (i.e., regional, country, or international studies), (d) different coverage (i.e., commodity, industry, sector), (e) different methods of estimation (i.e., growth accounting, parametric-econometric, nonparametric-DEA), (f) different functional specifications (i.e., primal versus dual; flexible versus inflexible), (g) different types of data (time series versus panel data), (h) whether the resulting measures have been adjusted for quality changes as well as for differences in the level of economic development, in order to explain differences in the estimated rate of productivity changes among previously published studies.

Economies of scope in research and teaching

Kristof De Witte, Nicky ROGGE, Laurens Cherchye, Tom Van Puyenbroeck
University Research

Teaching and research are widely regarded as the two key activities of academics. An analysis of how both core activities of academics exactly relate is, however, a complex and sometimes elusive matter. This paper proposes a non-parametric methodology rooted in Data Envelopment Analysis to study for the presence of economies of scope between teaching and research (i.e., the teaching-research nexus). The methodology offers several important advantages compared to the commonly used correlation analysis. One of these advantages is that DEA, thanks to its non-parametric nature, allows examining complex phenomena with only limited assumptions. This makes that DEA is well-suited to study the teaching-research nexus, where exact information or 'knowledge' on how the two activities relate is typically embedded in the data and hard to grasp.

Correlates Influencing Faculty Research Productivity-A Case of Taiwan

Flora Tien
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Conducting research is one of the major missions of universities. In order to promote research excellence, countries in Asia adopt various strategies to evoke competitions among universities attaining the goal. For instance, Japanese government pushes the 21st Century COE (Center of Excellence) Program to build globally competitive research universities. Korea implements Korea Brain 21 Project to nurture manpower for research and development. China establishes the 211 Big Projects to promote educational quality of elite universities. India devotes more than 80% of higher education expenditures to few elite colleges for strengthening their capability of international competition. Taiwan submits a five-year 50 billion Plan of special budget to enhance research capability of universities. The theme of these projects is the same: to promote research excellence toward world-leading universities. Faculty members in universities play a key role in this knowledge producing competition. In other words, faculty research performance not only influences which universities being selected into these projects, but also the influence the outcome of project evaluations in the future. What correlates influencing faculty research performance, therefore, become the main concern of this paper.

This paper aims at exploring correlates influencing faculty research productivity of Taiwanese faculty. Based on a comprehensive literature review, a theoretical framework model is build. The model is composed of the following components: personal characteristics (gender), institutional characteristics (institutional type), educational background (discipline, with doctoral degrees or not, domestically-trained or foreign trained), career measures (rank, years since rank), reward administration (rewarding research excellence, defining and communicating research performance goals with faculty, faculty autonomy), research motivation (motivation for intrinsic rewards, motivation for extrinsic rewards) and resource acquisition (time spent in research, hours of assistance per week, collegial networks) and an outcome variable of faculty research productivity.

Full-time Taiwanese faculty who are at or beyond the assistant professor level and are employed in nine institutions with graduate programs compose the survey population. Collectively, they work in fourteen different fields. The fourteen disciplines are: Chinese language & literature, English language & literature, history, political science, economics, sociology, law, mathematics, physics, chemistry, chemical engineering, electrical engineering, mechanical engineering, and civil engineering. A total of 2551 faculty members are investigated by the mail survey. 517 of them responded. Four waves of mailings are sent out to the above subjects. The response rate is 20.3%. After deleting cases of retired faculty and other kinds of invalid responses, 495 cases are used for further statistical analysis in

the paper. LISERAL and other appropriate statistical methods will be employed to explore the model of correlates influencing faculty research productivity. It is expected that research motivation which include both motivation for intrinsic rewards and motivation for extrinsic rewards having effects on faculty research productivity. The results of the paper, on one hand, will fulfill the literature gap of faculty research productivity. On the hand, it will offer suggestions to policy makers as well as universities on strategies enhancing faculty research productivity.

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School Quality, Operational Efficiency and Optimal Size-An Analysis of Higher Education Institutions in Taiwan

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As a result of low birth rate and over expansion in past decades, a few higher education institutions in Taiwan currently confront problems of low enrollment rate and financial distress. Educational authority in Taiwan has also asked these schools to reduce their study body, shut down problematic departments or consolidate with other institutions. However, are these schools operated efficiently? Are the current operational scales of these schools over or under size? Which schools are good or bad subjects for consolidation. These are important but missing information for school administrators in Taiwan. In order to provide objective information for schools' resource reallocation, investigating efficiency and optimal size of schools becomes an important research issue in contemporary higher educations of Taiwan. This study employs the stochastic unit cost frontier to measure cost efficiency of higher education institutions and to investigate their optimal size with considering heterogeneous school quality. Empirical results reveal a positive correlation between school optimal size and school quality. We find that over 40% of schools are identified as over size and need to reduce student size. Results also indicate that cost saving resulting from efficiency improvement will be higher than that from size adjustment. Therefore, managers of schools should also pay much attention to efficiency improvement while considering size adjustment. At last, candidates for school consolidation are also identified.

Modeling Efficiency, Credit Risk and Performance in a Heterogeneous Banking System

Paola BRIGHI, Cristina Bernini
Banking Risk and Efficiency Analysis

The issue of bank efficiency has raised great interest among academics and practitioners. If reaching efficiency is a common target for all banks, the measurement of the level of efficiency is significantly affected by the business model adopted by the bank (Berger and Black, 2011). Since the early 1990s, the banking industry has moved from interest to non-interest income target business model. Although it is undisputed that this shift represents a relevant step toward higher profits, no unique effects on the overall bank performance are confirmed. Empirical evidences have shown that the higher volatility of net-interest-income outweigh diversification benefits. Banks more oriented

to traditional activities could have suffered less than other banks of the "subprime and derivative" crisis, but in the future they may be more credit risk exposed. Furthermore, the recent financial crisis seems to have hit all banks differently with respect to their attitude towards traditional or not traditional banking activities. Finally, there could be differences in banking activities related to bank size and the distance between the bank's headquarter and local branches.

Firstly, the paper analyzes the impact of non-performing loans on both cost and profit efficiency, controlling for traditional loan growth rate which is an important driver of bank riskiness (Fiordelisi et al., 2010). Secondly, in testing the relationship lending hypothesis a new measure of functional distance is introduced, allowing to investigate if the closeness of local branches to the headquarter may increase the banking system efficiency. Finally, we explore whether these features uniformly affect Italian banks efficiency according to their size and juridical category.

We estimate cost and profit efficiency models using a stochastic frontier approach. We further investigate factors affecting bank efficiency in order to assess the importance of any (in)efficiency determinants. The inefficiency is specified as a function of internal balance-sheet ratios, relationship variables (i.e. operational banking distance) and environmental factors within a bank and over time. Based on the metafrontier notion, stochastic frontier functions and inefficiency models are estimated for different groups of banks, allowing to verify the hypothesis of a single frontier for the Italian banking system. To investigate these features, a panel data of 750 banks over the period 2006-2009 is considered. Banks are grouped with respect both to size (small, medium and large banks) and juridical specification (listed, saving and cooperative banks), obtaining four exhaustive groups. The banks' financial statements data used to estimate translog cost and profit frontiers are based on Bilbank dataset provided by the Italian Banking Association, A.B.I. (Rome). Environmental variables data are mainly based on ISTAT and Bank of Italy sources.

Preliminary results strongly reject the hypothesis of a single frontier for the Italian banking system. Heterogeneity between bank groups with respect to either cost/profit frontier or inefficiency determinants is detected. Among factors affecting efficiency the main relevant are the non performance loans, the relationship lending variables, the income and asset diversification factors and the market concentration degree.

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Efficiency and Risk: A Risk-Adjusted DEA Profit Analysis of Bank Holding Companies

Gary Ferrier

Banking Risk and Efficiency Analysis

The estimation of bank efficiency has become an extremely popular research endeavor. However, in 1995, Coelli ("Recent Developments in Frontier Modeling and Efficiency Measurement," Australian Journal of Agricultural Economics, 39, no. 3) lamented that the failure to consider risk was a shortcoming of the frontier models used to study efficiency. The problem is that ignoring risk can bias measures of inefficiency.

Banks are assumed to maximize profits. Because of inefficiency, a bank may fail to achieve the maximum level of profit available to it given the prices it faces and the technology available to it. However, profit may also fall short of its potential level if bank managers are risk-averse. A risk-averse against will trade some potential profit for reduced risk. Thus, if risk is not properly accounted for, risk-averse behavior is indistinguishable from inefficient behavior and profit shortfalls from both sources are lumped together as "inefficiency." Given that they have different causes,

it is important to measure how much of a profit shortfall is due to risk-averse behavior and how much of it is due to actual inefficiency.

In this paper, risk is explicitly modeled in a frontier profit function. Data on U.S. Bank Holding Companies (BHCs) are used to estimate the model. By simultaneously estimating BHCs' inefficiency and elative risk-aversion, the bias inherent in other models will be avoided. The resulting measure of risk-aversion are then be compared to measures of risk in BHCs' stock prices to assess the degree to which more risk-averse BHCs are able to limit their shareholders' risk.

Measuring bank efficiency: a risk adjusted approach using weight restrictions

Mette Asmild, Minyan ZHU

Banking Risk and Efficiency Analysis

The risk element of banks makes them different than other real sector firms. However, risk is rarely considered explicitly when measuring bank efficiency in the literature. This may lead to misinterpretation of banks' performance.

By considering data collected from the financial reports of the largest banking groups from EU-27 from 2006-2009 the present paper shows that banks which went through far-reaching restructuring with government aid show a distinctively different pattern in terms of funding structure and lending and investment portfolio than relatively prudent banks which did not receive substantial government aid. The distressed banks rely more on wholesale funding and are more exposed to property lending compared to relatively prudent banks. These characteristics observed from the data show that the input (funding) and output (lending) mixes in turn reflect banks' risk management strategies.

While measuring banks' efficiencies using DEA, the mixes are in turn revealed by the weights the banks put on the inputs and outputs. Therefore we use the weights for the low risk (which did not require substantial government aid) efficient banks to give weight restricted scores for all the banks; in effect a form of "risk adjusted" scores since they are based only on weights used by the low risk banks. That way the banks who seemingly took excessive risks (since they required massive bailouts) cannot get away with using inappropriate weights to make themselves look efficient, but are restricted to use weights also used by low risk banks.

Our results show that efficiency scores measured without any weight restrictions are higher among the distressed banks during the crisis compared to the scores with weight restrictions. This suggests without adjusting the risk element using weight restrictions, many banks which received significant state aid deep into the crisis could be misinterpreted as highly efficient banks before the crisis. Preliminary results also show that with the massive state aid across many inefficient banks during 2008-2009, the weighted efficiency scores tend to converge between relatively prudent and distressed banks.

How the financial crisis is affecting bank risk taking: an empirical investigation on European banks.

Paolo Mattana, Stefania Patrizia Sonia ROSSI

Banking Risk and Efficiency Analysis

The financial crisis from 2007 to the present urged a dramatic policy intervention both in US and in the European countries to counter bank defaults and avoid a disastrous financial instability. This massive bailout policy from one

side avoided the banking panic diffusion in the financial markets; on the other side may have twisted banks toward a moral hazard behavior. Banks in fact may have been encouraged, over the crisis, not to lower their risk profile as much as needed, betting on future government bailout policy.

In general terms, the effects of such policies on the behavior of banks are well documented and have been analyzed in detail by the recent literature. The theoretical contributions suggest the presence of two main effects: from one side, policy interventions, by reducing the market discipline, may increase excessive risk taking of banks, turning into a moral hazard effect (Hetzel, 2009). On the other side, policy makers announcing and committing ex-ante to a bailout policy may create a higher charter value of banks, which in turn generates a risk-reducing "value effect" that may outweigh the moral hazard component of such a policy (Hakenes-Schanabel, 2009). So far the empirical analysis has mainly been focused on the moral hazard effect, showing that in presence of financial safety net, banks tend to increase their risk profile (Gropp et al., 2010).

Our paper aims at investigating how the financial crisis and the subsequent bailout policy changed the bank risk taking of European banks. Using the 2007/2009 difference in the ratio (Loan Loss Provisions/Total Loans) as dependent variable, we estimate three different models for a sample of 1654 European banks.

In the first one, the hypothesis we check is the so called "too big to fail". The failure of a large bank produces financial instability and devastating effects on the whole economy. This creates expectations in the bank management of future bailout policy, which may have generated perverse incentives not to lower, as much as needed, previous excessive risk-taking over the crises. The crucial independent variable is bank size, either measured as total assets or as the ratio (bank total assets)/(country average total assets). We expect big banks to have reduced less than others their risk profile over the crises.

In the second hypothesis, we take into account the level of capitalization and the bank leverage as variables inducing moral hazard behavior. The idea here is that managers of weakly capitalized banks are less risk averse and engage in risk taking behavior. Therefore, low bank capitalization and high leverage are expected to have implied a less pronounced get-away over the crises from pre-crises risky behavior.

Finally, in the third hypothesis, we investigate whether central banks and governments, by announcing and committing ex-ante to a bailout policy - which reduces the cost of refinancing and affects the bank charter value - create a risk-reducing "value effect" and decrease moral hazard. From the perspective of our empirical analysis, we would expect that the change in risk taking over the crises will be significantly higher in banks with low market value. Notice that, the estimation of this third model implies that the sample reduces to 178 listed banks.

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Land Use and Farm Income in Nicaragua: A Semiparametric Fixed-Effects Analysis

Alexandre ALMEIDA, Boris Bravo-Ureta

Semi and Non-parametric Advances

The extent to which the land endowment of peasant farmers could help alleviate poverty has been the subject of a prolonged and heated debate. Some authors argue that more access to land can be a critical component for increasing rural income, absorbing surplus labor, and reducing poverty (Binswanger et al., 1995). Others argue that increasing land ownership would not contribute significantly to per capita income, and propose that alternative anti-poverty policy mechanisms should be considered (López and Valdés, 2000). Although increasing poor farmers' access to land is not the only way to alleviate poverty, this topic is returning to the center of the development agenda (World Bank, 2008), and it requires further analysis.

The main goal of this paper is to examine how the land endowments of Nicaraguan farmers affect their farm income, using a balanced household panel data set. Other determinants of peasant farmers' income are also included and investigated. The empirical analysis is based on both parametric and semiparametric methods. Parametric methods have been widely used, but semiparametric or nonparametric estimations, have the significant advantage of avoiding partially or fully the possible misspecification of functional forms. Despite this strength, their use is still limited in applied economics in general.

