EWEPA Algarve 2024

XVIII EUROPEAN WORKSHOP
ON EFFICIENCY AND
PRODUCTIVITY ANALYSIS
FARO, JUNE 18-21 2024

BOOK OF ABSTRACTS

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Book of ABSTRACTS

Tue|14:00-15:30 | Aud. - Plenary Early Career Day

Chair/Discussant: Chris Parmeter

EFFICIENCY AND PRODUCTIVITY ANALYSIS FROM A SYSTEM PERSPECTIVE: HISTORICAL OVERVIEW AND POSSIBLE FUTURE DEVELOPMENTS

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The last decade has witnessed an exponential proliferation of studies on Network Data Envelopment Analysis (NDEA) as a tool to measure efficiency and productivity for production systems. Those systems are composed of various layers of decision making (hierarchically organized) and potentially interconnected production processes. The decision makers face the problem of allocating resources to the various production processes in an efficient manner. In this presentation I will present the main ideas behind this approach, its epistemological foundation, some simple models and examples, and prospective future avenues of research.

Tue|16:00-18:00 | Aud. - PhD student's presentations

Chair: Antonio Peyrache

FROM TERROIR TO QUALITY: HANDLING THE RUN FOR EFFICIENCY ACROSS TIME AND SPACE FOR ITALIAN AGRI-FOOD FIRMS

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Discussant: Mette Asmild

In the actual externally-mined market for agricultural firms, the ability to turn inputs into outputs named efficiency has to be pursued by exploiting quality. We aim exploring the critical junctures between efficiency, quality and territorial riskiness, considering products whose quality is certified by geographical indications. Quality certifications - being guardian of terroir secrets - are questioned in their support to firms' run for efficient performance over time, despite and in line with the environment. Methodologically, non-parametric data envelopment analysis, difference-in-difference technique with genetic matching, and machine learning feature selection process are combined in a framework that we propose and apply to 2410 Italian agri-food firms, measured over 28 internal and external characteristics from 2015 to 2020. Despite acting under increasing environmental uncertainty, Italy still stands for a best-practice market for high-quality products in Europe. We assess its firms' efficiency, by secondly inquiring the changes in efficiency over time, after gaining

certifications. Thirdly, we evaluate whether being certified and thus collaborating entails less-caring of spatial threats, in terms of territorial riskiness, to reach efficient performances. Results are relevant for researchers, and promote some win-win strategies for governors and producers in a long-term oriented vision of the sector.

THE INCLUSION OF CO2 EMISSIONS IN SPANISH PORT PRODUCTIVITY AND EFFICIENCY ANALYSIS

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Discussant: Luis Orea

The regulatory landscape in the European maritime sector has undergone significant changes with the introduction of initiatives such as the FuelEU Maritime program, which aims to reduce emissions by 55% by 2030 and 90% by 2050 compared to 1990 levels. This regulation, expected to be enforced from January 2025, relies heavily on fee measures to incentivize emission reductions within the industry.

The empirical analysis conducted in this study focuses on assessing the impact of CO2 emissions on port efficiency, marking a turning point with respect to previous studies by incorporating emissions into the production function of cargo handling services. This comprehensive analysis contributes to the current discourse on port efficiency and environmental sustainability within the maritime industry. For this purpose, a Stochastic Frontier Analysis (SFA) will be applied to the 23 most significant Spanish ports and data from 2016 to 2020 will be analysed.

The study highlights an approximately 20% difference between total efficiency with and without emissions consideration, emphasizing the hidden costs of emissions. Consequently, the new EU regulation emerges as a crucial mechanism to address this discrepancy, suggesting that port-operating corporations bear the financial burden associated with mitigating emissions to achieve a tangible transfer of efficiency gains to society.

PROFITABILITY DECOMPOSITION IN DATA ENVELOPMENT ANALYSIS: UNRAVELING THE 'A DOLLAR IS NOT A DOLLAR' PHENOMENON IN ECONOMIC RESOURCE ALLOCATION

Authors: Alexander Ottl[1]; Mette Asmild[1]
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Discussant: Victor Podinovski

This paper addresses the challenge of determining the appropriate allocation efficiency in profitability estimations using Data Envelopment Analysis (DEA). In resource allocation, the traditional notion of cost, revenue, and profit efficiency assumes fungibility and unrestricted mobility of financial resources. However, upon closer examination, this assumption often proves to be overly simplistic, particularly when shorter time horizons are available for resource allocation. Weight restrictions offer a solution by enabling more accurate and feasible allocation adjustments, particularly when detailed price information is unavailable for all Decision Making Units (DMUs) and the allocation adjustments are more short-term. While weight restrictions have been applied in cost and revenue efficiency, their use in profitability efficiency has been lacking. We extend the use of weight restrictions to profitability efficiency and apply it to contract rice farming in Vietnam using a state-of-the-art dataset that includes

information on multiple contract types. Our approach provides a more nuanced understanding of profitability, allowing for fair and efficient resource allocation decisions.

Wed|09:00-10:30 | Grande Auditório – Plenary 1

Chair/Discussant: Oleg Badunenko

MULTIDIMENSIONAL POLICY EVALUATIONS AND THE EFFICIENCY-ENHANCING CHANNEL

Authors: Kristof De Witte [1]
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This presentation explores the nuances between efficiency and effectiveness in educational systems, starting with the educational production function and utilizing Stochastic Frontier Analysis (SFA) to estimate student under-achievement. We begin by examining how resource constraints can bridge the gap between efficiency and effectiveness. We then review non-parametric methods for evaluating the causal impact of policy changes within a multi-input, multi-output framework, highlighting the advantages of integrating econometric impact evaluation with efficiency analysis. In particular, we address endogeneity issues by introducing a quasi-experimental design within a conditional multi-input, multi-output efficiency framework. This allows for a decomposition of overall efficiency into 'group-specific' efficiency (reflecting internal managerial inefficiency) and 'program' efficiency (indicating the impact of policy interventions on performance). This decomposition facilitates the interpretation of efficiency scores in terms of causality. Finally, we extend this non-parametric framework to an SFA context. The practical application of these methodologies is demonstrated through case studies of secondary schools in Flanders, Belgium, showcasing their utility and effectiveness.

Wed|11:00-12:30 | Aud. – Special session: Office of the Audit Generals and Efficiency Analysis

Chair/Discussant: Jonas Månsson

José Carpinteiro, Tribunal de Contas, Portugal. Approaches to Performance Audit: Experience of the Portuguese Court of Auditors.
Jonas Månsson, Where do National Audit Offices and research meet? – some reflections from spending 15 years at both places?
Tonny Kawukit, Office of the Audit General, Uganda. Audit of Ugandan Custom Stations.
Kristoffer Grønsberg, Office of the Auditor General, Norway. Audit on Norwegian Hospitals.