The data used in this study are from the Living Standard Measurement Survey (LSMS), a nationwide household survey carried out by the Nicaraguan Statistical Service and the World Bank for the years 1998, 2001, and 2005. The LSMS covers a wide range of topics and is very useful for research purposes, because it is designed to follow the same households and individuals over time. A balanced panel for the study was made up by 559 households for each year, for a total of 1,677 observations.

The theoretical framework used is based on Finan et al. (2005). It considers distortions in labor, land, and credit markets commonly found in developing countries. Using data for Mexican farm households, the authors found that farm income increased as a concave, rather than a linear, function of farm size. These authors tested their hypothesis using a semiparametric specification; however, given the nature of their data, there were no controls for important differences between farmers such as managerial ability (technical efficiency) and soil productivity, which are almost always non-observable, but can be successfully incorporated in the model when panel data are available. Thus, we use a recent semiparametric approach along with panel data (Henderson et al., 2008) to account for heterogeneity of farms and farmers while also relaxing the functional form in a similar fashion as Finan et al. (2005) did. The econometric specification follows a Cobb-Douglas-type (C-D) production function, where the dependent variable is total value of farm output (TVFO) regressed on a rich set of exogenous variables including land (the nonparametric component) which is of particular interest here.

The results suggest that differences between the magnitude of the coefficients of the parametric and the semiparametric specifications were small. The impact of land on Total Value of Farm Output (TVFO) showed land elasticities ranging from 0.1656 to 0.3727, depending on the estimation method used. Regarding other determinants of TVFO, more robust results were obtained using the semiparametric specification. This gain in robustness suggests important policy actions that could be implemented to promote growth in agricultural income including: tenure reform in favor of untitled farmers; investment in education (especially for women); training; and the promotion of community associations. These policies might not be as costly economically and politically as land reforms, and therefore should be considered.

Some technical issues not addressed here are still under investigation. The first that merits additional examination concerns the tradeoffs between semiparametric models and the use of flexible functional forms for the production function such as the translog. A related matter would be to combine flexible functional forms within the semiparametric specification. Second, the inverse relationship hypothesis, i.e., farm size versus agricultural productivity, is a subject that, although old, requires more study. Third, expanding the nonparametric part of the model to include labor in addition to land is a promising avenue.

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Estimation of TFP Growth: A Semiparametric Smooth Coefficient Approach

Subal C. Kumbhakar, Kai SUN

Semi and Non-parametric Advances

Measurement of total factor productivity (TFP) growth has been the subject of investigations in many empirical studies. Various approaches have been used for this in the TFP growth literature. These approaches are classified by Diewert (1981) into parametric estimation of production/cost/distance functions, nonparametric indices, exact index numbers, and nonparametric methods using linear programming.

In estimating TFP growth and its components, our objective, in this paper, is to specify the technology as flexible as possible. Parametric model like translog can sometimes satisfy this objective. However, many researchers are attracted by more flexible specifications, such as kernel-based nonparametric or semiparametric models (Li and Racine 2006), which can capture heterogeneity in the underlying technology much better. A purely nonparametric model is attractive when there are not too many continuous regressors or when there are many observations to fit the relationship. Li, Huang, Li, and Fu (2002) proposed a model in which intercept and slope coefficients are all unknown smooth functions of some variables, so that researchers can obtain both heterogeneous intercept and slope coefficients. This model is coined as semiparametric smooth coefficient model (SPSCM). The SPSCM allows more flexibility than a parametric model and the sample size required to obtain a reliable estimation is not as large as required for estimating a purely nonparametric model.

In this paper we consider estimating the TFP growth model from a growth formulation of an input distance function (IDF), which fits naturally into a SPSCM. Empirically, we examine TFP growth of the U.S. electricity generating plants during the period 1986-1998. The contribution of this paper is to relax the functional form assumption on these coefficients which in our model are completely nonparametric.

An additional feature of our application is that we have price information, which enables us to compute the observed (the Divisia) TFP growth. The Divisia TFP growth is then used as the benchmark against which estimated TFP growth from SPSCM and parametric models are compared. We find that estimated TFP growth from the SPSCM comes very close to the Divisia index, thereby confirming the conventional wisdom that the residual component will be smaller if a flexible functional form is used. The other lesson we draw from the application is that if the objective is to estimate TFP growth from the estimated components, it is better to use a growth formulation because it ties up TFP growth with its components thereby reducing the unexplained component which is captured by a zero mean noise term in the regression. This is true whether one uses a parametric or semiparametric function.

References: Diewert (1981), Li and Racine (2006), Li, Huang, Li, and Fu (2002)

On the econometric estimation of the directional distance function

Andrew Johnson, Mika KORTELAINEN, Timo Kuosmanen

Semi and Non-parametric Advances

This paper concentrates on the challenges in the econometric estimation of the directional distance function (DDF). A large number of recent studies estimate DDF with the corrected ordinary least squares or stochastic frontier methods. Most of the previous econometric studies have used approaches, which can be very sensitive to endogeneity and commensurability (or data scaling) problems. These problems result from the fact that the translation property of the DDF is imposed by adding the left-hand side (or dependent) variable to some of the explanatory variables (outputs and/or inputs) in the right-hand side. Further, the added variable can have very different units of measurement. One solution to both problems is to use a specific direction vector, which scales only

one output or one input, because then one can avoid the appearance of the dependent variable in the right-hand side. However, in many applications this specific direction vector is difficult to justify and thus more general econometric method is needed. In our paper, we propose an alternative stochastic frontier approach for parametric estimation of the DDF that is less sensitive to endogeneity than previous approaches, but which also allows one to use general direction vectors without commensurability problems. Moreover, we show how this parametric approach can be generalized to semi- and nonparametric estimation of the DDF.

Another relevant restriction of the previous econometric studies estimating the DDF is that, besides the translation property, other properties or axioms of the DDF such as monotonicity or concavity have not been imposed. This is in sharp contrast to studies using DEA or parametric programming, but also to some recent papers that estimate the Shepard's distance functions with the regression methods. Since the estimated DDF can violate monotonicity and/or concavity constraints, it is important to consider regression approaches that allow one to impose these axioms. In our paper, we compare different constrained estimation approaches and their main advantages and disadvantages. We show that the quadratic functional form (used in many earlier studies) is not a flexible specification if one imposes monotonicity and concavity constraints in addition to the translation property. Thus, if one wants to estimate a stochastic DDF subject to regularity constraints, our results suggest that one should use the more flexible nonparametric constrained methods. We illustrate these results with simulated examples and with an empirical application to the railroads.

Stochastic axiomatic estimation of joint production: Does competition affect the performance?

Timo Kuosmanen, Andrew JOHNSON

Semi and Non-parametric Advances

Joint production of multiple outputs is a common feature of complex production systems. However, joint production functions continue to be notoriously difficult to estimate. This paper develops a new estimation procedure that employs the directional distance function to adapt the Convex Nonparametric Least Squares (CNLS) regression to the general multi-input multi-output joint production setting. We show that this CNLS regression subject to shape constraints on frontier can be augmented with a sign constraint on residuals to obtain a data envelopment analysis type nonparametric production function estimator as a special case. Additionally, analysis of the sources of inefficiency using contextual variables models as described in Johnson and Kuosmanen (2011) is also possible. The statistical properties of this type of semi-parametric estimator still hold, most importantly the parameters converge at the standard parametric rate of order n-1/2. Therefore, the conventional methods of statistical inference can be applied. These insights are then used to investigate the classic joint production. The results indicate that CNLS is more robust to errors in the data and can provide considerable different insights than previous methods of analyzing joint production.

Cost Efficiency of German Mutual Fund Complexes

Alexander SCHAEFER, Raimond Maurer

Hedge Funds, Mutual Funds and Portfolio Efficiency

German mutual fund complexes are far from being cost efficient. Depending on the approach used to measure efficiency, the average scores range from 0.26 to 0.54. Cost efficiency exhibits a downward trend over time, i.e. the

average degree of inefficiency in our sample increases. There is also evidence that the efficiency of mutual fund complexes offering real estate funds is at least 10

We derive these results by using nonparametric linear programming and parametric statistical methods. These techniques are known as data envelopment analysis and stochastic frontier approach, respectively. In the analysis the sum of operating and commission expenses is used as input and the assets under management differentiated into retail and institutional funds are used as outputs. In the case of the data envelopment analysis we choose an input-orientation and allow for variable returns to scale. In the case of the stochastic frontier approach a translog cost function is defined and estimated using fixed effects allowing efficiency to be either time-invariant or time-varying. Finally, for the nonparametric approach we run multiple second stage regressions to assess the impact of explanatory variables on cost efficiency. For the parametric approach, these explanatory variables are directly incorporated in the estimation of the cost function. Based on a set of consistency conditions, the results are qualitatively the same within the nonparametric and parametric approaches, but consistency between the approaches is less pronounced.

To the best of our knowledge, we are the first to carry out such an analysis for mutual fund complexes. We will use the term mutual fund complex to clarify that efficiency on the level of mutual fund complexes and not on the level of individual funds is considered. In contrast to mutual fund complexes, there is extensive literature on the efficiency of banks and insurance companies. In the study of Brissimis et al. (2010), European banks exhibit a high level of efficiency. The European insurance companies analyzed in Fenn et al. (2008) show also a high level of efficiency.

The lack of literature regarding efficiency on the level of mutual fund complexes is surprising, since they are important financial intermediaries managing about one third of the global assets of institutional investors. A similar picture emerges in relation to Germany. At the end of June 2009, private households in Germany had invested about EUR bn 520 in mutual funds while roughly EUR bn 1,500 of household assets were invested with insurance companies and in pension funds.

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Hedge Fund Performance Appraisal: A panel of Non-parametric Approaches using Directional Measures

Nicolas NALPAS, Léopold Simar, Anne Vanhems

Hedge Funds, Mutual Funds and Portfolio Efficiency

Hedge Funds have received a lot of attention in recent years due to their low correlation with major asset classes together with their ability to provide significant positive returns. Despites the financial crisis, with more than 7,000 HF available to investors, the fund selection process is a very challenging task that is hardly achieved by traditional parametric methods.

Since the pioneering works by Treynor, Sharpe and Jensen, a lot of performance measures have been introduced and empirically applied for evaluating the performance of funds. Recently studies adopted production frontiers methods, which have the ability to incorporate many factors that are associated with fund performances in addition to the usual risk and return measures (like for example transaction costs and management and performance fees, location). Among these methods, a classical nonparametric technique is called Data Envelopment Analysis (DEA). Using linear programming formulation, it defines a correspondence between multiple inputs and outputs without imposing any functional form. Unlike standard approaches using multi-factors models, production frontiers' methods do not require the specification of a benchmark, which is a crucial issue when measuring hedge fund performances. Moreover, the non-parametric feature of frontiers methods makes not necessary a statistical structure (e.g. normality) on returns like traditional (parametric) measures. Nevertheless, such methods are sensitive to signs of

inputs/outputs combinations what impose strong constraints on their choices (e.g. Gregoriou et al., 2005). In this paper, using recent results proposed by Simar and Vanhems (2010), we propose to assess HF performance through directional techniques applied to DEA and robust FDH (e.g. Cazals et al., 2002) that preserve unit invariance and that allow to handle the negative inputs/outputs found in the data.

The empirical analysis is conducted using TASS Hedge Funds database that contains more than 6,000 hedge funds. We analyze their performance using monthly data over the period August 2003 to August 2009. Because of hedge funds heterogeneity in terms of both investment strategies and types of markets in which they operate, we separate our analysis by examining six hedge fund classes: Market Neutral, Funds of Funds, Event Driven, Global Macro and Fixed Income Arbitrage.

The aim of this paper is to assess the reliability of the nonparametric methods described above in their hedge funds ranking. We examine the robustness of hedge funds rankings to changes in the input-output combinations. In particular, we compare the different nonparametric rankings with traditional performance measures used in the finance literature (Sharpe Ratio, Modified Sharpe Ratio, Omega ...).

Polynomial Goal Programming and Shortage Function Approaches to Reconstruct MVS Portfolio Frontiers: A Preliminary Comparison

Walter Briec, Kristiaan Kerstens, Ignace VAN DE WOESTYNE

Hedge Funds, Mutual Funds and Portfolio Efficiency

The main aim of this contribution is to compare existing and newly developed techniques for geometrically representing mean-variance-skewness portfolio frontiers based on the rather widely adapted methodology of polynomial goal programming (PGP) on the one hand and the more recent approach based on the shortage function on the other hand. Moreover, we explain the working of these different methodologies in detail and provide graphical illustrations.

A Bitter Brew? How Index Fund Speculation can Drive up Commodity Prices

Jaap BOS, Maarten Van der Molen

Hedge Funds, Mutual Funds and Portfolio Efficiency

There is a growing debate about the effects of speculative buying by index funds in commodity futures and over-the-counter derivatives markets. On one side of this debate are those that argue that these effects include commodity prices far exceeding fundamental values, resulting in a 'bubble' (Masters, 2008). On the other side of the debate are those that argue that the bubble argument is flawed as a result of a misinterpretation of the impact of commodity futures markets on commodity prices (Irwin and Sanders, 2010). In the last decade, rising food prices have led to riots in India, Mexico and Yemen, a boycott of tomatoes in Argentina during the presidential elections, a one-day boycott of pasta organized by Italian shops and an announcement by the Russian government that prices for milk, bread and other foods prices were to be frozen for a couple of months (Kingsbury, 2007). The consequences of rising food prices are particularly worrying for third world countries, where people spend between 60 and 80 percent of their income on food, compared to 10 to 20 percent for people in industrialized countries (Wahl, 2008). TheWorld Bank forecasts that between 73 and 105 million people will fall below the absolute poverty line due to food crises as the result of rising prices (World Bank, 2008). In this paper, we revisited this debate by introducing a nonparametric DEA approach to explaining the coffee price. With this approach, we are able to investigate the effect of index fund speculation on the coffee price. Our results show that the position taken by

index funds in the coffee futures market has indeed on occasion contributed significantly to peak coffee prices. This effect, however, is spiky, which explains why traditional approaches relying on mean and variance techniques will tend to miss it. We use a DEA model [3], including the [2] bootstrap procedure. We also employ an FDH model, as a robustness test. We test with the help of [1]. Although less frequent than the critics of index funds would like to believe, the impact of index fund speculation on the coffee price is nevertheless substantial. During times when index fund speculation affects the coffee price, we find that this results in losses of consumer surplus in excess of 20 percent. Further robustness analyses reveal that our model, including index funds speculation, is able to track the coffee price very accurately, that the effect of index funds speculation on the coffee price is significant, and that there is some evidence of a market impact effect of index funds on the coffee price. [1]Dimitris N. Politis, Joseph P. Romano, and Michael Wolf. On the asymptotic theory of subsampling. Statistica Sinica, 11(4):1105-1124, 2001. [2] Léopold Simar and Paul W. Wilson. Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models author(s): Léopold simar and paul w. wilson source: Management science, vol. 44, no. 1 (jan., 1998), pp. 49-61. Management Science, 44(1):49-61, 1998. [3] Emmanuel Thanassoulis, Maria C. S. Portela, and Despi´c. Data envelopment analysis: The mathematical programming approach to efficiency analysis. In Harold O. Fried, C. A. Knox Lovell, and Shelton S. Schmidt, editors, The Measurement of Productive Efficiency and Productivity Growth, pages 251-420, New York, USA, 2008. Oxford University Press.

Structure-conduct-performance in the Islamic banking industry

Hanen Hamdani, Mohamed Néjib OUERTANI

Regulation, Development, Foreign-owned Banks

This paper estimates technical inefficiency and investigate structure-conduct-performance paradigm in the Islamic banking industry. In our limited knowledge this is the first empirical study dealing with scp in the islamic banking context. We use a parametric approach by estimating a stochastic translog production frontier. The model is estimated on a panel of 80 banks (from many country) observed over the period 20002-2007. Furthermore, we consider that all these banks share the same technology. The first findings indicate that globally the islamic banks are inefficient and we do not find any support to the paradigm SCP.

The impact of foreign-owned Islamic banks and Islamic bank subsidiaries on Malaysian bank efficiency and productivity

Mariani ABDUL-MAJID, David Saal

Regulation, Development, Foreign-owned Banks

In recent years, Malaysia has converted the Islamic banking windows operations of its conventional banks into full-fledged Islamic bank subsidiaries and attracted foreign-owned Islamic banks. While the establishment of full-fledged Islamic bank subsidiaries is meant to encourage more flexible operations, which will allow the new Islamic banks to engage in a range of activities similar to those of commercial, investment and merchant banks, the policy of attracting full-fledged foreign Islamic banks is aimed at enhancing the competitiveness of the domestic Islamic banking industry. Given this policy context, this study aims to examine the impact of foreign-owned Islamic banks and Islamic banking subsidiaries on Malaysian banks efficiency and productivity. We employ stochastic frontier analysis to analyze the efficiency of Malaysian commercial banks during 1996-2009, and particularly focuses on determining the impact of foreign-owned Islamic banks and Islamic bank subsidiaries on cost performance. We

model the impact of bank characteristics such as foreign-ownership and Islamic banking after taking into account the difference between Islamic banks operating as subsidiaries of conventional banks, full-fledged Islamic banks and Islamic banking windows operating within conventional banks. We also test the impact of mergers, public ownership and economic crises on bank performance. In addition, we decompose productivity change into efficiency, technical, and scale change using a generalised Malmquist productivity index. Our preliminary results show that on average, Malaysian banks experience moderate diseconomies of scale and annual productivity change of -0.68 percent, with the latter driven primarily by scale effects. In addition, both full-fledged foreign- and domestic-owned Islamic banks have higher input requirements than other banks. In contrast, foreign-owned banks operating purely conventional banking and domestic-owned Islamic banks which operate as subsidiaries are found to more cost efficient than other banks. These results suggest that the flexible operation of Islamic bank subsidiaries within domestic banks have helped to improve Malaysian bank cost performance. Finally, our results suggest that while the East Asian financial crisis had an interim cost-decreasing effect in 1998, the recent economic crisis has yet to exhibit a significant impact on Malaysian bank cost performance.

Efficiency Analysis of Commercial Banks: A Robust Nonparametric Approach

Anamaria ALDEA, Luiza Badin, Carmen Lipara

Regulation, Development, Foreign-owned Banks

Regardless of type, size or tradition in fund raising, banks play a key role in providing the participants to economy's life with financial resources to support economic growth. The latest crisis, either it started as a financial or as an economic crisis, left a visible mark on banks' financial statements, drawing attention to regulators, clients, investors, employees and all other interested persons. Numerous scientific studies showed that the soundness and health of banking system is a requirement to avoid systemic risk which, at the end, may have a negative impact on economic evolution.

In this paper, we consider listed commercial banks from FactSet database, as their reduced activity on financial markets is usually associated with lower risk, contrary to investment banks, whose behavior has been criticized in the past years as being one of the generators of the current crisis.

The 2009 data for these banks were analyzed to observe how the latest crisis has contaminated the entire world and implicitly have impacted banks' performance. We have chosen 2009 data for our analysis in order to incorporate the lag effect too, given the different timing and causes of the crisis in the countries in which the selected listed commercial banks are running their activities. We start our analysis with a preliminary test of the returns to scale using a bootstrap algorithm proposed by Simar and Wilson (2002). Further, to measure the technical efficiency of commercial banks from different countries, we perform a nonparametric efficiency analysis based on robust estimation of partial frontiers (Cazals, Florens and Simar, 2002, Daouia and Simar, 2007)

The results provide a perspective on how listed commercial banks performed in 2009, after the crisis materialized in almost all the countries in which the selected listed banks run their operations. Better efficiency performances can be related to lower magnitude of financial crisis in some regions of the world and to different regulations active in the corresponding countries.

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An efficiency and productivity analysis of banking industry re-capitalization and financial crisis

Meryem Duygun FETHI, Mohamed Shaban, Thomas Weyman-Jones

Regulation, Development, Foreign-owned Banks

This paper describes procedures in panel data stochastic frontier analysis econometrics for efficiency measurement and productivity decomposition in banking systems with a special focus on the period following a financial crisis. In the recovery from a banking crisis, policy makers will try to re-capitalize the banking system, but this has the potential to impose significant costs, (see King, 2010). We develop an analytical framework that models the re-capitalization process as a requirement to hold levels of a fixed input, i.e. equity or owners' capital, above the long run equilibrium level. To capture the effect of this under-leveraging we adopt a model of the banking industry technology based on a weakly-disposable input requirements set that permits the measurement of efficiency and productivity in an uneconomic region of the banking technology. Panel data methods then permit a productivity decomposition to be developed that can distinguish between technical change, efficiency change, scale change and exogenous factors such as policy and regulatory constraints; see Sickles (2005) on panel data methods and Bauer (1990) on productivity change. We use two important results from the literature: the shadow return on equity capital (the fixed input) is the negative of the elasticity of cost with respect to the level of equity capital (the envelope theorem), and this elasticity in turn impacts on the measured elasticity of scale; in addition, out of equilibrium and assuming a weakly disposable technology, this shadow return may become negative and this would be expected when the banking firms are required to hold larger levels of the fixed input (equity capital) than they would choose in long run equilibrium. This paper uses a panel data set of banks in from an emerging/transition economy that has experienced and recovered from financial crisis. Two empirical findings are of particular note. Where the banking system has been restructured through re-capitalization, this has directly led to the shadow return on equity turning negative. This negative shadow return on equity is an offset to total factor productivity change and it has reduced the efficiency gains, e.g. allocative, technical and scale, achieved elsewhere by the banking system restructuring. There is an important policy lesson that a successful banking industry recapitalization has a measurable resource cost in restricting the banking system's overall productivity growth during the recovery phase. References: Bauer, P. W. (1990) "Decomposing TFP Growth in the Presence of Cost Inefficiency, Nonconstant Returns to Scale, and Technological Progress", Journal of Productivity Analysis, 1, 287-299.

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What Causes Productivity Change in West European Banking: A Generalized Metafrontier Malmquist Index Analysis

Tai-Hsin Huang, Chi-Chuan LEE

Banks Productivity

This paper aims to provide new insights of productivity growth with a newly developed generalized metafrontier Malmquist productivity index (gMMPI) for banking industries across 15 West European nations during the period 1993-2006. Following Orea (2002), a key advantage of the proposed method is that it allows for consideration of the role of scale effects. We also broaden our capacity in decomposing various sources of productivity change in the metafrontier context. The empirical results reveal that, on average, the banking industries experienced productivity growth arising from technical efficiency change and scale effects. This confirms that a more competitive and

integrated financial market induced by financial deregulations is indeed able to improve banking productivity. Furthermore, the catch-up in scale and in technical change is found to underlie the metafrontier productivity growth. Finally, larger banks and conservative banks tend to grow faster than smaller ones.

Decomposing Malmquist indices into local and global effects

Mette ASMILD, Kwaku Ohene-Asare, Fai Tam

Banks Productivity

In a recent paper Asmild and Tam (2007) defined a Global Malmquist Index, that provides an overall measure of the productivity changes across a set of observations. The paper further decomposed this index into global versions of the traditional efficiency change and frontier shift components.

The present paper extends this work by defining a further decomposition of the global frontier shift, into components that indicate whether an observation is situated in a more or less favourable location in the production possibility set. This decomposition has potentially interesting policy implications which we illustrate using empirical data on Ghanaian banks.

A Dynamic Network Production Model for Bangladeshi Banks

Hirofumi Fukuyama, Bill WEBER

Banks Productivity

A network model of the bank production process is developed and integrated into a dynamic Luenberger productivity indicator. We assume that there are two stages to bank production in each period. In the first stage, bank managers use inputs (labor, physical capital, and equity capital) to produce an intermediate output of deposits. The first stage of production in period t is constrained by the amount of bad loans that were generated in period t+1. Bad loans generated from a previous period act as an undesirable input in the first stage and require the use of larger amounts of desirable inputs to offset their effects. In the second stage of production bank managers use the intermediate output generated from the first stage to produce a portfolio of loans and securities investments. The lending process of the second stage also generates some bad loans which in turn become an undesirable input to the first stage of production in a subsequent period. While the managers of stage 1 want to maximize the intermediate output of deposits, the managers of stage 2 want to minimize the use of deposits in generating the portfolio of loans and securities. In a given period bank managers are assumed to try and maximize the size of the production possibility set by choosing deposits. The basic network model can be solved for each period and the optimal level of deposits determined on a period by period basis.

The network model of production is extended to a dynamic Luenberger productivity indicator where resources are reallocated across time. In this dynamic framework bank managers want to choose the level of deposits to maximize production over all periods, not just in a single period. Thus, the dynamic framework recognized that while lending opportunities in one period are available, the state of the economy might cause many loans to go bad reducing production possibilities in subsequent periods. Therefore, a process of foregoing lending opportunities in one period and reallocating resources to expand lending in a subsequent period could enhance bank performance in terms of maximizing loans and securities and simultaneously minimizing bad loans.

An empirical example is offered using twenty-one Bangladeshi banks that producing during the period 2005 to 2008. The directional distance function serves as the measure of bank performance and is estimated using DEA

(data envelopment analysis). Actual deposits are compared with optimal deposits for the two stage network model and with optimal deposits found as the solution to the dynamic two stage network model. inputs.

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Turkish Bank Efficiency: Estimation with Undesirable Outputs

Albert Assaf, Roman MATOUSEK

Bad Loans and Efficiency

This study curries out a systematic analysis of productivity and efficiency of the Turkish banking. We deploy an innovative parametric model introduced by Atkinson and Dorfman (2005). This model takes directly into consideration an undesirable output - non-performing loans (NPLs). The application of this methodological approach contributes to the current theoretical research on bank efficiency and fully discloses the fundamental shortcomings of the traditional parametric models that do not take into account the effect of undesirable outputs. The paper makes four main contributions. First, we investigate the impact of an undesirable output (NPLs) on bank efficiency. We apply the Bayesian measurement of productivity and efficiency with undesirable output introduced by Atkinson and Dorfman (2005). Second, our methodology allows us to provide an analysis of efficiency levels of individual inputs/outputs and compare them with the estimated optimal levels. This is an important addition to the current research on bank efficiency. Third, we analyse bank efficiency during the bank consolidation program that took place after the crisis in 2002. The analysed period covers the last quarter of 2002 and ends in June 2010. Finally, we discuss the contribution of our results with other recent studies on bank efficiency in Turkey. In addition, we assume that foreign banks should presumably show higher efficiency compared to domestic banks. This expectation is also underpinned by broadly accepted principles that rapid and successful restructuring of banking sectors should be reflected in higher levels of bank efficiency. We have found several interesting results. We show that bank efficiency reflected the state of the Turkish economy after the crisis in 2000-1. Furthermore, there persists a gap between the best and worst performing banks. NPLs significantly reduce bank efficiency and productivity. We could not confirm the hypothesis that foreign banks have higher efficiency scores as we saw in new EU countries.

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Non-performing loans and banking efficiency of Kazakh banking

Karligash KENJEGALIEVA, Anthony Glass

Bad Loans and Efficiency

Using monthly data, this study investigates the trend of risk management and operational performance of Kazakh banks over the period April 2007 - Dec 2010. The data allows us to examine the effects of global financial crisis on Kazakh banking industry. We use Stochastic Frontier Analysis estimators to estimate efficiency scores and productivity indices. The components of the productivity index - the efficiency change and the components of the technological shift - are then decomposed into factors determined by the technology, adjusted for 'risk and environment', 'risk management' and 'environmental effects'. Banking risk is modelled using six categories of non-performing loans and provisions for loans. It is found that the main driver of productivity change in Kazakh banks

is technological improvement, which, in the beginning of the analysed period, hinged on the banks' ability to capitalise on advanced technology and successfully take into account risk and environmental factors. Whereas, in the later sampled periods, we show that one of the most important factors of technological improvement/decline is risk management.

Loan Loss Provisioning and Efficeincy in Indonesian Banks

Muliaman Hadad, Maximilian Hall, Wimboh Santoso, Richard SIMPER

Bad Loans and Efficiency

This paper analyses the process of loan loss provisioning of Indonesian banks and how this affect their profit efficiency. We firstly examine the nature of loan loss provisioning in Indonesia with respect to their implementation of the Basel accord and examine how this has changed due to the recent Global Financial Crisis. We next estimate parametric x-efficiency and scale efficiency scores for Indonesian banks using a variety of models to analyse the sensitivity of ranks and scores obtained. Finally, the x-efficiency and scale efficiencies scores are incorporated into a general specification model to determine whether they have any effect on the loan loss provisioning of Indonesian banks.

Structural Change and Adjustment Costs in Polish Agriculture: A Dynamic Frontier Approach

Supawat Runsuriyawiboon, Heinrich HOCKMANN

Efficiency in Agriculture IV

Compared to other countries in the EU, Polish agriculture is dominated by rather small holdings with low levels of specialisation which were additionally characterized by a relatively low degree of market integration. After accession, forces resulted from the internal market were assumed to provide significant pressure on the farming sector which in turn would introduce pronounced and fast adjustment processes. However, neither a pronounced trend in farms growth, a higher degree of specialisation nor changes in the specialisation in production could be observed. In our paper we focus on the role of adjustment cost and show that they are significant and can be regarded as a source of the sluggish adjustment processes. In particular we characterize the cost structure of the Polish farm under dynamic adjustment and analyse to what extend adjustment cost affect the exploitation of resources in Polish agriculture (technical efficiency) and to what extend they induce a suboptimal allocation of the resources (allocative inefficiency).