Wed|11:00-12:30|CC - Agricultural, Food and Natural Resource Productivity Analyses in Ibero-America: Session Organized by the Iberoamerican Network of Agrifood and Natural Resource Economics (RIEARN) - RIEARN I

Chair: Federico Garcia and Boris Bravo-Ureta

THE DETERMINANTS OF THE AGRICULTURAL TFP GROWTH IN THE BRAZILIAN SEMIARID REGION – AN ANALYSIS FOR THE PERIOD 2006-2017

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This study aims to analyse the determinants of the agricultural total factor productivity (TFP) in the Brazilian semiarid region, characterized by lower levels of income and economic development indicators. Using panel data from Brazilian municipalities in the two last censuses years (2006, and 2017) and combining with climate data, which corresponds to 2524 observations, we estimated the production technology utilized in the Brazilian agricultural production in the semiarid region, using stochastic production frontier methods, that account for exogenous factors that impact its environment. Additionally, we calculated the TFP index (TFPI) that was decomposed into technical efficiency, technological change, scale efficiency, and environmental efficiency. Since the decomposition accounts for observed and unobserved environmental effects, the contribution of this paper is to obtain a more realistic and flexible assessment of Brazilian semiarid agricultural productivity growth in the period 2006-2017.

The empirical model's data are: output, conventional inputs, institutional environment including producers' organizations, producer and farm characteristics and technical and extension services, the annual average temperature and rainfall, and the growing degree-days, aridity index, and seasonality of temperature.

Our results should generate insights for agricultural and regional policies to increase the sector's efficiency, promoting the region's social and economic development.

CLIMATE CHANGE, DROUGHT, AND AGRICULTURAL PRODUCTION IN BRAZIL

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Climate change is likely to impact the occurrence of natural disasters such as drought. This paper calculates a standardized precipitation evapotranspiration index (SPEI) and uses it to analyse the frequency, duration and severity of drought in Brazil (1901-2020). Second, the study uses annual panel data to estimate the causal effects of drought on agricultural production (1974-2019), and calculates the distribution of impacts across municipalities. Third, the paper compares annual panel and long difference estimates to shed light on adaptation/intensification over a longer period. Finally, by combining the panel estimates with seven CMIP6 global climate models, the study provides a range of projections for drought impacts (2025-2100). Results indicate that drought severity increased substantially in the second half of the 20th century and again in the 2010s. Estimates show that ten

percent of the time droughts reduced municipal production by 30% or more, with considerable spatial heterogeneity. Impacts were larger on area harvested than on land productivity. Long difference estimates do not indicate adaptation. Rather, impacts have intensified over time. A substantial risk to agricultural production is identified in the 21st century, especially under more pessimistic global warming scenarios, with annual losses rising to over 15% by 2100. Policy implications are discussed.

ASSESSMENT OF DEFORESTATION AND CLIMATE CHANGE EFFECTS ON BRAZILIAN AGRICULTURAL PRODUCTIVITY AND EFFICIENCY LEVELS: AN EMPIRICAL APPROACH USING STOCHASTIC FRONTIER ANALYSIS

Authors: André Danelon[1]; Silke Hüttel[2]; Stefan Seifert[2]; Humberto Spolador[1]; Subal Kumbhakar[3]
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Agricultural productivity is vital for economic development, ensuring food security, employment, and income. Stable and high productivity also helps Brazil to stabilize exchange rates through agricultural exports. Recent studies show that Brazilian agriculture has experienced substantial total factor productivity growth of more than 3.5% annually since 1975. However, the expansion of agriculture on forestland in the Cerrado and Amazon biomes raises environmental and climatic concerns. For instance, recent estimates suggest that an additional 5.7 million hectares of forests and savannahs would need to be transformed into agricultural land in the next 15 years under current soybean yield trends and growth trends. This expansion breaches Brazil's 2030 pledge to halt illegal deforestation, as over 90% of Amazon deforestation is unlawful. Therefore, a central challenge is to balance the fight against deforestation and supporting the economy. In this paper, we investigate the extent to which TFP growth was dependent on deforestation. Using city-level panel data for four groups of agricultural and livestock products from 1995 to 2017, data on deforestation (since 1985), and climatic patterns (since 1961), we employ a stochastic panel frontier approach to quantify the impact of deforestation on TFP growth while accounting for climate change effects. We provide new insights into the interplay between TFP performance, deforestation, and climatic shocks in Brazil.

THE EFFECTS OF WEATHER VARIABILITY AND CLIMATE CHANGE ON FARM OUTPUT AND PRODUCTIVITY GROWTH IN LATIN AMERICAN AND CARIBBEAN COUNTRIES: A STOCHASTIC METAFRONTIER ANALYSIS

Authors: Michée Arnold Lachaud[1]; Boris Bravo-Ureta[2]; Eric Njuki[3]; Jason Beckman[3]
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The goal of this study is to investigate Total Factor Productivity Change with special emphasis on technical efficiency disparities and technological gaps in diverse production environments accounting for weather variability and climate change. We use panel data from various sources, including the University of East Anglia's Climatic Research Unit, the Intergovernmental Panel on Climate Change, and the Food and Agriculture Organization, spanning 27 LAC countries over a 59-year period (1961-2019). We utilize the stochastic metafrontier production approach to account for structural differences in production technologies along with a two-period panel of long differences to capture adaptation to climate change. The analysis provides technical efficiency scores and technological gap ratios for different regions. Findings reveal that weather variability consistently hampers production

across regions, while climate change is projected to cause significant productivity reductions (4.2–16.2%) from 2020 to 2050, contingent on climate scenarios and discount rates. Long-term adaptation has only managed to offset 15% of the detrimental effects in the short term. This result implies that existing adaptation efforts fall short and that moderating short-term output losses effectively in the long term remains challenging. The study underscores the critical need for effective climate adaptation strategies to address potential output losses and enhance overall productivity in these regions.

Wed|11:00-12:30|SA - DEA Method I

Chair: Laurens Cherchye

RATIO-DATA CONVEXITY AND THE FREE DISPOSAL HULL MODEL

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As a solution to some specific inconsistencies, brought about by the joint presence of volume and ratio variables in a convex production technology, Olesen, Pedersen and Podinovski proposed a general model based on the selective convexity assumption, where combinations of DMUs having the same level of ratio variables are considered. Besides defining a Ratio-VRS (R-VRS) model, these authors also introduce a Ratio-CRS (R-CRS) version that allows for various proportional scaling rules of different ratio variables. These production models are an extension of the free disposal hull (FDH), which is thought to be an "unnecessarily small" technology. Our paper discusses the R-VRS technology generated by the selective convexity assumption based on "modified DMUs". We show that this technology does not satisfy the minimum extrapolation principle, contrary to its analogue derived from convex combinations of "observed DMUs". This latter R-VRS technology is smaller than the former and coincides with the FDH model when no subset of observed DMUs shares the same value of the sub-vector of ratio variables. Besides developing a suitable computational method for our proposed R-VRS technology, we consider three different data sets - including ratio data - to compare the efficiency estimates obtained from: the FDH model, R-VRS with "observed DMUs", R-VRS with "modified DMUs". We also perform an analysis of the statistical significance of the differences in the distribution of efficiency scores.