We use the dynamic efficiency model introduced by Rungsuriyawiboon and Stefanou (2007). This approach integrates the static production efficiency model and the dynamic duality model of intertemporal decision making. We extend the model by allowing for a multiple quasi-fixed inputs case. The dynamic efficiency model defines the relationship between the actual and behavioral value function of the dynamic programming equation for a firm's intertemporal cost minimization behavior leading to a system of equations of the conditional optimized actual demand for variable inputs and net investment in quasi-fixed inputs. A quadratic functional form is used to specify a value function of the dynamic programming equation. The model is estimated using the system GMM (generalized method of moments) estimator.

We will use a balanced panel data set comprising more the 8000 farms for the period 2004 - 2007. The data set includes detailed information on agricultural outputs and inputs. The data set allows to use two output (crop

and livestock output) and six input variables (labor, overhead, fertilizer, livestock, land and capital) where land and capital inputs are defined as quasi-fixed inputs. The sample comprises farms from all over Poland. In addition all kinds of farm type are covered. This will allow us to conduct detailed analyses regarding the regional and specialisation effects on adjustment costs as well as technical and allocative efficiency.

First findings confirm the significance of adjustment costs: (1) the estimated adjustment rate of each quasi-fixed input is relatively low implying that both capital stock and land adjust slowly to the long-run equilibrium levels 2) measures of efficiency scores obtained from the static efficiency model differ significantly from those of the dynamic efficiency model 3) polish farms underutilized overhead and livestock inputs relative to labour input and 4) there were large differences of efficiency scores among Polish farms in different regions.

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Accounting for Heterogeneity in Firm Efficiency Estimation using a Primal-Dual Non-parametric Approach

Antonella Caiumi, Federico PERALI

Efficiency in Agriculture IV

This paper deals with the issue of comparability among household-firms in the context of the non-parametric measurement of efficiency (Afriat 1972, Färe et al. 1994). This problem is particularly relevant in agriculture, where the production unit is the farm-household. The study proposes a novel approach to deal with heterogeneity exploiting an analogy with the literature of interpersonal comparisons. The high degree of heterogeneity of the agricultural production units arises from differences both in the firm structure and in the household composition. Unlike the parametric approach, the non-parametric framework does not allow to explicitly handle non-economic information related to specific firm or household characteristics (Jorgenson, Lau and Stoker 1982). This limitation has generally restrained the possibilities of applying the non-parametric approach in the efficiency evaluation on small samples of homogeneous firms (Chavas and Cox 1990). This study provides an approach to overcome such limitations with the aim of encouraging the joint application of parametric and non-parametric techniques as instruments of cross-validation. The non-parametric approach is a powerful tool of analysis in so far as it allows representing the production both in the primal and in the dual space, which corresponds respectively to the lower and upper limit of the technological frontier. This characteristic makes the non-parametric approach particularly helpful in the efficiency analysis by providing the interval of the efficiency measures derived through any possible representation of the underlying technology. The applications of the non-parametric approach to the dual space are rare in the literature due to the high rejections of the implicit economic rationality criteria. This evidence is often motivated by the high degree of heterogeneity in the production technology, in addition to the presence of technological progress and production inefficiency. This study computes primal-dual non-parametric measures of technical, allocative and scale efficiency while maintaining the hypothesis of cost minimization for a sample of 1.500 Italian agricultural firm-households. In order to explicitly account for the presence of heterogeneity, we correct the observed input usage by using specific 'equivalence' scales derived from the parametric estimation of the production frontier modified through the explicit treatment of firm heterogeneity on the same dataset. This procedure permits to derive non-parametric efficiency measures by controlling for the presence of exogenous non-economic factors. Our global inefficiency measures are mainly explained by technical inefficiency. This holds both for corrected and uncorrected input usage data that returns comparable results. However, the outcomes at the firm level vary substantially when heterogeneity is accounted for. This suggests that our data transformation captures part of the heterogeneity. Failing to properly account for differences among production units might have relevant implications when the policy analysis is targeted towards specific groups of firm-households of particular policy interest.

Drivers of Dynamic Efficiency of Dutch Vegetables Producers

Alfons OUDE LANSINK, Spiro Stefanou E., Elvira Silva

Efficiency in Agriculture IV

The economics literature counts numerous studies that analysed technical and allocative efficiency of. In the literature on nonparametric efficiency analysis, only very few authors have acknowledged the dynamic nature of factors of production like labour and capital. Doing so is essential when assessing the actual potential for improving the performance in the short and long run.

This paper measures dynamic technical and allocative inefficiency of a sample of horticultural firms over the period 1997-1999.

Dynamic technical inefficiency is measured using a directional distance function and assumes that firms face adjustment costs in adjusting capital. Allocative inefficiency is determined residually using the duality between the dynamic directional distance function and the long-term cost function. Technical and allocative inefficiency are regressed on a set of regressors using a bootstrap method.

Results suggest that substantial long-term cost savings (44%) can be obtained. Technical inefficiency is the largest component of cost inefficiency allowing for an average improvement of 33%. The average allocative inefficiency is 0.10. A bootstrap method is used to regress allocative and technical inefficiency as well as the cost inefficiency of individual inputs on socio-economic variables. Modernity of structures has a negative impact on technical inefficiency. Modernity of machinery and installations has a significant impact on the inefficiency in the use of individual inputs. Location in the glasshouse district, family labour, operator's age and modernity of structures also have significant impacts on the inefficiency of individual inputs.

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Productivity Evaluation of Taiwanese Semiconductor Companies Using the Slacks-based Malmquist DEA Approach

Mei-Ying Huang

Sectorial Analysis II

Most of the previous research related to the semiconductor industry in Taiwan has been directed at the role of government or the industrial development strategy in improving the competitiveness of the industry. However, few studies focus on the productivity performance of semiconductor firms in Taiwan. In this paper, we evaluate the productivity performance of Taiwanese semiconductor companies and investigate the key factors which may affect firms' performance. We adopt the non-oriented slacks-based DEA model (SBM) of Tone (2001, EJOR) and extend it to a Malmquist SBM productivity index to measure firms' productivity changes over time. Using firm data for the Taiwanese semiconductor industry, we examine the relative efficiency and productivity growth of this industry for the years 2002 - 2007. The empirical results show that efficiency scores generated from the non-oriented SBM are in general higher than those from the traditional input-oriented DEA model (BCC). The SBM results also indicate that the mean efficiency scores of the sample firms increase over time except 2004. Results also show that among three semiconductor sub-industries, the Design sub-industry has the highest mean efficiency score; this is followed by the Packaging sub-industry and the manufacturing sub-industry. The Malmquist SBM productivity index presents the dynamic effects of catch-up, frontier-shift and productivity changes of sample firms over time. The results of

such model for the whole industry show that the changes of catch-up (recovery) and frontier-shift (innovation) are found to be fluctuating and opposite over time, which indicating instable productivity effects in the study period. However, such productivity effects, including catch-up and frontier-shift effects, vary by sub-industries. Among three sub-industries, the manufacturing sub-industry is the one with the largest fluctuation, whereas the packaging sub-industry is a sub-industry with relative stable productivity effects. Finally, the determinant factors which affect the efficiency levels and productivity change effects of individual semiconductor firms are also examined for each sub-industry. The empirical results of this paper could provide useful management information to Taiwanese semiconductor companies for their formulating effective strategies or plans to improve their technologies and efficiency levels.

Performance trends in the construction industry worldwide: an overview of the turn of the century

Isabel HORTA, Ana Camanho S., Jill Johnes, Geraint Johnes

Sectorial Analysis II

Due to the fierce competitive environment in the Construction Industry (CI), performance assessment has become a key issue in this sector. The evolution of CI strategy and managerial policies also attracted attention in the research community. Performance assessment in the CI typically involves the use of Key Performance Indicators. In some countries, company indicators are available in Web benchmarking platforms, enabling external benchmarking among registered companies (see Costa et al., 2006 for a literature review). More recently, the potential of using frontier methods to analyze performance in the CI has started to be explored (e.g. El-Mashaleh et al., 2007). These studies focus on the performance of individual companies, providing insights concerning the strengths, weaknesses and targets for improvement. Other studies focus on the assessment of the CI sector of particular countries (e.g. Xue et al., 2008). To date, comparisons of the CI sector of different countries have not been explored. Cross-country comparisons were only conducted in other sectors, such as in banking or agriculture. This study aimed to develop a quantitative approach to measure the efficiency levels and productivity change of construction companies worldwide, identifying the factors that may influence performance. In particular, we studied if location, activity profile, and company size have an impact on the efficiency of construction companies. For this purpose, we divided the companies in three regions (Europe, Asia and North America), and in the three main activity profiles (Buildings, Heavy & Civil and Specialty Trade). The methodology adopted involved the estimation of efficiency levels using Data Envelopment Analysis (DEA), complemented with bootstrapping. The factors that promote high efficiency levels were identified using a panel data truncated regression. To evaluate the productivity change of construction companies over time we used the Malmquist index, complemented with bootstrapping. The performance assessment model specified characterized companies mainly from a financial perspective. The model was specified with three inputs and one output. The inputs considered were total current liabilities, shareholders' funds, and cost of goods sold. The output was the value of sales. The sample studied consisted of 118 companies operating between 1995 and 2003, with data available in the OSIRIS database published by Bureau van Dijk (www.bvdep.com). The results revealed that the efficiency levels tended to increase over the period analysed. In particular, 1995 corresponded to the year with the worst efficiency level whilst 1998 and 2003 were the best years. Concerning the impact of location on efficiency levels, we found that North American companies performed better than the European and Asian counterparts. Concerning activity profiles, Trade companies showed higher efficiency than Building and Heavy & Civil companies. We also concluded that higher efficiency levels were observed in larger companies. In terms of productivity change, European and Asian companies increased their productivity in most of the years analyzed, whereas North American companies only increased productivity in 1996 and 2002. Buildings, Heavy & Civil and Trade companies experienced productivity improvement in most of the years analyzed.

EU industrial specialization: Is it a macro or micro phenomenon?

Lu ZHANG, Jaap Bos

Sectorial Analysis II

The European Union (EU) has enjoyed a period of remarkable economic integration in the past two decades, reflected by a very rapid growth in cross-border commercial trade and capital flows. Extensive research has emphasized that economic integration has had a strong impact on the production structures of the EU economies, which have become increasingly specialized over the years.

Research on the causes of industrial specialization has been broadly divided into two separate strands. On the one hand, macroeconomic factors, such as trade and financial integration were identified to be important forces in driving specialization (Kalemli-Ozcan el al., 2003; Bos, et al., 2011). However, it is unclear from this literature that through which channel trade and financial integration have affected the sectoral composition of these countries and what sort of firm/industry characteristic accounts for the greater sensitivity to integration. On the other hand, recent microeconomic literature has highlighted the importance of analyzing firm-level adjustment processes in response to openness to foreign trade (Melitz, 2003). Although these studies have found considerable evidence of substantial reallocation effects within an industry following trade integration, they are mainly industry-/country-specific and provide little guidance regarding how firm-level adjustments has any implication on the changes in the sectoral composition observed at the macro-level.

Consequently, the purpose of this paper is to explore how trade and financial integration affect the sectoral composition within EU economies. In addition, we account for firm/industry level heterogeneity, i.e. the potential for reallocation in response to trade and financial integration. Such knowledge is important, as it enhances our comprehension of the real impact of trade and financial integration and makes it possible to draw predictions concerning the further changes in the industrial composition of countries.

Our paper aims to contribute to the literature in three distinct ways. First, we document a specific channel through which trade and financial integration affect industry structures, namely reallocation. Second, we propose measures to capture the potential for reallocation through the dispersion of firm-level efficiency and scale. Firm-level efficiency and scale are estimated using stochastic frontier analysis (SFA). Lastly, we compile a unique firm panel across EU countries during the period 1994-2006 using the Amadeus database.

Our results show that countries with higher level of trade openness and (to a lesser extent) financial openness experience stronger shifts in production towards industries with a larger potential for reallocation (a large dispersion of firm efficiency and scale within an industry). This finding is consistent with trade and financial integration facilitating the reallocation of economic activities.

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Productivities of Major Semiconductor Firms in Taiwan, Hong Kong and China

Shu-Chin HUANG, Chang-Ching Lin, Yu-Hung Chen

Sectorial Analysis II

Globalization has become a wave of unrest. Many Taiwanese and Cantonese semiconductor suppliers have conducted direct investment in mainland China in order to gain an advantageous position. Production technologies

have been transferred with the investment from Taiwan and Hong Kong to mainland China, while the investors might have also benefited from the investment to increase scale efficiency. Similarly, producers from other countries have invested in and transferred technologies to mainland China, particularly in the past two decades. Over the years, semiconductor suppliers in the Great China Area have grown competitiveness on the international stage. It is important to know their performance and relative strength for firms and governments to make strategic development in the industry. This paper estimates productivities of listed semiconductor suppliers in Taiwan (205 firms), Hong Kong (27 firms) and mainland China (32 firms) in 2005-2008. We compare costs and revenues of these companies and estimate their relative total factor productivities by using three-stage Data Envelopment Analysis. Major results of this research are discussed according to firms' location, size and industrial type. In terms of location, the results show that, assuming variable returns to scale, the average pure technical efficiencies (PTEs) in 2005-2008 were 0.524, 0.541 and 0.377 in Taiwan, Hong Kong and mainland China, respectively, and the average scale efficiencies (SEs) were 0.896, 0.844 and 0.837 in the three places, respectively. Firms in mainland China had significantly lower PTE than Taiwan and Hong Kong suppliers, but they had competitive SE. Moreover, mainland China suppliers grew in both PTE and SE during the study period until financial crisis in 2008. In contrast, Taiwan and Hong Kong suppliers show a decline in PTEs over the period, though SE remained progress. Regarding to firm size, we found that, assuming constant returns to scale, large firms had significantly higher technical efficiency (TE) than small and medium enterprises (SMEs) on average, and Taiwan and Hong Kong large firms had significantly higher TEs than mainland China large suppliers. However, mainland China SMEs showed strong growth in TE before the 2008 financial crisis, and managed to outperform Taiwan and Hong Kong SMEs before the crisis. In respect of industrial type, we classified semiconductor firms into four types: the upper, middle and lower streams, and terminal suppliers. The results depict that, assuming constant returns to scale, the middle stream manufacturers had the highest TE on average, followed by the lower stream manufacturers and then terminal suppliers. The upper stream producers had the lowest TE in the study period. Taiwan suppliers perform relatively better in the terminal supply sector, Hong Kong was better in the upper stream, and mainland China was especially weak in the upper stream and terminal suppliers. Notably, TEs in Hong Kong lower stream and terminal supply sector had significantly declined over the period, while China producers had grown stronger in the middle stream. The main contributions of this paper are twofold. First, we show the relative TE, PTE and SE of major semiconductor producers in Taiwan, Hong Kong and mainland China. In particular, we compare costs, relative strength and weakness of these semiconductor suppliers according to their location, firm size and industrial type. This is the first paper managed to provide the comparison, and the information is useful for both governments and firms to make strategic decisions in the industry. Second, this paper applied the three-stage DEA approach to measure efficiencies, in which location, industry and firm size effects are eliminated. We report both one-stage and the three-stage DEA results for the comparison. It shows that location, industry and firm size significantly affect the one-stage DEA results and thus, the three-stage approach is needed to adjust the effects in order to reveal the firm's true production efficiency. This adjustment is important but has been neglected in most existing studies.

The impact of ownership on efficiency and performance in the Ukrainian Banking industry

Elina KOLOMAYNEN, Bernhard Mahlberg, Peter Haiss

Ownership and Banking

A developed financial system characterised by high productivity is essential for any well-functioning economy. A wide body of literature covers various aspects of efficiency in the banking sector: cost efficiency as well as profit efficiency; cross-border and domestic issues; concentrated vs. dispersed markets, inherited vs. earned efficiency (pre/post privatization), mature vs. emerging markets, and the impact of regulation and the legal environment. Particularly the banking sector of the New EU Member States has attracted quite some research, including comparative studies with emerging markets in Asia and Latin America. Typically these studies focus on discussing the

impact of ownership type (foreign vs. domestic ownership; state owned vs. privately held; acquired vs. greenfield), the role of bank size, and of privatization and management in bank efficiency. Some of these studies also address institutional aspects e.g. resulting from EU membership. European transition economies like Ukraine, Moldova and Bjelorussia which lack such an institutional embedding have, however, received less attention. Particularly large banking markets like Ukraine should therefore be of great interest as a role model, and we try to cover that gap.

In many emerging market studies, foreign ownership is associated with higher productivity which is partly explained by access to cheaper refinance, more efficient work procedures, better IT infrastructure and risk management introduced by foreign owners. Nevertheless, some cross-country studies (Borovicka, 2007) on the contrary show a negative impact of foreign ownership on efficiency. This may be explained by cream-skimming effect as foreign investors initially choose most efficient banks for acquisition which leads to higher efficiency of foreign ownership. Thus privatization issues matter as well in the relationship and need to be considered.

The Ukrainian banking sector is the second largest among the members of the Commonwealth of Independent States (CIS) by assets size. Since the country's independence after the collapse of the Soviet Union in 1991, the Ukraine has already gone through several economic crises which had a major impact on its banking sector. The importance of foreign banks in Ukraine has been increasing since 1999.The economic crisis of 2008-2009 hit Ukraine hard as the national currency, the Ukrainian hryvnya (UAH) devalued almost 60% against the USD in fourth quarter of 2008. According to Moody's, most Ukrainian banks were be still loss-making or only marginally profitable in 2010, and a break-even is expected in 2011. Therefore, the problem of profitability and efficiency of the banks in Ukraine struggling for their existence is very timely.

Our study focuses on the development of the banking system in the Ukraine over the 2001 to 2009 period. We apply the stochastic frontier approach (Battese and Coelli, 1995) for a sample of large Ukrainian banks. The advantage of the applied method is its ability to measure long-term profitability. We use data from the Bankscope database and from the National Bank of Ukraine (NBU). We expect the foreign-owned banks to show higher efficiency in comparison to their domestic counterparts. We also analyse difference in the efficiency of private and state-owned banks in Ukraine.

Entrepreneurial Finance and Performance: A Transaction Cost Economics Approach

Alicia ROBB, Robert Seamans

Ownership and Banking

We extend transactions cost economics to the entrepreneurial setting. The transaction cost economics project finance framework suggests equity is better suited to projects with high levels of asset specificity while debt is better suited to projects with low levels of asset specificity. We apply this transaction cost economics framework to the entrepreneurial finance setting and generate two hypotheses: 1) as asset specificity increases, the firm will be less likely to use debt and more likely to use equity; and 2) performance is adversely affected when the use of debt and equity are not properly aligned with asset specificity. We test these hypotheses using data from the Kauffman Firm Survey, a longitudinal survey of businesses that began operations in 2004 that are tracked over the 2004-2008 period. To assess Hypothesis 1 we run regressions of the following form: (1) debt ratio-it = beta-1 asset specificity measure-it + X-it + epsilon-it where debt ratio-it is the ratio of debt to debt + equity for firm i at time t, where asset specificity measure-it will be one of three measures and where X-it is a vector of control variables. From (1) we obtain predicted values for each firm's debt ratio, and use these to construct measures of misalignment between predicted debt ratio and actual debt ratio. More formally, (2) misalignment-it = debt ratio-it - predicted(debt ratio-it) We then first difference the absolute values of the misalignment to obtain a measure of change in misalignment: (3) Delta misalignment-it = abs(misalignment-it) - abs(misalignment-it-1) Finally, we investigate the effect of misalignment on performance outcomes: (4) performance-it = beta-2 delta misalignment-it + X-it + eta-it Empirically, our results show that firms align their debt ratio with their asset specificity and performance is adversely affected when the use of debt and equity are not properly aligned with asset specificity. Our results are robust

to different measures of asset specificity and performance and highlight the importance of matching the type of finance used to the characteristics of the project. In contrast to prior empirical work linking financial structure to asset specificity, we focus on very small firms, which are likely engaged in only a single project. Our results add to other empirical work in this area providing additional support for the central predictions of transaction cost economics as applied to corporate finance. In addition, our results show how transaction cost economics can also be applied to new, entrepreneurial firms. The results have significant implications for new firms. In order to better create and capture value, a new firm should arrange financing in alignment with its underlying assets. Our study shows that appropriate financial structure leads to new firms being able to create and capture value. From a policy point of view, these results suggest that policymakers should work to ensure that many types of financing are available without hindrance to new firms. New firms that have ready access to debt and equity financing will be able to use the appropriate mix of financing required by their venture and in turn will have better performance prospects.

Bank Efficiency in Transition Countries with regard to Bank-Customer-Relation as an Unobservable Input

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Ownership and Banking

Relevance and Objective In the aftermath of the financial crisis, the issue of quality of the relationship of commercial banks and their customers gained importance and should be regarded in efficiency measurement. As banking is a highly restricted industry, managerial ability becomes, to a large extent, evident in the quality of the relationship of a bank towards its customers. Regarding the literature on banking efficiency, numerous studies focus on Central and Eastern Europe and analyze effects of ownership (foreign, domestic) in emerging markets. However, there is a consensus about the positive effect of a well established bank-customer relationship (BCR) on efficiency. For example Hasan and Morton (2000) find lower inefficiencies in banks with a higher number of service hours to customers. Borovika et al. (2007) prove that strategic investors seek (cream skimming) more efficient domestic banks and perform better than Greenfield banks. In general, econometric models on banking, which are used for Stochastic Frontier Analysis, implicitly assume that the effects of BCR (among other factors) are picked up by the inefficiency term. This paper elaborates the inclusion of an unobserved input into a profit (cost) function to account for BCR effects. Approach Based on the transformation function of financial institutions (Freixas, Rochet 2008) and in line with numerous studies of banking efficiency, we apply the intermediation approach for defining a profit (cost) function. Following an approach of Bos and Kolari (2005), we allow for a heterogeneous output mix and include the leverage ratio as a control variable for risk preferences. As done by Alvarez et al. (2004) we introduce an unobserved random variable into the translog profit (cost) function and estimate a Random Coefficients Stochastic Frontier Model. Data The panel data from Bureau van Dijk (BANKSCOPE) contains balance sheet data of annual reports of 373 banks in Central and Eastern Europe for the period 2002 to 2009. From financial institutions with a banking license, we select Commercial Banks, Cooperative Banks and Microfinance Institutions. All three types of institutions are deposit taking banks which offer financial services to customers and engage in investment and off balance sheet activities. Calculating both one cost and one profit frontier requires all banks to be profit maximizing but also allows for testing this assumption. Expected results We develop an empirical model that is estimable as a stochastic frontier with random coefficients and provide an analytical link between the unobservable input BCR and efficiency values. We expect to obtain a model that is more suitable to assess different banking policies concerning the extent and quality of services to customers. Besides the methodological issue, the paper contributes to the ongoing discussion on the specification of inputs and outputs in assessing efficiency in the banking industry.

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Revealing Efficiency Gains from Bank Mergers: DEA vs. FDH Technical Efficiency, Scale and Scope Effects

Mircea EPURE, Kristiaan Kerstens, Diego Prior

The Effects of Bank Mergers

Efficiency literature offers surveys on the effect of the mergers and acquisitions (M&As) of banking units (see, e.g., Amel et al. (2004)). Even if consensus exists on the forces driving these M&As, results on efficiency gains remain in general inconclusive. It is difficult to deduce a clear conclusion on whether M&As improve bank efficiency or if merged banks are more efficient than non-merged ones. One can speculate that the choice of theoretical assumptions could play a role in this lack of findings. A common aspect of most previous research is the use of convex technologies. Thus, it may be useful to also utilize non-convex technologies (see Briec et al. 2004).

When performing multi-objective examinations of non-parametric technical efficiency frontiers, one can assume convex (DEA) or non-convex (FDH) technologies. The convex method is by far more popular. Nonetheless, non-convex frontiers offer more accurate inner approximations of the true technology (Briec et al. 2004). Practically, one finds that DEA inefficiency is always higher than, or equal to, FDH inefficiency. This implies that potential post-M&As gains expressed as a convex frontier target are sometimes too hard to attain. Thus, this analysis uses both DEA and FDH to reveal potential gains from M&As, and illustrates the differences between the two.

Specifically, M&As are analyzed as proposed by Bogetoft and Otto (2011). Thus, one first computes the overall gains from merging. This measure is then is decomposed into technical efficiency, scale and scope effects. The technical efficiency effect illustrates the ability of merged units to be on the best practice frontier. Next, the second component shows the potential reductions of inefficiencies due to scale effects. These may also appear when no technical efficiency gains are possible, and are attractive for technologies with economies of scale which allow for production at lower costs. Lastly, a positive scope effect exists when one can obtain via merging output combinations that require less inputs to produce or that match existing combinations in a better way (see Bogetoft and Otto, (2001: 265-272) for a detailed description of this decomposition).

The analyzed sample consists of 32 M&As that occurred during 1988-2006 in the Spanish banking industry. Yearly computations are run on an outlier-free sample formed by all banking units (merged or unmerged). The gains from M&As are evaluated considering three years pre- and post-M&A event, plus the year of the merger. Preliminary results show significant reductions of technical and scale inefficiencies, mostly two years after the merger event. However, before reaching a clear conclusion the complete decomposition results as well as DEA-FDH comparisons must be computed.

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The Impact of Merger on the Branch Efficiency of a Canadian bank

Joseph Paradi, Haiyan ZHU

The Effects of Bank Mergers

Using the nonparametric technique of Data Envelopment Analysis (DEA) (Cooper et al. 2007), this study investigates the operational efficiency of the branch networks for the two pre-merger financial firms as well as the network of the merged firm in 2000 and 2003, respectively. The dataset used in this study included 1036 pre-merger branches and 835 post-merger branches. The 835 post-merger branches consisted of 190 'physically-merged' branches and 645 'culturally-merged' branches. The 'physically-merged' means one or more pre-merger branches were closed and subsequently merged into one post-merger branch. The term of 'culturally-merged' means the adoption of more advanced organizational culture between the two merged firms, but no physical closures of branches. The results suggested that there was an economic rationale for mergers in the banking industry. In general, the merger had improved the productivity of bank branches and the post-merger branch network experienced an increase in efficiency scores. However, the relative changes in branch efficiency were not uniform across the new branch network. Some branches appeared to perform better while other worse as a result of the merger. The efficiency changes for the 'physically-merged' and the 'culturally-merged' branches were examined separately. We also examined the probability and the branch characteristics associated with the efficiency changes through probit analysis. The Malmquist index analysis based on input-oriented DEA model was conducted to analyze the productivity change of firms over time. Using the Ray and Desli (1997) VRS approach, the Malmquist index was decomposed into pure technical efficiency change, pure technical change, and scale change to identify the main source of productivity improvements. Furthermore, multivariate regression analysis was conducted to investigate the external factors that might affect performance gains with efficiency changes as dependent variables and operating context factors as independent variables. Two dependent variables were technical efficiency and scale efficiency. Seven independent variables included geographical location, local market type, average age of the population, employment rate, level of education, average household income, and population density. Bootstrapping methodology proposed by Simar and Wilson (2006) was used to provide statistical inference for the regression coefficients. In this paper, we provided an extensive empirical investigation on the efficiency effects of bank mergers. Whereas most previous studies have focused primarily on bank mergers at whole institutional level, this study explored the merger effects at bank branch level. A new perspective was introduced for understanding the merger impacts and estimating the possibility of efficiency changes in the future merger process. Cooper W.W., Seiford L.M., Tone, K., Data envelopment analysis: a comprehensive text with models, applications, references and DEA-solver software, New York: Springer, 2007, 2nd ed. Ray, S.C., Desli, E., Productivity growth, technical progress, and efficiency change in industrialized countries: Comment, The American Economic Review, 1997, 87, 1033-1039. Simar L., Wilson P.W., Estimation and inference in two-stage, semi-parametric models of production processes, Journal of Econometrics, 2007, 136, 31-64.

Bank efficiency, business model and the merger process in financial center

Claudia CURI, Paolo Guarda, Ana Lozano-Vivas, Valentin Zelenyuk

The Effects of Bank Mergers

US and European banking sectors faced an unprecedented wave of consolidation over the last 20 years. The merger process requires a more comprehensive approach to performance measurement to allow for factors affecting decisions by banking executives and regulators. In particular, the wave of consolidation invalidates some time-invariant performance measures for the purposes of historical comparisons. Changes in bank performance may reflect changes to bank business models, adapting to variations in risk appetite over time. In this paper we propose

a modification of standard DEA to assess whether bank consolidation leads to performance improvements. We study operational efficiency pre- and post- consolidation focussing on international banks in Luxembourg during the recent financial crisis. Empirical results are obtained from the two-stage DEA procedure proposed by Simar and Wilson (2007) as well as other non-parametric techniques based on the bootstrap (Simar and Zelenyuk, 2007).