SOME PROBLEMS WITH BENEFIT OF THE DOUBT MODELS

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Benefit of the Doubt (BoD) models are increasingly popular in the literature with flexibility around technology assumptions and ease of understanding for managers and practitioners. Most of the focus has been on the efficiency scores with little attention paid to benchmarking in terms of target values and the appropriateness of peers. Specifically, there are problems that arise when weight restrictions are imposed, particularly the effects on efficient frontiers, further compounded when virtual weight

restrictions are used. These affect target values and benchmarking peers with nonintuitive effects as the lower bounds on the restrictions are increased.

A further question concerns how size can be incorporated to allow for scale economies. Further issues arise with respect to units-invariance properties for output oriented models.

We illustrate these issues using sustainability data comprising GRI measures and provide some thoughts towards addressing these problems.

A PAIRWISE-FRONTIER-BASED CLASSIFICATION METHOD FOR TWO-GROUP CLASSIFICATION

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Mathematical programming methods have been widely used to generate a separating boundary that can be used for two-group classification. A nonlinear separating boundary may have better performance than the linear ones, but requires a pre-specification of a nonlinear function form. This contribution proposes a novel pairwise-frontier-based classification (PFC) method to approximate nonlinear separating boundaries, without predetermining a nonlinear function form. It consists of two steps that explicitly handle overlap. The first step is to identify the overlap. Importantly, we propose to construct frontiers based on background knowledge of classification, thus ensuring that their intersection (i.e., overlap) is not increased by blindly applying commonly used axioms. Depending on the axioms applied, either convex frontiers are constructed using a Data Envelopment Analysis model, or nonconvex frontiers are constructed using a Free Disposal Hull model. The second step minimizes identified overlaps by allowing training observations to be misclassified, but all training observations that have been correctly classified remain correctly classified. The PFC method with hard frontiers is then extended to a one with soft frontiers. The applicability of the proposed PFC methods is illustrated by simulation studies and real-life data sets. The results show that the proposed method is competitive with some well-established classifiers and even performs better with unbalanced data sets.

NONPARAMETRIC IDENTIFICATION OF FACTOR-BIASED AND HICKS-NEUTRAL TECHNICAL CHANGE

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We study the nonparametric identification of factor-biased and Hicks-neutral technical change. To focus our discussion, we mainly concentrate on a setting with a single output and two inputs (capital and labor); however, we also show that our main insights can be extended to settings with multiple outputs and more than two inputs. We assume an empirical analyst who can use at least two firm observations that are subject to the same production technology. The analyst observes output and input quantities and input prices; we also show how to relax the assumption of perfectly observed prices (using price/weight restrictions). Our main identifying assumption is cost minimizing firm behavior; but we also indicate how this assumption of full cost efficiency can be weakened in practice (in the tradition of Data Envelopment Analysis). We mainly consider two cases: the first case makes no returns-to-scale assumption, and the second case assumes constant returns-to-scale; we also

indicate how we can actually account for alternative returns-to-scale assumptions. We define the testable implications of factor-biased and Hicks-neutral technical change; and we show to use these testable implications to (set) identify the magnitude of technical change. We also show how to deal with combinations of factor-biased and Hicks-neutral technical change (à la Demirer, 2022; currently R&R at Econometrica). We conclude by illustrating the empirical usefulness of our theoretical results.

Wed|11:00-12:30|3E - Productivity Analysis I

Chair: Léopold Simar

A NEW BIENNIAL TOTAL FACTOR PRODUCTIVITY MALMQUIST INDEX

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Based on the Biennial Malmquist Index, defined in 2011, and on the total factor productivity Malmquist Index, based on the proportional distance function and defined in 2020, we are going to present a new Biennial Malmquist Index that, for the first time, is a total factor productivity index. After showing that the new Biennal can always be computed, we end up with an illustrative example.

PERMUTATION TESTS ON COMPARISONS OF PRODUCTION FRONTIERS OVER TIME AND BETWEEN GROUPS IN NONPARAMETRIC MODELS

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In this talk a set of significance tests for DEA-based productivity comparison will be discussed. More precisely, tests for productivity change over time and tests for differences between different production plans are introduced. The tests for productivity change over time also include a test for whether a specific growth in production has happened. The tests are based on permutation methods and have the advantage that they are usable also when only relatively small samples sizes are obtainable. However, in the small sample case one needs to be careful about which hypotheses are being tested. In general, permutation techniques, where one recompute the test statistic over permutations of data, have a long history in statistics and have become increasingly useful as the availability of computational power has increased. We furthermore demonstrate, both theoretically and by a simulation study, that the test is consistent under an asymptotic scenario with increasing sample size.

CONICAL FDH ESTIMATORS OF DIRECTIONAL DISTANCES AND LUENBERGER PRODUCTIVITY INDICES FOR GENERAL TECHNOLOGIES

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In productivity and efficiency analysis, directional distances become very popular, due to their flexibility for choosing the direction to evaluate the distance of Decision Making Units (DMUs) to the efficient frontier of the production set. The theory and the statistical properties of these measures are today well known in various situations. But so far, the way to measure directional distances to the cone spanned by the attain- able set has not been analyzed. In this paper we fill this gap and describe how to define and estimate directional distances to this cone, for general technologies, i.e. without imposing convexity. Their statistical properties are also developed. This allows to measures distances to non-convex attainable set under CRS but also to measure and estimate Luenberger productivity indices and their decompositions for general technologies. The way to make inference on these indices is also described in details. We propose illustrations with some simulated data, as well as, a practical example of inference on Luenberger productivity indices and their decompositions with a well-known real data set.

STATISTICAL INFERENCE FOR HICKS – MOORSTEEN PRODUCTIVITY INDICES

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The statistical framework for the Malmquist productivity index (MPI) is now well-developed and emphasizes the importance of developing such a framework for its alternatives. We try to fill this gap in the literature for another popular measure, known as Hicks–Moorsteen Productivity Index (HMPI). Unlike MPI, the HMPI has a total factor productivity interpretation in the sense of measuring productivity as the ratio of aggregated outputs to aggregated inputs and has other useful advantages over MPI. In this work, we develop a novel framework for statistical inference for HMPI in various contexts: when its components are known or when they are replaced with non-parametric envelopment estimators. This will be done for a particular firm's HMPI as well as for the simple mean (unweighted) HMPI and the aggregate (weighted) HMPI. Our results further enrich the recent theoretical developments of nonparametric envelopment estimators for the various efficiency and productivity measures. We examine the performance of these theoretical results for the unweighted and weighted mean of HMPI using Monte-Carlo simulations and also provide an empirical illustration.

Wed|11:00-12:30|3D - Electricity Regulation I

Chair: Ørjan Mydland

HANDLING LARGE ELECTRICITY PRICE VARIATION IN REGULATION OF ELECTRICITY DSOS IN NORWAY

Authors: Hilde Marit Kvile[1]; Eivind Skjærven[1]; Peder Undeli[1]
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Electricity distribution system operators (DSO) are natural monopolies. In Norway, NVE-RME regulate the DSOs. We use benchmarking in the regulation to promote cost efficiency. We apply DEA with an approach to minimize the input that is total costs. This approach assumes that the DSOs face the same prices for their input factors, but this assumption has been challenged lately when it comes to network losses. Physically, electricity gets lost during distribution and the DSOs pay for this. This cost is one of the elements in the total costs in the benchmarking. Norway has five price areas, and since 2022 the cost of electricity has varied greatly across these areas. The southern parts of Norway have experienced all time high electricity prices lasting for months and months, whereas the northern areas have had all time low prices. This has led NVE-RME to consider if we should change the approach in our benchmarking. We are therefore exploring models with more inputs, where we can allow theinput price of the network losses tto vary across the five Norwegian price areas.

INCENTIVIZING THE OPTIMAL LEVEL OF SPARE CAPACITY

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The Norwegian Energy Regulatory Authority (NVE-RME) has applied DEA to determine revenue caps for electricity distribution system operators since 1997 . With increased electrification a que of projects wanting to connect to the grid has formed. NVE-RME is now working on balancing the incentives of low cost, correct quality of service and making sure grid connections are offered as fast socio-economically optimal. Analysis of possible incentives are explored both directly in the DEA model, but also in other parts of the method RME apply for revenue cap calculation.

REGULATION OF ELECTRIC ENERGY DISTRIBUTION IN GERMANY: STATUS QUO AND CONSIDERED CHANGES

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Electric energy regulation is the norm in many European countries. In Germany, incentive regulation of electricity distribution grids was carried out for the first time in 2009. After three completed regulatory periods, the fourth regulatory period is now in progress, and for the next regulatory period, energy regulation in Germany will be fundamentally reformed. The previous "normative" regulation in form of the Incentive Regulation Ordinance (Anreizregulierungsverordnung – ARegV) will no longer be continued. Instead, the new regulation will rely on the separate responsibility and independence of the regulatory authority (Bundesnetzagentur – BNetzA), as provided for in EU directives. Starting with a summary of the ARegV regulations used to calculate the revenue cap for the fourth regulatory period, we give an overview of considered changes to incentive regulation in Germany in subsequent regulatory periods. The changes under discussion comprise, e.g., greater consideration of the

challenges posed by the energy transition (accelerated grid expansion) and shortening the regulatory period so that occurring costs can be included in the revenue caps more quickly.

EFFECTS ON ELECTRICITY DISTRIBUTION COMPANIES DUE TO THE INCREASE IN ELECTRIC VEHICLES IN NORWAY

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This study examines the effects of electric vehicles (EVs) on the technical efficiency of power distribution companies (PDCs). The rapid increase in the number of electric vehicles in Norway presents challenges such as grid infrastructure, grid capacity, and reliability. However, there are also opportunities, such as growth in demand, smart grid infrastructure, and regulatory changes. In our analysis, we use spatial stochastic frontier analysis and incorporate spatial dependency based on balanced panel data collected from the Norwegian Water Resources and Energy Directorate from 2016 to 2021. Taking into account spatial dependence in terms of inefficiency and noise, we identify the influence of electric vehicles on the technical efficiency of power distribution companies. The inclusion of spatial dependency accounts for the fact that EVs owners may charge their cars not only at home but also along the roads when traveling. These dynamics impact distribution companies differently than, for example, electricity usage for household heating. Our findings suggest that the increasing adoption of EVs has improved the technical efficiency of PDCs. The results can guide the development of effective regulatory frameworks, investments in energy infrastructure, and strategies to manage the power grid to ensure the reliable and efficient integration of EVs into the existing power system.

Wed|11:00-12:30|3B - Country Analysis

Chair: Mercedes Sánchez

INTANGIBLE CAPITAL AS DRIVER OF PRODUCTIVITY: A REGIONAL AND SECTORAL APPROACH

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Productivity growth in EU has long been lower than in USA. Reducing this gap depends on investment in intangible assets (R&D, software and database, innovative property and other assets). This study provides evidence of the impact of intangible capital on regions' productivity by sectors and types of intangible capital showing that these assets are powerful drivers of productivity gains in many sectors. It focuses on the specific case of the Spanish regions because at this moment, Spain is one of the few countries in the world with information on intangible investments at regional level by branches of activity and types of assets. This represents the main novelty of this paper and an important contribution to the literature since the role of these assets has not been analysed with this breakdown due to lack of data. Adopting panel data techniques and instrumental variables, the results first show

that regions with higher investment in intangible assets get higher levels of labor productivity. They also show that software, database and R&D have greater impact than other intangible assets such as design, innovative property or organizational capital. The main intangibles for the industry sector are R&D, software and databases while the non-R&D intangibles affect productivity more strongly in the services sector. Finally, the importance of intangibles is lower in the primary sector, and comes mainly from the R&D intangibles.

EU WASTE RECYCLING TARGETS: WHERE ARE WE AT?. A PERFORMANCE EVOLUTION ASSESSMENT

Authors: Laura Carosi[1]; Giovanna D'Inverno[1]; Trinidad Gómez[2]; Maria Molinos-Senante[3]; Giulia Romano[1]
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Over the last decade the European legislator has set ambitious recycling targets for municipal waste and packaging waste so to achieve a more circular economy and to contribute to the European Green Deal's sustainability goals. In this paper, we evaluate the European countries performance evolution with respect to the constantly evolving waste management legal framework and their response to the definition of increasingly demanding targets. To do so, we suggest an innovative dynamic composite indicator to evaluate the country performance with respect to different packaging waste categories and taking into account their deviation from the set targets. In particular, the proposed synthetic indicator distinguishes targets in terms of essential thresholds and aspiration levels.

The essential thresholds do not allow for compensations between strengths and weaknesses of the evaluated units and grants that certain fundamental standards are met. The aspiration levels are targets that countries should aim at to foster their sustainability, but they are not compulsory. We monitor the evolution of 27 European countries from 2015 to 2020, where the packaging legislative framework has undergone important developments.

The tool provides policy-relevant findings, important to identify best practices and to define priority actions so to enhance the transition of lagging-behind countries towards a more circular economy.

ECONOMIC DEVELOPMENT AND FOOD WASTE: A CROSS-COUNTRY EXAMINATION USING STOCHASTIC FRONTIER ANALYSIS

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Despite the critical importance of understanding household food waste for global food security and environmental sustainability, quantitative research examining long-term trends across countries remains remarkably limited. Addressing this gap, our study employs stochastic frontier analysis within a panel data framework to advance methodological approaches in studying household food waste dynamics. This method offers a nuanced perspective on efficiency changes over time and across various nations, enabling the identification of long-term patterns in food waste. It differentiates between persistent inefficiencies linked to intrinsic country characteristics and transient inefficiencies arising from economic development processes. Our findings reveal a worrying trend of increasing food

waste globally, particularly in high-income and emerging economies, such as the BRIC nations, associated with economic growth and changing dietary preferences. These insights highlight the urgent need for tailored interventions and the promotion of effective strategies to mitigate food waste. Moreover, our methodological innovations contribute to the broader field of efficiency and productivity analysis by providing a novel approach to examine performance and inefficiency in the context of household food waste management.