The impact of the institutional form on the cost efficiency of nursing homes.

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Health Policy

In Switzerland nursing home services are provided by regulated public and private nursing homes. They are characterized by different institutional forms i.e. private law institutions (foundations or associations) and public law institutions (administrative units). Some public nursing homes have been created as foundations. The issue of the most efficient institutional form in the provision of long-term care is an interesting one to whom the economic literature has not given a conclusive answer so far (Frank & Salkever, 1994). In particular, the literature has focused mainly on the effect of ownership comparing for-profit and not-for profit organizations, while the majority of the long-term care industry is characterized by not-for profit nursing homes (public and private). Within the not-for profit sector little empirical work has been done on the impact of ownership on the productive efficiency (Malani, Philipson, and David, 2003; Ballou and Weisbroad, 2003; Farsi and Filippini, 2004). In this paper we are mainly interested in analyzing, from both a theoretical and en empirical point of view, the impact of the institutional form on the performance of not-for profit nursing homes. To our knowledge, only few empirical studies have been carried out on this topic. This research question is important because in Switzerland local government have the possibility to create nursing homes with private legal form such as foundations. The impact of ownership form is also analysed. The present paper aims at discussing cost efficiency in highly regulated markets for long-term care with not-for profit nursing homes. We formulate hypotheses on the effects of the institutional form on the cost efficiency of nursing homes by developing a theoretical model of managerial behaviour. We then try to validate these hypotheses by means of an empirical approach. In particular, we compare the performance of different institutional forms and try to disentangle time-invariant inefficiency from inefficiency that varies over time. Our theoretical model follows a bargaining approach (e.g. Schmitz, 2000). We model the interaction between management and governing body in nursing homes when the efficiency type and the managerial effort to reduce costs are unobservable to the regulator. The manager shares the objectives of the governing body depending on the nursing home institutional type. Building on Worthington and Dollery (2000), we hypothesize that managers responding to local governments face more constraints in pursuing efficient choices than managers in private law institutions. The model predicts that private law institutions are more likely to increase their effort in reducing costs since the disutility caused by unexpected costs (e.g. fund raising activity or managerial punishment) is higher and administrative constraints are lower as compared to public law forms.

For the empirical analysis, we estimate and compare cost functions under different institutional forms using three approaches. The first one includes a dummy variable in non-frontier models to capture the institutional form. This strategy is inspired by the observation that the institutional form does not change over time. The second approach follows a two-step strategy. Inefficiency scores are initially estimated from frontier models. The impact of the institutional form on the estimated inefficiencies is then tested through the Kruskal-Wallis test. Since constant inefficiency cannot be fully disentangled from other unobserved factors or sources of inefficiency, we consider a third approach where the dichotomous variable is directly included into the benchmarking frontier and the remaining net inefficiencies are interpreted as managerial skills. Overall, we find evidence that private law institutions are more cost efficient than public law nursing homes. The results are consistent across different econometric techniques.

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Have cost-containment policies affected hospital activity? Evidence from a panel of Italian hospitals

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Health Policy

Since 1992, several reforms have been introduced in the Italian health care sector, with the aim of improving efficiency of service provision while cutting total expenditures. Changes have been mostly related to the organization and delivery of services and to the reimbursement mechanism, although their implementation and structure have been highly heterogeneous across regions. This has been particularly true for the hospital sector, which absorbs about 50As a formal assessment of the effect of such changes does not exist, the aim of this paper is to evaluate to which extent the set of national and regional cost control policies implemented has affected hospital activities in terms of efficiency. Using a large longitudinal database of Italian hospitals over the period 1999-2007, we are able to study efficiency changes over time and by region and ownership status and to study the effects driven by merging activities, closure decisions, bail-out programs and demand pressure. We investigate these issues using a stochastic frontier approach, adopting a Bayesian inferential scheme. In stochastic frontier (SF) models the inferential performances of maximum likelihood estimator (MLE) heavily depends on the ratio between the standard deviations of the specification error and the inefficiency term. In all those cases in which the inefficiency term is preponderant in determining the random variability, the MLE presents significant convergence problems caused by the non regular shape of the likelihood surface. Moreover, sophisticated panel data models, such as the "true" SF specifications (Greene, 2005), are more intensely affected by high values of this ratio.

In order to overcome this methodological problem, for the first time in this literature, we implement the Bayesian variant of the true random effects estimator, which is less influenced by this type of data problems. Furthermore, we obtain consistent estimates of the inefficiency term by jointly estimating the technology and the mean inefficiency parameters. This approach allows us i) to disentangle across hospital unobserved heterogeneity from hospital inefficient behavior and ii) to provide more precise estimates of both technology and efficiency. Overall, our results show some degree of effectiveness of these policies in shaping hospital efficiency. In particular, we observe changes in the technical efficiency over time and the existence of non negligible level of heterogeneity by ownership status. Closure of marginal hospitals, merging activities and bail-out programs seem to be positively related to technical efficiency.

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Comparative analysis of referral and drug costs at the level of specialty: General medicine and geriatrics

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Health Policy

The aim of this paper is to compare a sample of English General Practitioner (GP) units at the Geriatric and General Medicine specialty level in terms of their referral and drug prescription costs. The cost comparison is done on a contextualized basis, where we use some proxy variables to account for the severity of the health conditions of inpatients and outpatients, and to account for the need of GPs incurring drug prescription costs. We use Data Envelopment Analysis (DEA) to compute cost efficiency measures of GP units and to decompose these measures into technical and allocative components. In addition, we also identify further sources of cost inefficiency related to prices. The results reveal a varying potential across GP practices for cost savings through volume reductions, switching between referral types and drugs and through seeking better unit cost profiles. This offers the potential to transfer cost saving practices from benchmark to other GP practices by type of savings available.

Stochastic frontier analysis of quality-adjusted cost-efficiency:

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Water and Waste Management

This paper models cost-efficiency in waste collection management in the Netherlands between 2005-2008, using data on Dutch municipalities. With both translog cost functions and stochastic frontier analysis cost-efficiency in the waste management is estimated. The panel-data structure allows disentangling time-effects from cross-level effects, simultaneously estimating both. A first extension considers quality-adjusted prices by incorporating service level and environmental effects. A second extension of the model addresses the potential endogeneity of the decision of municipalities to contract out waste collection and which price system to use. These extensions contribute to the cost-function literature, which is dominated by estimation of simple cost-functions under the assumption of exogenous regressors, see also the overview of Bel and Warner (2008). Waste management is a large and important sector, see OECD (2000). In many developed countries, including the Netherlands, government has a legal obligation to collect waste. Furthermore it is a large sector with in the Dutch case over 100 firms, 600 municipalities -which are responsible for waste collection- and yearly costs summing up to two billion euros. The efficiency effects of three types of variables are estimated. The first category consists of covariates that are directly influenceable by municipalities. These include the decision to contract out waste collection (to either a private or public company), which collection method (f.e. frequency) to use and how to use price incentives to stimulate inhabitants to separate waste. The second type of regressors are not directly influenceable by municipalities but are affected by government policy, in particular the degree of market competition in the waste collection sector. There is a trade-off here between scale economies, exploitation of which leads to some market concentration, and avoiding market power, which calls for a substantial number of waste collection firms (see Dijkgraaf and Gradus (2005)). These scale economies are determined by relating costs to the number of inhabitants. The third category consists of control-variables that for all practical purposes cannot be influenced by policy, such as density of the population, region, average income of inhabitants and number of people per household. The first preliminary results show that costs vary substantially across municipalities. Costs per inhabitant are positively and significantly related to the volume of waste treated. Furthermore, urban areas have higher costs, and contracting out waste collection hardly has an effect on costs. The final results will be related both to the substantial and evolving international literature on efficiency in the waste management sector and to the discussion on cost-efficiency, quality, privatization and innovation in the public sector, as the results are relevant for both.

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Consolidating the Water Industry: An Analysis of the Potential Gains from Horizontal and Vertical Integration in a Conditional Efficiency Framework

Michael Zschille
Water and Waste Management

The German water supply industry usually is regarded as being highly fragmented, thus inhibiting high potentials for efficiency improvements through profound consolidation. The current structure of high fragmentation has developed for political reasons due to the federalistic structures in Germany. However, there are now claims for a consolidation of the entire German water industry, e.g. from the German Monopolies Commission.

We provide a profound analysis of the potential gains from horizontal and vertical integration of the German water industry based on a Data Envelopment Analysis (DEA) approach. The paper yields evidence on two important aspects of water industry restructuring: First on horizontal integration being discussed in different countries with similarly fragmented water industries, and second on vertical separation plans relevant for the highly consolidated English and Welsh water industry. We thereby extend the literature on conditional efficiency approaches.

We apply DEA to analyze the potential gains from horizontal mergers between neighboring water utilities and from vertical integration between water production and water distribution companies based on an approach proposed by Bogetoft and Wang (2005). The analysis is based on a dataset of 653 German water utilities in 2006. A production model with the network length and the number of employees representing capital and labor inputs is used. Outputs are the amount of water delivered to final customers, the amount of water delivered to other water utilities and the number of connections to the customers. Structural variables with a significant impact on efficiency are detected based on a bootstrapped truncated regression analysis (Simar and Wilson, 2007). To take into account those structural variables appropriately, we apply a conditional efficiency framework to calculate efficiency scores given the operating environment (Daraio and Simar, 2007). A conditional super-efficiency analysis is used for the detection of potential outliers. We analyze 87 cases of horizontal integration and four cases of vertical integration.

The results show that all cases of horizontal integration would lead to substantial efficiency gains. The decomposition of the overall gains shows that those improvement potentials are based on learning effects within the integrated companies, harmonization effects in the production plans and to a smaller extent also on scale effects. Vertical integration appears to result in substantial efficiency improvement potentials in three out of the four analyzed cases. Those improvement potentials are based on learning effects and on harmonization effects that outweigh negative scale effects. Based on our results, a consolidation of the German water supply industry thus appears to be beneficial under efficiency aspects. Our results however only represent potential gains from mergers. Decisions for mergers of course need to take into account the individual circumstances in the water utilities like different firm cultures or the political environment.

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The cost of recycling in municipal solid waste service: heterogeneity, size and diversification

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Water and Waste Management

In the last decade, with the implementation in Italy of the main European directives on urban waste, a process of radical transformation of the sector has started. The driving force of the reform concerns the accountability of local municipalities on the whole cycle of waste management. In particular, the definition of Optimal Territorial Areas (OTAs) has created in many cases management systems suitable to support efficiency levels that small and medium-sized municipalities would not be able to cope on their own. The recent amendments, which provide for the elimination of OTAs, would seem to fundamentally change the course of aggregation and integration laboriously conducted so far, with a return to fragmentation and "in-house" management forms. A supply-side analysis supporting the policy-makers in the configuration of the sector seems therefore particularly useful.

This study is based on the estimation of a cost frontier at the municipal level concerning the phases of collection, treatment and disposal of waste, with particular attention to the presence of economies of scale and the impact on costs of the process of increasing the share of recycling waste. The analysis of the role of size and, in parallel, the cost of waste separation is particularly delicate, as it is strongly influenced by environmental factors, model of governance (inter-municipal consortium, independent multi-service or single-service firm) and also political decisions (proxied by the political colour of local administrations). The study therefore intends to consider simultaneously different cost drivers, comparing several frontier models, all encompassing a control for heterogeneity.

The data used were collected from Eco-Cerved, which is a database powered annually by Italian municipalities through a survey of information on treated volumes for disposal and recycling as well as costs of service. In this case, the selected information concerns around 400 Italian municipalities for the years 2004, 2005 and 2006. Several panel data cost frontier models were estimated that incorporate diverse specifications for inefficiency and unobserved heterogeneity terms, the latter being evaluated at the group level (latent class model, meta-frontier approach) and at the firm level (panel data models, true fixed and random effects). A comparison among the different approaches, discussing the contribution of each of them to the specific analysed context, is also provided.

To date, only few national and international studies dealt with this topic and the investigation results would seem contradictory, albeit with a convergence about significant savings for the small size. With regard to the impact on costs due to the share of recycling on total waste, publications are very limited. Initial estimates were conducted by combining the overall costs of collection, treatment and disposal of waste to total quantities, prices of productive factors and some environmental variables. Overall, significant cost savings related to population density and weak economies of scale would seem to emerge.

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Rate Regulation and the Le Chatelier Principle

Gerald GRANDERSON, Finn Førsund

Regulation II

This paper examines whether rate-of return regulation alters the input quantities firms use to produce their selected output level when the corresponding input prices change, in a manner that reflects the Le Chatelier Principle (does the Le Chatelier principle hold for firms subject to rate-of-return regulation). The Le Chatelier principle states that for variable inputs, a change in the input quantity due to a change in its input price in the short-run is less elastic than the change in the input quantity due to a change in its input price in the long-run. With rate regulation, regulators set an allowed rate of return the firm can earn on capital. The allowed rate is

assumed to exceed the financial cost of capital, but is less than the máximum rate the firm can earn if not regulated (the monopoly rate).

Färe and Logan (1983) showed that rate regulation can limit the input combinations a firm can use to produce its selected output level. An extension of the Le Chatelier principle for the rate regulated firm would hypothesize that (i) a change in the short-run derived demand for an input due to a change in its input price would be less price elastic than a change in the long-run derived demand for an input following a change in its input price, and (ii) a change in the input quantity due to a change in its input price under a binding regulation constraint would be less price elastic than a change in the input quantity due to a change in its input price when the regulation constraint is not binding (firms under a binding regulation constraint operate on the rate regulated cost function, while firms under a non-binding regulation constraint operate on the unregulated cost function: the rate regulated cost function lies above the unregulated cost function).

For example, the unregulated firm has an incentive to substitute other inputs for capital when the price of capital rises. The rate regulated firm has little incentive to substitute from capital to other inputs when the price of capital rises. This is because using less capital reduces the allowable profits the regulated firm can earn. Thus, the unregulated elasticity of capital with respect to an increase in the price of capital is likely to be more price elastic than the rate regulated elasticity of capital with respect to an increase in the price of capital (a Le Chatelier principle effect). Theoretically, rate regulation provides the firm with an incentive to substitute towards capital when the price of non-capital inputs rise. Thus, with regards to non-capital inputs (substituting a non-capital input for another non-capital input), theoretically, the unregulated own-price and cross-price input elasticities of demand may be more price elastic than the corresponding rate regulated own-price and cross-price input elasticities of demand.