GREEN SMES STRATEGIES: AN INTEGRATED APPROACH TO RESOURCE EFFICIENCY, GREEN MARKETS AND SUPPORTS IN SMES

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SMEs, representing over 50% of the national GDP and 70% of industrial pollution in the EU, and play a fundamental role in the sustainable transition according to the European Green Deal. It is emphasized that micro-level actions towards renewable energy positively influence the adoption of macro strategies for achieving climate neutrality. Promoting environmental awareness and government research is essential as drivers for a Circular Economy in SMEs. The study aims to quantify the efficiency of European SMEs in the responsible resource use and adaptation to green markets. With a sample of 13,343 surveys conducted on SMEs in the EU-27 in 2021, a two-stage DEA-Bootstrap model is employed. The correlation between renewable energy efficiency and green market dynamics is assessed, alongside an evaluation of whether public and private measures have facilitated progress in environmental projects. The results indicate that SMEs are not adequately directing their efforts towards renewable energy, underscoring the need for more support. Decision-makers, both internal and external, are encouraged to enhance incentives, subsidies, and advisory services, particularly during the phase when SMEs' own resources could lead to actions such as water and energy savings, recycling, and the design of environmentally-friendly products.

Wed|14:00-15:30|Aud. – Justice

Chair: Pablo Arocena

EVALUATING SPECIALIZATION AND DIVERSIFICATION ECONOMIES IN JUDICIAL COURTS

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The functioning of a nation's judicial system profoundly influences society, the economy, and the well-being of its citizens. Consequently, ensuring the optimal and equitable operation of the judiciary necessitates courts of justice operating at the utmost levels of quality, efficiency, and effectiveness. In Spain, as in other European countries, the concern for improving the efficiency and organization of its courts occupies a prominent place in the public debate surrounding pending reforms in the administration of justice. This study focuses on the first level of the judicial system in Spain, which encompasses three primary types of courts. The first type is the courts of first instance solely focused

on civil jurisdiction. The second type is the instruction courts, with exclusive competence in criminal jurisdiction, specifically in the investigative phase. Lastly, the third type comprises the combined courts of first instance and instruction, which handle cases in both jurisdictions. This article employs a DEA approach to (i) assess the efficiency of these three types of courts from 2005 to 2022, and (ii) analyze whether there are advantages from specialization or diversification in the configuration of the courts of justice.

THE EFFICIENCY OF DISTRICT COURTS IN NORWAY AFTER THE REFORM: A DEA ANALYSIS

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In the recent years, the district courts have been reformed in Norway, by merging them from 60 to 23 ones. However, the new government decided to return to the previous number of district courts, arguing that the courts should be independent and closer to people. Nevertheless, many judges, the police, prosecutors, the lawyers' association, and even the children's ombudsman opposed such a return. However, each such decision must be justified and lead to an increase in efficiency of the district court system. Therefore, in this study, we analysed the efficiency of reformed Norwegian district courts using several Data envelopment analysis (DEA) models. The study results demonstrate the presence of increasing returns to scale, significant reserves for improving the efficiency of court system in this country, e.g. through new mergers. Certain policy implications including new mergers are formulated. Given certain limitations due to the low number of district courts (DMUs) in Norway, further research with cross-country DEA including other Nordic countries is recommended.

ECONOMIES OF SCALE IN DISTRICT COURTS

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There are many studies on district courts that report scale efficiency and link these findings to optimal size. However, already Førsund (1996) showed that linking scale efficiency to optimal size based on DEA results is hazardous. To put more structure on the model a parametrization is made. In a multi-input multi output framework the common way is to use the fact that the input/output distance function has the property of being homogeneous of degree of 1 in output/input. The normal procedure is to choose one of the inputs/outputs and normalize the data, leaving a one-dimensional left-hand side and apply a stochastic frontier model. However, tests have shown that this approach is sensitive the choice of scaling input/output. In this study we use the rarely used deterministic parametric method introduced by Ray (1998, 2003). The novelty of the model is that the distance function is computed directly, and that the homogeneity condition is imposed rather than assumed. In the study data from 2000-2018 on all Swedish courts is used. Of special interest is the courts that during the period have been merged. Preliminary results suggest, without making any causal claims, that the scale elasticity for merged district courts do not differ from unmerged courts.

UNDER(MINING) JUDICIAL EFFICIENCY: A DATA-DRIVEN EXPLORATION OF DYNAMICS IN PORTUGAL'S JUDICIAL SYSTEM

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This study embarks on a data-driven investigation into the operational dynamics of Portugal's first instance courts, leveraging Data Envelopment Analysis (DEA) and the Meta-Malmquist Index (MMI) to unveil the layers of efficiency and productivity over the 2015-2023 period. By employing a comprehensive dataset detailing case volumes, judicial resources, and dispositional metrics, we assess the technical efficiency and productivity changes across various courts. Our analysis reveals significant variability in efficiency, attributed to differences in resource allocation, procedural complexities, and regional disparities. The MMI further elucidates temporal shifts in productivity, attributing these to technological advancements and policy reforms. This exploration not only highlights the critical role of data science in judicial reform but also sets a benchmark for comparative efficiency analyses within European judicial systems. The findings propose actionable insights for enhancing judicial performance, ultimately contributing to a more robust and equitable legal infrastructure.

Wed|14:00-15:30|-1A - Agriculture I

Chair: Yang Liu

AGRICULTURAL MECHANIZATION SERVICES, ADVERSE SELECTION AND BY-STAGE PRODUCTIVITY OF SMALL FARMS: EVIDENCE FROM WHEAT PRODUCTION IN NORTHERN

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The rapid growth of mechanization services has played a crucial role in revolutionizing agricultural production in developing countries where small farms are predominant. However, little is known on how mechanization services impact the productivity of small farms by substituting their own machinery and labor across different stages of production. In this paper, we empirically examine the influence of mechanization services on the productivity of small farms at various stages of production, and assess its overall impact at the farm level. We utilize a panel data of 145 wheat farms in Northern China for the period of 2013-2020, which includes comprehensive information on inputs and outputs at each stage of production. Our results show that, after accounting for stage-specific characteristics, mechanization services are likely to have a detrimental effect on the productivity of the plant protection stage. Since the plant protection stage is chain-linked with other stages of production, this impedes the further enhancement of capital intensity and productivity at the farm level. These findings provide valuable insights on whether the optimal selection of service providers and service packages based on the stage of production, while satisfying the cost-minimization condition for each stage, would be a beneficial strategy for small farm users of mechanization services aiming to enhance productivity.

PRODUCTIVITY CHANGE OF ESTONIAN DAIRY FARMS FROM 2006-2022: COMPARISON OF TOTAL FACTOR PRODUCTIVITY AND AGRICULTURAL TERMS OF TRADE

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The objective of this research paper is to examine the changes in productivity of Estonian dairy farms between the years 2006 and 2022. The analysis utilizes data from the Estonian Farm Accountancy Data Network (FADN).

In the first stage, the evaluation of total factor productivity in Estonian dairy production is conducted. Data envelopment analysis (DEA) is employed to estimate the changes in total factor productivity. The transitive Färe-Primont index is utilized for the calculation of TFP. The findings reveal that productivity levels are higher in larger farms, whereas small farms contribute to a lower overall productivity level. The change in TFP is significantly influenced by farm gate milk prices.

In the second stage of analysis, the agricultural terms of trade is introduced as a measure of fluctuations in input and output prices within the agricultural sector. The costs of agricultural production tend to increase at a faster rate compared to the prices of agricultural outputs. Therefore, in order to offset declining terms of trade, productivity gains become crucial.

The ability of farms to withstand the impact of fluctuating terms of trade depends on their specific characteristics, as well as their capacity to improve productivity or utilize additional support. The analysis identifies the characteristics of dairy farms that are associated with productivity gains despite losses in terms of trade.

REGIONAL DEVELOPMENT AND INTELLECTUAL CAPITAL: UNVEILING THE INNOVATION-TRADITION DILEMMA

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In the agri-food sector, intellectual capital includes innovation and tradition, which are often wrongly perceived as incompatible. The impact of intellectual capital on regional development has not been widely studied, particularly in the context of the Italian agri-food sector, which has a strong territorial heterogeneity. This paper aims to measure the impact of intellectual capital and know-how on regional development in the agricultural sector using a nonparametric efficiency methodology applied to a unique geographic area-based dataset. The study finds that innovation, measured by patents, has a better impact on efficiency than the relational component, which has an inverted U-shaped effect.

ASSESSING HOW PRODUCTION TECHNOLOGY DIVERSITY IMPACTS ENVIRONMENTAL TOTAL FACTOR PRODUCTIVITY IN CHINA'S AGRICULTURE AT THE PROVINCIAL SCALE

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Navigating the details of the agricultural sector's internal diversity poses a challenge in pinpointing the root causes of suboptimal productivity, which further hampers policy formulation and environmental sustainability. To address the issue of heterogeneity among different production processes, this paper delineates agricultural production activities as its boundary and constructs production accounts for China's four main agricultural subsectors, including crop, animal husbandry, forestry, and fishery. Based on Data Envelopment Analysis and considering environmental impacts, this study utilizes the Metafrontier-Malmquist-Luenberger productivity index to measure the dynamic changes and specific composition of Environmental Total Factor Productivity (ETFP) by subsectors at provincial level from 2000 to 2020. The results indicate that annual growth rate of ETFP in forestry and fishery are 1.53% and 0.89%, respectively, while crop and animal husbandry experienced initial growth and a decreasing trend. The ETFP growth is primarily driven by technological progress and enhanced scale efficiency, with GHG emissions significantly contributing to inefficiency. However, due to the presence of regional and sectoral heterogeneity, different types of production technologies exert heterogeneous influences on ETFP. Therefore, distinct environmental regulatory strategies may be needed to underscore the policy implications for more refined agricultural management and sustainable development.

Wed|14:00-15:30|CC - Agricultural, Food and Natural Resource Productivity Analyses in Ibero-America: Session Organized by the Iberoamerican Network of Agrifood and Natural Resource Economics (RIEARN) - RIEARN II

Chair: Federico Garcia and Boris Bravo-Ureta

EXPLORING AGRICULTURAL PRODUCTIVITY DYNAMICS IN THE BRAZILIAN CERRADO: INSIGHTS FROM VARIED LAND INPUT MEASURES

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This paper presents an empirical analysis of the agricultural productivity in the Brazilian Cerrado biome, a region predominantly characterized as capital-intensive. The study aims to assess the use of different measures of land input, and its effect on productivity analysis.

Using municipality-level pooled data from the 2006 and 2017 Brazilian Agricultural Censuses, the study employs three distinct Stochastic Frontiers models, each one with a different measure of land input. These variables were obtained from the amount of agricultural area and the ranges of property sizes, with means of 115,96 ha, 37,50 ha, and 4,06 ha.

Additionally, environmental variables were included in these models, and the inefficiency term was controlled by educational, technical assistance, and social capital variables.

Despite variations in land measurement, the results show that the relationship among elasticities remains consistent in this capital-intensive production system. Constant returns to scale were observed in all analyses, with the same pattern of technical change.

The results showed that the largest land elasticity estimate was 0.2947, while the lowest was 0.1118, and the main difference was captured by the capital elasticity, keeping the labor elasticity almost invariant. At the same time, the average Technical Efficiency in each model was 0.7636, 0.7685, and 0.7721.

Finally, we observed the same behavior of the variables in the technical inefficiency term in all models.

DIGITAL FARMING TECHNOLOGY ADOPTION AND TECHNICAL EFFICIENCY OF BRAZILIAN BEEF CATTLE FARMS

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Digital farming technology adoption may increase efficiency and sustainability in beef cattle farming. This article assessed the adoption and impacts of operational and financial management software on Technical Efficiency (TE) and Technology Gap Ratio (TGR) scores of feedlots. These management systems have been connected to sensors and radio frequency identification (RFID) technology to improve data collection capacity and provide farm management control in real time. The selectivity correction model for Stochastic Production Frontiers (SPFs) was combined with a meta-frontier approach. A sample of 114 feedlots located in the main Brazilian beef cattle producers' regions provided cross-sectional farm-level primary data for the year 2021. Production scale, use of consulting companies, farmer's age and adoption of traceability systems significantly affected software's adoption decisions. SPFs and meta-frontier estimates revealed that, on average, TE scores of adopters were statistically significantly higher than those of non-adopters. Notwithstanding, the average of non-adopters' TGR was slightly higher than that of adopters. These findings indicate that management software adoption was relevant to increase efficiency in inputs use through improvements in feedlot control and reducing information costs, but did not result in technical change. Strategies for greater diffusion of management software and complementary digital technologies are relevant for Brazilian beef industry.

TECHNICAL EFFICIENCY OF COW-CALF SYSTEMS IN PASTURE BASED RANCHES

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Beef production has been in the spotlight of the climate change debate since 2006, when FAO overestimated its impact on green house gas (GHG) emissions. Uruguay's beef sector develops over the Pampas biome taking advantage of the natural grasslands. The objective of this paper is to estimate the trade-off of cow-calf ranches selling decisions, technical efficiency and potential climate change impacts of policy recommendations. Theoretically, cow-calf ranches produce calves as the main product. Natural grassland feeding allows for low cost system but presents some caveats on management, as the system depends on rain and weather conditions to produce forage. The academia

establishes that the weaning rate can be increased from 65% (national average) to over 80% without significant cost to the rancher. A multi-output model at the smallest administrative level available is constructed to analyze how decisions on whether to increase weaning rates or sell cows, adjusting for soil quality, rain fed, and forage availability, is performed. The data comes from the national agricultural ministry, and it is provided at the smallest administrative census region. A stochastic frontier is estimated to determine the inefficiency. Additionally, a bad output is incorporated estimating the amount of GHG emissions from different systems to compare potential climatic change effects. The data conforming a panel from 2016/17 to 2022/23.