To test for the Le Chatelier principle under rate regulation, we follow Färe and Logan (1986), Nelson and Wohar (1983), in estimating a translog rate-of-return regulated cost function. The rate regulated cost function is used to compute regulated own-price and cross-price input elasticities of demand. Following Färe and Logan (1986), the unregulated cost function is derived from the rate regulated cost function. The unregulated cost function is used to compute the standard (unregulated) own-price and cross-price input elasticities of demand. The data sample is a panel of 34 U.S. investor owned electric utilities from 1992 to 2000.

Using stochastic frontier analysis to inform utilities regulation, with an application to the water and sanitation sector in Brazil

Celine NAUGES, Christopher O'Donnell

Regulation II

In the water and sanitation sector where utilities act as local monopolies there is limited scope for direct competition between providers. As a consequence, service operators may not always have an incentive to adopt best practice. In order for the regulators to assess what best practice should be, benchmarking and performance comparison are traditionally called for.

Measures of cost economies and calculation of total factor productivity (TFP) indices are common tools to analyse and compare performances among a group of utilities (Saal, Parker and Jones, 2007; Seroa da Motta and Moreira, 2006). In this paper, we propose to estimate a parametric cost frontier using data from Brazil. Parametric cost frontiers allow estimation of cost economies while controlling for utilities' technical efficiency. Another nice feature of this model is that the estimated coefficients can be used to calculate the minimum cost of operation of each utility with a corresponding 95

The empirical illustration involves analysis of panel data over the 2004-2008 years. Brazil provides an interesting case study because of the on-going (long-lasting) debate on the management of water utilities and in particular the choice of state (or regional) versus municipality-operated utilities. Today around 80% of the population are served by 26 state-wide firms. The rest of the market is served by local operators. State companies are believed to perform

poorly compared with their municipal counterparts, which tend to be more profitable, despite the fact that state companies typically level higher user charges. State companies argue that this is partly due to the fact that they cover rural areas where service delivery is costlier. The latter is perceived as an issue in Brazil for the main reason that the poorest population, which mostly live in rural areas (and is served by state companies), ends up being charged a higher price for water than the population living in urban areas (which is also wealthier on average).

In this paper we show how the estimation of a parametric cost frontier allows analysts to obtain a number of meaningful measures of performance including the minimum cost at which each utility could operate. Comparisons can then be made between state- and municipality-operated companies, between private and public utilities, across different regions, and across water-only and water and wastewater utilities. We also show how the estimated coefficients can be used to calculate the marginal costs of providing particular services by particular utilities, which can then be compared to the prices charged to customers by the utilities. The findings of this study should thus be useful for the Brazilian regulators and provide insights to enlighten the debate regarding choice of municipal versus state-wide companies.

We believe that the contribution of this paper goes beyond the analysis of the Brazilian water and sanitation sector. It should be useful to regulators in general in a context of increased reliance on benchmarking and information on core cost and performance of water supply and sanitation utilities.

Measuring Returns to Scale in DEA Models when the Firm is Regulated

Pierre OUELLETTE, Jean-Patrice Quesnel, Stéphane Vigeant

Regulation II

Regulation is an everyday reality of the firm. In this paper we address the important question of measuring returns to scale when firms are regulated. We find that the standard formulas do not apply. In the standard framework of data envelopment analysis (DEA) models, the returns to scale are fully characterized using the multiplier on the convexity constraint of inefficient decision making units (DMU) using the projection of the input-output vector on the frontier. In this paper, we investigate how the returns to scale measurements in DEA models are affected by the presence of regulatory constraints. These additional constraints change the role played by the convexity constraint. In order to avoid biased estimation of the returns to scale, we show that the interaction between the regulatory and the convexity constraints has to be taken into account.

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Productivity development in electricity distribution - the local grids in Sweden 2000-2009

Göran Ek

Energy

A review of the productivity development in the electricity distribution industry in Sweden is important because it will give possibility to compare the design and application of the system of economic regulation with the outcome of the grid companies regarding productivity.

Two models are applied for the study. The first model for the measuring productivity consists of seven variables. Operative cost as input and six products (distributed energy and number of customers both divided in high and low voltage, maximum load for the year to the upstream grid and the total length of the grids lines. The other model is the operative cost substituted by total cost (operative cost plus capital cost).

The methods applied are the Data Envelopment Analysis (DEA) combined with Malmquist productivity index. The number of grids participating in the panel consists of 154 firms. The 10 year panel data base have in total 1540 observations.

In order to check the results a translog regression estimation will be done. For that exercise we use the SFA estimation technique.

The productivity development is then compared to the change in tariffs to see if productivity gains are shared with the customer.

Market Reforms and The Performance of The Electricity Industry in Malaysia

Kok Fong SEE, Tim Coelli

Energy

The empirical study is aimed to identify the performance difference between Malaysian and international electricity generating companies. The data involved 190 annual observations across 65 electricity generating companies in six different Asia Pacific countries (the United States, Australia, Singapore, South Korea, Thailand and Malaysia) that were collected from 2003 to 2005. The stochastic frontier and technical inefficiency effects model is employed in the study, involving two input variables (i.e., nameplate capacity and implicit quantity of operating inputs), one output variable (i.e., electricity sent-out) and three explanatory variables (i.e., private ownership, plant age and year of observation). Our analysis finds that Malaysian electricity generating companies are relatively efficient in comparison to the selected international electricity generating companies, with a mean technical efficiency score of 0.87 relative to a mean technical efficiency score across all utilities of 0.79. The empirical results may be explained in a number of ways. First, one could argue that the superior performance of the Malaysian plants is perhaps a consequence of the use of second best data (i.e., aggregate input variables and approximate price deflators). Alternatively, the empirical results may be reliable and hence some commentators may argue that further market reform is not necessary. However, this conclusion should not be drawn until better quality data can be organized and additional analyses conducted.

Regulations and performance in Dutch network sectors. The effect of liberalization on costs development in 1985-2009

Jos Blank, Adrie DUMAIJ, Alex van Heezik, David Hollanders

Energy

The Dutch government has been working towards liberalization of the market in public network sectors since the late 1980s in order to increase productivity with the expectation of better quality of services and lower prices. Although these objectives have been analysed by empirical studies for different networks separately (electricity: [1]; gas: [2]; water supply [3]; telecommunications; rail transport), no systematic inter-sectorial studies have been carried out. This paper examines the effects of liberalisation on productivity in four Dutch network sectors. In contrast to the mainstream productivity analyses we focus on long term productivity changes by applying parametric

techniques to time series. Since the observations for different sectors can be regarded as cross-sectional observations, the data set can also be seen as a quasi-panel data set. This allows us to construct an inter-sectorial productivity frontier and to add a new dimension to sectorial-economic analysis. We also identify characteristics of market structure and market regulations and establish the effects of these variables on productivity change. The variables are taken in differences to eliminate autoregression and modeled by a translog cost function, including prices, service levels and market characteristics. We construct the quasi-panel data set for railroads, energy, water supply and telecommunications in the period 1985-2009. Three main regulation periods were identified for each of the sectors (government regulation period, enforcing liberalization period, and regulated competition period). The preliminary outcomes show that frontier analysis can be very well applied to inter-sectorial comparisons. Further, it shows that productivity generally declined in all sectors and prices increased. In particular, in the water and railroad sector the decline of productivity was substantial. It therefore appears that market regulation did not contribute to an improvement in productivity change.

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A decomposition of the determinants of economies of scope: with an application to vertical integration in the US public electric utility sector

Pablo AROCENA, David Saal, Thomas Triebs

Energy

Together with scale economies, economies of scope (or synonymous concepts like synergies and diversification economies) are fundamental to the economic analysis of firms and markets. Thus, from a managerial perspective, the presence of such economies largely justifies strategic managerial decisions with regard to the horizontal and vertical boundaries of the firm. Moreover, from a regulatory perspective, economies of scope are not only an important determinant of the efficient configuration of an industry, but also influence the potential for introducing workable market competition into utility industries such as gas, electricity, and telecoms. Given their importance and implications it is not surprising that a large number of past studies have investigated the presence and the degree of scope economies in a variety of industries. Most papers of this vast literature measure scope economies after estimating a cost function, while Stochastic Frontier Analysis and Data Envelopment Analysis are employed to a much lesser extent. Though the use of nonparametric frontier models has been comparatively less explored, several variants of Färe's (1986) seminal approach have been applied to the estimation of scope and diversification economies in diverse industries, e.g. the provision of local public services, banking, hospitals and electricity. However, with the notable exception of Chavas and Kim (2007, 2010), virtually no attempt to decompose scope economies, and thereby better understand its determinants, has been made. This paper therefore provides a decomposition of scope economies measure into four components: a price effect, a quantity effect, an input mix effect, and a scale effect. Moreover, we illustrate our decomposition by examining the economies of vertical integration in a sample of public US electric utilities by means of non parametric frontier analysis. The electricity industry, as other network industries (e.g. water, gas), has been subject to fundamental reforms worldwide, which have fostered the vertical separation or unbundling of several stages of the business. Our analysis of vertical scope economies and its sources therefore has important policy implications for our understanding of the impact of such reforms as well as on the direction of further industry restructuring.

Management Practices and Firm Efficiency

Thomas TRIEBS, Subal C. Kumbhakar
Management and Sport Efficiency

The objective of this paper is to account for observed management performance in the estimation of a production function and firm efficiency. It is widely acknowledged that management is an important though generally unobserved input for production. Production models include management as part of the residual (e.g. Stochastic Frontier Analysis), time-invariant firm fixed-effects or most recently time-varying random effects (Alvarez et al. 2004). Even though the latter allows estimating the firm specific level of management it remains unobserved and therefore its measurement and its impact on production and efficiency is model specific. The direct measurement of management practices by Bloom & Van Reenen 2007 allows the inclusion of management as an observed input. They find a significant positive correlation between sales and management in an "average" production function setting. They also find that competition, family ownership, and the country where the firm operates are drivers of management practice. We propose a range of models that with increasing flexibility include management as an input and/or an explanatory variable for efficiency.

When modelling a production function and efficiency explanatory variable can enter as inputs, explanatory variables for the distribution of efficiency, or as explanatory variables for the coefficients. Our first model includes management as a separable input into the production function where the constant is replaced by observed management performance indicators and the inefficiency term is interpreted as deviations from best-practice management performance. Second, we allow for interactions between traditional inputs (i.e., capital, labour, and materials) and management performance as well as management as an explanatory variable for the distribution of inefficiency. We will test whether management performance is an input, determines inefficiency, or both. Third, we will allow management to influence the coefficients of the traditional inputs either using a two-step model where coefficients are linear functions of management performance or a semiparametric smooth coefficient model which increases flexibility further (Q. Li et al. 2002). The last model allows for the interpretation of management as a facilitating input that unlike traditional inputs is not necessary to produce a minimum of output.

The data is taken from Bloom & Van Reenen 2007. It is a sample of 732 medium-sized manufacturing firms from the United States, the United Kingdom, Germany, and France for the years 1996 to 2004. The data for firms' management practices was collected in 2004 through surveys and therefore is time-invariant. The data distinguishes four management practice types: operations, monitoring, targets, and incentives. The scores for each type are based on numerous questions designed to extract information on how the firm manages the various activities. The original survey data is scaled 1 to 5 where the higher the score the better the firm's management practice. Additional variables include sales, capital, labour, and materials which we will use as inputs and outputs for the production function as well as a host of other explanatory variables like ownership firm and firm age.

Following the results Bloom & Van Reenen 2007 we expect management to have a positive impact on firm performance. Our results will allow us to quantify the relative impact of management on the production function and efficiency. A better understanding of how management influences production will help firms and regulators to design better incentives.

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Expectations with Unrealistic of Optimism: An Empirical Application

Humberto BREA, Emili Grifell-Tatjé, Luis Orea
Management and Sport Efficiency

Several studies claim that people have a tendency of being overoptimistic (Coelho; 2010; Lovallo & Kahnenman, 2003). Furthermore, some researchers suggest that optimism could be revalent in managers as a result of the selection process (Heaton, 2002). Nevertheless, there is very little literature about the subject of optimism and managerial decisions. (Coelho,2010). In this study we present a frontier model of expectations with an optimistic bias based on the adaptive expectation model. In our framework optimism is considered as a positive random term which skews expectations from a normal forecast based on rational assumptions. We model investment decision based on expectations about key variables such as sales or cash flow. We posit that managers' skewed viewpoint of reality make them commit systematic mistakes when deciding the investment levels of their firms.

An application of the empirical model in the context of the American retailing industry is provided We expect that all firms will exhibit some degree of "excess of optimism" but more successful firms will show moderate levels. This paper contributes to expand the literature about unrealistic optimism as well as apply productivity and efficiency techniques in the management field.

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EVALUATING FOOTBALL CLUBS PERFORMANCE WITH NETWORK DEA TYPE MODELS: EVIDENCE FROM THE GREEK LEAGUE

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Management and Sport Efficiency

In this paper, we provide comparable results from three network DEA type models about the athletic or on-field performance of football clubs participating in the Greek league using data for 10 consecutive seasons (1998/99 to 2007/08). The evaluation takes place at two activity levels: the first level involves the offensive and defensive operations and the second the final ranking at the end of the season. Two of the models (Garcia-Sanchez, 2007; Seol et al., 2007) evaluate the offensive and defensive performance of the teams separately. For the offensive operation, goals scored are used as an output and the number of shots and headers, the number of crosses and the number of assists as inputs. For the defensive operation, the inverse of goals conceded is used as an output and the number of saves, the number of clearances and the number of steals as inputs. The third model (Sexton and Lewis, 2003) considers the activities of the first level as a joint process with two outputs and six inputs. At the second level, the three models follow quite different routes: the first model (Garcia-Sanchez, 2007) uses the efficiency scores of the first level analysis as inputs and the accumulated points at the end of the season as an output. The second model (Seol et al., 2007) adopts constant input set up and uses the efficiency scores of the first level analysis as outputs. Finally, the third model (Sexton and Lewis, 2003) uses the outputs of the first level (i.e., goals scored and inverse of goals conceded) as inputs in the second level and the accumulated points at the end of the season as an output. We examine whether the three models considered result in significant differences in efficiency scores, the characteristic of their distribution as well as the ranking of teams.

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Steroids in Major League Baseball

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In this paper, we analyze the performance of select major league baseball players using nonparametric frontier estimation. All players in a given season are evaluated relative to each other. Measuring performance for each player in each season, we construct an age-performance profile. Profiles of players in the pre-steroid era are compared with known steroid users.