TECHNOLOGY ADOPTION AND IMPACTS IN AGRICULTURE PRODUCTION: A SYSTEMATIC REVIEW FROM THE STOCHASTIC FRONTIER APPROACH

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Through a systematic literature review (SLR), this study identified the main agricultural production technologies adopted by farmers and analyzed their impacts in technical efficiency (TE) and technology gap ratio (TGR) of adopters and non-adopters. We compared the various methodologies used to estimate the production frontiers and meta-frontiers, providing a more comprehensive view of agricultural technology impacts. The comparison of these methods revealed a significant variation in TE results, emphasizing the need for carefulness in interpreting the results. The identified and analyzed technologies were categorized into four groups and their respective subgroups: biotechnology, digital technology, sustainable agriculture practices, and public policies that create direct incentives for technology adoption. All of them showed a positive impact on TE of farms, with a particular emphasis on technical assistance/rural extension access. Given the barriers faced by farmers in adopting technologies, especially in developing countries and family farming, the adoption of "simple" technologies can have a greater impact on TE than investments in more advanced (and expensive) practices. Finally, the compilation of works presented in this SLR provides valuable information to guide producers, researchers, technology developers, and public agents in the selection and prioritization of technologies to be promoted and diffused.

Wed|14:00-15:30|SA - DEA Methods II

Chair: Lars Skage Engebretsen

GROUP DECISION MAKING WITH IMPRECISE DATA ENVELOPMENT ANALYSIS FOR RISK ASSESSMENT

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Data Envelopment Analysis (DEA) has been widely utilised in real-world applications to assess the efficiency of groups of decision-making units (DMUs) with multiple inputs and outputs. A key result of the DEA-based efficiency analysis is the ranking of DMUs according to their relative efficiency scores. The challenge in DEA becomes evident when gathering primary data from various experts,

practitioners, or decision-makers to eliminate bias in decision-making. The notable issue in group decision-making lies in effectively combining individual judgments without compromising outcomes, including two popular approaches: prior to efficiency assessment (at the data level) and after efficiency assessment (at the efficiency level). As group decision-making often involves intuition and subjective assessments, linguistic terms are commonly employed to capture the inherent imprecision and vagueness in human decision-making. In this paper, we characterise the linguistic terms used in questionnaires to represent decision-makers' subjective judgments and perceptions. A novel DEA-based model is proposed to aggregate individual judgments and evaluate DMU efficiency in uncertain environments. An example in risk assessment is provided to demonstrate the effectiveness and suitability of this approach.

DATA ENVELOPMENT ANALYSIS IN MANAGEMENT ACCOUNTING: NEW FRONTIERS EXPLORING INDUSTRY CHARACTERISTICS

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Since the 1980s, Data Envelopment Analysis (DEA) has served as a pivotal tool in management accounting for assessing performance, traditionally from a production economics angle—focusing on physical production inputs and outputs within homogeneous production settings. Recently, the shift towards utilizing financial data from external databases for DEA has expanded its application, allowing for comparisons across industries and over time. This shift prompts questions regarding how the selection of performance metrics influences DEA's effectiveness in measuring business performance and the effect of industry characteristics on these assessments. Our study compares ten DEA models across six industries, revealing that while DEA scores remain consistent with changes in accounting variables for the same performance metric, they vary significantly across different metrics. Additionally, industry contexts systematically influence DEA outcomes. Our findings highlight the implications for future management accounting research using DEA and financial data, emphasizing the need to consider metric selection and industry-specific factors.

DATA ENVELOPMENT ANALYSIS (DEA) FOR STOCHASTIC DYNAMIC COST-EFFICIENCY ANALYSIS OF INVENTORY CONTROL SYSTEMS: A WINDOW ANALYSIS, CHANCE- CONSTRAINED, AND PRINCIPLES OF OPTIMAL CONTROL THEORY APPROACH

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This research introduces a novel Stochastic Data Envelopment Analysis (SDEA) model with principles of Optimal Control Theory (OCT), employing a Window Analysis (WA) approach jointly with Chance-Constrained Programming (CCP) for constructing the probabilistic constraints, considering the probability of each window, also computing the average values and the covariance matrices of each window over time. It incorporates dynamic characteristics from recent models, for example, inventory costs as intermediate measures, by considering relationships among total costs related to demand,

production or ordered quantities, and inventory variables (e.g., inventory costs, costs of product purchased, and costs of goods sold), and their uncertainties, to assess the total cost efficiency of inventory control systems dynamically and stochastically. The OCT principles are used to relate variables and incorporate dynamics into the control system, while the CCP and WA are used to create the windows over time and incorporate their stochastics. The expected result of this research is an SDEA with principles of OCT to be applied to control systems of Decision-Making Units (DMUs), for example, using data from accounting variables of the retailing sector and considering a total cost efficiency of inventory and production (or ordered quantities) over time and under uncertainties, i.e., capturing real-world characteristics, thus enhancing the analysis, and contributing to more efficient control systems.

PIONEER – MAKING EFFICIENCY ANALYSES EASIER

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Since the popularisation of the DEA method, several applications have been published for performing DEA. LIMDEP (Green (1995, 2002)), MAXDEA (Cheng (2014)), DEAFrontier (Zhu (2014)), Warwick DEA (Griffin and Steel (2007), DEAP (O'Donnell (2010) and Coelli (1997)), Frontier Analyst (Houssain and Jones (2001), OnFront (Färe and Grosskopf (1998)), PIM-DEA (Thanassaulis (2001) among many others.

In recent years, freely available packages for languages like R and Python, including packages like Benchmarking, rDEA and FEAR, have become widespread and popular. These packages have made efficiency analyses both more available and powerful for users with programming skills. For non-programmers the options remain limited. User-friendly, click-based software are often either outdated, or available through subscription only. The Office of the Auditor General of Norway has developed an intuitive and user-friendly application, pioneeR, to make efficiency and productivity analyses more available and accessible for auditors, researchers, and others.

PioneeR is an open-source R package and Shiny application for DEA and enable users to experiment with different DEA models without the need of any programming skills, while still being able to create reproducible results for validation with the R language.

In the latest version we introduce bias-corrected efficiency scores and confidence intervals by bootstrapping following Simar and Wilson (1998).

Wed|14:00-15:30|3E - Productivity Analysis II

Chair: Thomas Triebs

THE KOREAN ECONOMY: PRODUCTIVITY, TECHNOLOGICAL CHANGE, AND RD INVESTMENT

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Korea boasts a high R&D intensity and drive technological change. In theory, such efforts should translate to rising total factor productivity (TFP). However, despite the significant R&D spending, Korea's TFP growth has exhibited a worrying downward trend, raising concerns about R&D efficiency and the potential "R&D paradox."

This study explores the multifaceted relationship between R&D investment, productivity, and technological change in the Korean economy.

Data primarily originates from the Bank of Korea Economic Statistics System (ECOS), encompassing R&D stock categorized by the 2008 System of National Accounts (SNA), macroeconomic indicators from 1973 to 2018, and industry-level data from 1993 to 2018.

Key findings:

Divergent Productivity Trends: Labor productivity exhibits continuous growth, while capital productivity declines consistently.

Elasticity of Substitution: Estimates range from 0.68 to 0.72, indicating moderate substitutability between labor and capital.

Labor-Augmenting Technological Change: R&D investments primarily drive labor-augmenting technological change, evident in increasing labor productivity.

Industry-Specific Dynamics: Manufacturing exhibits strong positive impacts of R&D on labor-augmenting change, while the service sector reveals diverse patterns across industries. Real estate, business services, and medical sectors show contrasting trends with capital-augmenting technological change outpacing labor-augmenting advancements.