Heterogeneity of the age-productivity and age-wage pattern with regard to sector affiliation

Bernhard MAHLBERG, Inga Freund, Alexia Prskawetz
Labor Productivity

Demographic change in industrialized countries will have profound consequences for the economic sustainability in the years to come. Low levels of fertility and increasing survival to old age, accompanied with moderate levels of migration, will imply a pronounced ageing of the population and at the individual level. While individual ageing may be argued to be a success story with rising number of years experienced in good health, population ageing is associated with negative consequences for the financial sustainability of prevailing social security systems. The process of ageing becomes apparent, when having a look at the figures for Austria in 2009 as well the projections until 2030: The median age of the population will increase from 41.3 to 45.4 years and the proportion of the population aged 65+ increases from 17.4 percent to 24.1 percent. Thus, half of the Austrian population will be older than 45.4 years and about one quarter will be at least 65 years old in less than 20 years from now. Moreover, the old-age dependency ratio will rise from 25.7 percent to 39.4 percent; meaning that instead of four persons at working age it will be no more than two and a half taking economically care of one "old" individual. But what will happen, if the labor force itself, i.e. the output producing and overall supporting entity, ages?

Based on a yearly balanced panel data set for Austrian firms ranging from 2002 to 2005, we analyze whether the employees' age distribution is correlated with labor productivity in an average firm. The data set covers 19,633 firms per year, which is approximately 7 percent of the Austrian firm population in the investigated sectors and accords to about 66 percent of value added as well as around 56 percent of overall employees. It encompasses the economic branches of production and selected sections of the service sector.

As we will present, the sector affiliation of a firm plays an important role for the age-productivity/ - wage relation. On the one hand, different working tasks in various economic areas also require an individual mix of skills potentially leading to distinct age-productivity/ -wage schedules. On the other hand, the more conservative seniority wage schemes are less common in more advanced industries. In concrete terms, we find that, while the negative

wage (and productivity) correlation emanating from the share of young employees is rather robust, the results with regard to the share of old aged employees are quite differentiated and insightful: The seniority wage effect is obviously prevalent in industries belonging to the secondary sector, whereas the positive productivity contribution of employees aged 50 years and above predominantly arises from tertiary sector industries. Considering, that the service sector, where we do not find older employees to be over-paid, comprises a still expanding sector - while the overall industrial and constructional sector may be characterized as slightly more traditional -, these results might imply that in the future an ageing workforce might not necessarily imply overpayment and lower productivity.

Another decomposition of aggregate labor productivity growth

Giannis KARAGIANNIS

Labor Productivity

This paper develops a decomposition of aggregate labor productivity growth based on the production possibility frontier approach, the gross output measure of the industry labor productivity, and Domar weights to aggregate them. Aggregate labor productivity growth is attributed to the direct productivity effect, the labor reallocation effect, and the material intensity (deepening) effect. The relative contribution of the productivity effect may be larger than we thought because previous decompositions ignore the indirect effect of industry-level increases in labor productivity, which is associated with the possibility that part of an industry's gross output is used as an intermediate input by the other industries. In addition, the relative importance of the reallocation effects would be smaller than it was though once we account for indirect effect of industry-level increases in labor productivity as we end up with only the labor reallocation effect and instead of the materials reallocation effect we have a substitution effect dealing with material deepening.

An unbiased estimation of a wage frontier and its evolution over time

M Jose PEREZ-VILLADONIGA, Ana Rodriguez-Alvarez

Labor Productivity

One of the main areas of research in Labour Economics has been the human capital theory and the estimation of wage equations, that was first postulated by Mincer (1974). Traditionally, empirical studies have estimated wage regressions, focusing on mean earnings rather than potential earnings, not following the theoretical concept of a production function, i.e. to obtain the maximum potential given the available resources. In this respect, recent studies have proposed the use of alternative techniques, such as production frontier methodology to obtain a wage frontier, this is, the maximum wage that can be obtained with a given human capital (Jensen, 2006 among others).

The concept of potential earnings can be understood within the neoclassical theory of investment and production. Investment in human capital, such as schooling or labour market experience, represents the input that will be transformed into the wage perceived by the worker (output) given the observed characteristics that determine it. Issues such as the type of market in which the worker operates and whether there are information problems should be taken into account in the analysis. The frontier analysis of this productive process can be used to compute the (in)efficiency in the transformation of human capital into earnings.

The inefficiency measured this way could be attributed to employers' discrimination. Several authors, as Robinson and Wunnava (1989); Hunt-McCool and Warren (1993), Dawson et al. (2001); García et al. (2002) and Díaz and Sánchez (2007) have used this frontier methodology to analyse wage discrimination by gender and/or nationality.

Following the previous methodology, in this paper we will estimate a transformation function, with a stochastic frontier approach, to measure and explain (in)efficiency in the transformation of workers' human capital into wages and analyse its evolution over time. Furthermore, and in contrast to previous work, we try to develop a theoretical framework to study this issue.

In this sense, the idea of introducing assumptions on workers' behaviour is important both from an economic and an econometric perspective. Workers are economic agents and so are maximizers. Hence, given the technology, the amount of inputs (such as education or experience) is determined through the worker's objective function. Then, the chosen amounts of inputs are endogenously decided. This theoretical endogeneity will cause econometric problems of endogeneity, and the estimated coefficients will be biased. In this study we propose a new methodology (based on the model of Kumbhakar, 2010) that allows (still recognizing theoretical endogeneity) to estimate technology circumventing these econometric problems.

With this methodology proposed, we seek to obtain unbiased estimates of the wage frontier to explain inefficiency in achieving the maximum wage given the worker's productivity and given the restrictions faced by the worker, both individual restrictions and market restrictions. Moreover, starting from the Batesse model Coelli (1995), we will be able to explain such inefficiency as a function of a set of variables, analysing whether there are systematic differences among groups of workers (attending to their gender or nationality) and its evolution over time. In order to do so, we will use the panel provided by the Spanish Continuous Sample of Labour Lives (Muestra Continua de Vidas Laborales) 2009.

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An Application of Data Envelopment Analysis to Measure Technical Efficiency on a Sample of Irish Dairy Farms

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Dairy Farms

Since joining the European Union (EU), Irish milk production has been regulated by Common Agricultural Policy (CAP) through market support and the milk quota regime. The policy reform between now and 2015 will create significant opportunities for Irish dairy farmers, facilitated by the allocation of additional quota paving the way for its removal by 2015. This will allow for expansion unlimited by quota for the first time since milk quotas were introduced. In order for dairy farmers to prosper post quota they must become more efficient. The aim of

this study was to determine the levels of technical efficiency on a sample of Irish dairy farms utilizing Data Envelopment Analysis (DEA) and to identify key management and production factors that differ between efficient and inefficient producers. DEA is a non parametric method of efficiency analysis that employs linear programming to estimate the 'best practice' production frontier. Efficiency scores in DEA are censored between 0 and 1. DEA was subsequently used in this study to generate technical efficiency scores under both constant returns to scale (CRS) and variable returns to scale (VRS) assumptions. Data was provided from the National Farm Survey (NFS) for 2008, which is an annual survey of 1,200 Irish farms weighted by size and system to represent the total population. Subsequently, a randomly selected sub-sample of 190 specialist dairy farms was selected. The inputs used in this analysis were land area in hectares, average cow numbers, physical quantities of labour, concentrate and fertilizer and other direct and overhead costs. Output was expressed as kg of milk solids and included total milk solids produced and a milk equivalent of other farm output from subsidiary farm enterprises. Technical efficiency scores were generated on a whole farm basis. The average technical efficiency scores were 0.785 under CRS and 0.833 under VRS showing that Irish dairy farms were on average technically inefficient in 2008. Key production characteristics of efficient and inefficient producers were compared using an analysis of variance, PROC GLM in SAS to determine what was causing differences in technical efficiency. Technically efficient producers were defined as efficient with a score of 1, therefore efficient producers with a score of 100% were compared to technically inefficient producers with a score of $<$100%. Efficient producers used less input per unit of output, had higher production per cow and per hectare in terms of total output and had a longer grazing season, higher milk quality standard, were more likely to have participated in milk recording and had greater land quality compared to the inefficient producers.

Modelling the impact of climatic risk on dairy production: A case study of Florida and Georgia

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Dairy Farms

In spite of agro-technological advancements, global climate change is a growing challenge to agricultural production particularly to livestock enterprises. Dairy cows need an optimum range of atmospheric conditions to be most productive while temperature and humidity impose heat stress problems. Droughts can also impact grazing activities and thus dairy production. As a consequence, modeling climate risk and potential climate change impact on agricultural production have become issues of utmost importance. A sizable volume of work exists in the field of productivity and efficiency analysis for dairy farmers. However, proper treatment of climatic conditions and risk is absent in this literature.

This paper aims to contribute to the literature by examining the link between dairy productivity analysis and climate risk. The main purpose of this paper is twofold: (i) to propose a two step modeling framework to model potential climate change impact on milk production; and (ii) to determine the best model to characterize the dairy production technology.

We take the following steps to accomplish our objectives. First, we determine the 'best-fit' functional form for dairy production, incorporating climate variables. The Equivalent Temperature Index (ETI) is used to measure heat stress. We apply two commonly used indices to measure drought conditions: the Palmer Drought Index (PDI); and the El Nino Southern Oscillation (ENSO). In step two, ETI, PDI, and ENSO are separately modeled in a Box-Jenkins time series framework and cumulative logit framework respectively. Next, we carry out a forecasting analysis, integrating the models from step one and two. Our benchmark is the widely used Battese and Coelli (1995) stochastic frontier model. All these models are fitted and the corresponding model parameters are estimated under non-informative priors in a Bayesian framework, to make non-nested model comparisons straightforward through the Deviance Information Criterion (DIC).

We utilize an unbalanced panel of 406 observations (103 dairy farms, 14 years) from Florida and Georgia in southeastern US. Matching data on atmospheric variables (temperature, drought, humidity) come from the National

Climatic Data Center of the National Oceanic and Atmospheric Administration.

Our results provide information concerning the relative importance of the various components of productivity growth as well as the impact of atmospheric variables. The coefficients of climatic variables indicate the extent to which dairy farmers might be affected by climate change. Such results can be valuable to farmers and policy makers for designing mitigation strategies. Suggestions that might emerge concerning avenues to increase efficiency would also be helpful to farmers as well as policy makers.

TE scores indicate that most of the dairy farms are highly efficient and inclusion of climatic variables raises TE scores. Thus, the results suggest adverse climatic condition is a source of farmer inefficiency and a negative relationship exists between productivity growth and climate change.

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Productivity and profitability change on Finnish and Norwegian dairy farms: Does EU membership matter?

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Dairy Farms

Norwegian and Finnish agriculture and agricultural policy have shared several common features in the past. Since 1995 these countries have followed different routes. Finland joined the European Union but Norway decided to stay out of it. Although Finland started to follow EU's common agricultural policy, national exceptions have also been allowed. Anyhow, the accession of Finland to EU followed an immediate decrease in product prices and an increase in direct payments. Norway has been able to create her own policy, which of course has reflections from the CAP and the WTO negotiations. Differences in the economic and institutional environment of agriculture may have affected productivity and profitability of farms directly and/or indirectly via changes in the behavior of farmers.

The objective of this paper is to test whether Finland's joining to the EU led to a divergence in technological, efficiency and profitability change between Finnish and Norwegian dairy farms. The Finnish accession into EU required considerable strategic adjustments from farmers and in the whole food chain. It altered the preconditions of agri-food sector in ways that are expected to have a significant influence on the development of productivity and competitiveness. The extent and speed of this change together with long term farm level data provides a unique opportunity for such a study. A comparison between Norway and Finland is facilitated by similarities with respect to the industry structure before the accession and harsh natural conditions.

One of the main analytical challenges of this study is, whether it is possible to isolate the effect of the EU-membership from other influential factors. Are differences, if any, in technological and efficiency change between Finland and Norway really caused by the EU membership and related changes in agricultural policy, or are they caused by other factors like macro-economic conditions? The starting point of the analysis is to estimate the patterns of these growth rates, to find possible differences first and when such differences emerge we search for possible sources for this divergence.

We apply a farm level unbalanced panel data of Finnish and Norwegian dairy farms for the period from 1991(89) to 2008. The data cover sufficiently long period before and after the Finnish EU-accession. Several methods are available for the analysis and decomposition of productivity/profitability change. Because of the nature of agricultural production, the stochastic frontier framework with several inputs and outputs is preferred for the presentation of technology. Input distance functions are used in defining TFP growth and its components, because in both countries the quota system has been effective. Actual price changes are used to recover the price effects in profitability change.

Productivity Growth Within and Between Seven European Union Countries: An Analysis of Dairy Farms Using Stochastic Input Distance Functions and Meta-frontiers

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Dairy Farms

The general objective of this study is to examine total factor productivity growth in multi-output farms, in which dairy is the major activity, located in countries that are members of the European Union (EU). In particular, we are interested in comparing productivity growth between and within countries. To this end, we examine whether countries share the same technology or not. We then address the following question: Are subsides provided to farms in the frame of the Common Agricultural Policy of the EU productivity enhancing or not?

This paper uses data from the European Farm Accountancy Data Network (FADN) for seven EU countries for the 18 year period going from 1990 to 2007. The countries included are: Denmark, France; Germany; Ireland; Spain; the Netherlands; and the United Kingdom. The FADN database consists of yearly accounting information for professional farmers, rotating over several years, typically five; therefore, the data sets are unbalanced panels. All individual country data sets contain farms where at least 66

We choose a stochastic input distance frontier (IDF) contending that farmers have relatively more control of inputs than outputs as recently articulated by Kumbhakar et al. (2008). The first step in the estimation process is to obtain individual country stochastic IDFs and then the data for all countries are pooled and a common stochastic IDF is estimated. This pooled model makes it possible to test formally for differences between the group frontiers using a generalized likelihood-ratio test. The individual and pooled models are estimated using the Battese and Coelli (1995) framework. Alternative specifications concerning the channels by which subsidies affect productivity are estimated and contrasted.

The hypothesis that all countries share the same technology is rejected so a meta-frontier, which envelopes the individual country frontiers, is estimated using linear programming techniques (O'Donnell et al., 2008). The specification of the meta-frontier is the same as for the individual and pooled models except that in the former the inefficiency effects component is dropped. Once all models are estimated the individual country frontiers are used to calculate total factor productivity growth and the estimated meta-frontier is used to perform comparisons of Technical Efficiency, Economies of Scale and technological gap ratios across countries (O'Donnell, et al., 2008) over different dimensions (e.g., time; farm size; policy regimes) and model specification. Some key results indicate that TE is relatively high across countries, EOS are prevalent, and that model specification does have an effect on how subsidies affect productivity growth.

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