ANALYZING COMPETITIVENESS IN SMALL OPEN ADVANCED ECONOMIES THROUGH TOTAL FACTOR PRODUCTIVITY: INSIGHTS AND IMPLICATION FOR SWEDEN

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We have performed a replication study, where we corroborated the findings in the seminal work by Färe et al. (1994). The replication study was extended to include a comprehensive database and use an alternative total factor productivity (TFP) index, Bjurek-Hicks-Moorsteen (BHM) index. This study, which builds upon the replication study, aims to extend the analysis of TFP to include an alternative index, Färe-Primont index, which helps in multitemporal and multilateral comparisons. This study will employ TFP as a measure to examine the competitiveness among small open advanced economies (SOAE).We use three distinct TFP indices, viz., Malmquist index, BHM index and Färe-Primont to evaluate productivity development across the SOAE, with special focus on Sweden. A comparative analysis of the three indices will throw light on the unique characteristics of these indices and will provide a nuanced understanding of different approaches to TFP. Moreover, the replication and extended study revealed that there was a lack of growth in productivity in the past two decades across these economies. The financial crisis had an adverse impact on productivity due to lack of innovation and inefficient allocation of resources that also impeded the adoption of new technologies. It would be intriguing to evaluate the determinants of the (in)efficiency in the SOAE. We will employ

econometric techniques to conduct a second stage analysis and evaluate the factors influencing the TFP estimates.

INNOVATION OUTPUT POSSIBILITIES AND PERFORMANCE CHANGE FOR EUROPE AND ITS INTERNATIONAL COMPETITORS

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In this paper, we use data from the European Commission's Innovation Output Indicator (IOI) and the flexible weighting Benefit-of-the-Doubt model to empirically estimate the set of innovation output possibilities for European Union, its Member States, and its international competitors in the field of innovative activities. We find that the best practice frontier of innovation output possibilities over the last decade is to a large extent defined by EU's international competitors. The innovation outputs of the EU27 block in 2022 are about 81% of those realized in the best-practice frontier, highlighting existing room for improvements. Additional information useful for policy making purposes is provided for individual countries, such as frontier targets and countries that could serve as peers for each individual country. We then use the global Malmquist productivity index to assess changes in innovation output performance during the last decade and decompose these to measures of change in frontier performances and individual country innovative activity catching up. We find notable improvements in the performance of many European Union countries and a 5% improvement for the EU block between 2012 and 2022, which are to much extent attributed to catching up with frontier performances. We also document evidence for some catching up between pre- and post-2004 accession EU Member States.

FIRM SUBSIDIES AND INPUT USE

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Subsidy for industry is a widely used policy tool. Policy makers hope that subsidies increase or decrease input use (labor or capital), improve productivity, or foster innovation. Generally, and with the exception of correcting externalities, i.e. pollution or lack of innovation, economists see subsidy as a source of inefficiency. But is it possible that subsidies are a second-best? This could be due to the presence of other constraints or for economic development. We analyze the impact of subsidy on relative input use. Relative input use is important because it has implications for economic efficiency and equity. Subsidies might cause relative input use to deviate from opportunity costs, which unless these do not reflect social cost lead to cost inefficiency. In turn, changes in input use might affect the elasticity of substitution, which affects the income distribution between capital and labor. Our application is China in the early 2000s. Our results show that subsidy affects relative price efficiency and substitution elasticities. There is evidence that subsidies increase the relative use of capital. And somewhat counter-intuitively this improves relative price efficiency. This is probably because any bias due to subsidy is dominated by other distortions. We find these economically meaningful effects despite the average subsidy, less than half a percent of sales, being relatively low.

Wed|14:00-15:30|3D – Regulation

Chair: David Saal

THE ROLE OF POLITICAL FACTORS AND DEMAND UNCERTAINTY IN THE EXCESS OF CAPACITY FOR LANDLORD PORT AUTHORITIES: AN APPLICATION TO THE SPANISH CASE

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Using data on Spanish port authorities (PA) for the period 2003-2022, we model the difference between observed and potential output using a output-distance frontier approach. In our analysis, we will consider the analysis of excess capacity for two different types of ports according the classification done by the Trans-European Transport Network (TEN-T) project that classifies European ports as core or comprehensive.

The starting point for our analysis is to derive a theoretical framework. We consider a landlord port model, in which the port authority is responsible for the investment in port infrastructure. Then, PA grant a terminal operating company (TOC) the right to exploit a certain area of the port to handle the cargo investing in superstructure. In return, the PA receives two different sources of revenues from the TOC: (i) a concession fee for occupancy and (ii) a cargo fee related to the use of space and common services. Finally, the TOC charges a port service fee which covers port services.

The empirical specification is based on the multi-service context for the port authority provision of port infrastructure services. We use a output-oriented distance function for analysing the PA technology and the difference between maximum and observed outputs which will be assumed to depend on the degree of demand uncertainty, the cost of service capacity, the concentration of cargo and its specialization, and political factors related to the PA governance.

A REGULATORY PERSPECTIVE FOR ROBUST BENCHMARKING OF UTILITIES

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Regulators employing benchmarking methods in practical and ongoing assessments often encounter challenges with existing models, particularly in scenarios marked by limitations within smaller regulated sectors, extreme values, noise, and outliers. Traditionally two different approaches are used; Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). However, both approaches struggle to overcome when the practical constraints intersect with the models' theoretical assumptions, and it becomes necessary to explore alternative approaches.

In this context, the DEA-Order-M method emerges as a relevant and practical solution. By extending DEA, DEA-Order-M provides a nuanced approach to address limitations within smaller regulated sectors, extreme values, noise, and outliers. DEA-Order-M is more robust to these challenges in the sense that it does not envelop all the data points unlike DEA, and does not rely on the same

problematic assumptions as SFA. The method involves multiple iterations, each selecting a random set of M firms to form the efficient frontier in the given iteration. However, the value of M is critical. This study investigates the regulatory perspective and explores the practical implications of using Order-M as an alternative benchmarking method.

ECONOMIC ANALYSIS OF WATER MANAGEMENT IN THE EUROPEAN UNION

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Multiple concerns regarding water management persist at the global level. In the European Union, the Water Framework Directive (WFD) is the main regulatory framework to address water-related policy. However, water management must also consider the complex relationships between water-using sectors. The Water, Energy, Food, and Ecosystems (WEFE) Nexus emerged as a conceptual approach to address this interlinkage but still needs dedicated economic approaches. We fill this gap by applying two methodological approaches from the economic literature. First, following a traditional approach to policy analysis, we implement positive mathematical programming (PMP). Second, we use a stochastic frontier analysis to estimate production functions and derive demand curves for water-using sectors. We compare the results from the two approaches in a theoretical framework to understand the distribution of economic benefits among water-using sectors. Our analysis uses data from high-resolution input-output tables extended to environmental and non-monetary inputs for the European Union. Results highlight the potential of the production function approach to give further insights for policy analysis.

ASSESSING THE PERFORMANCE OF COMPLEX NETWORK SYSTEMS UNDER THE LASSO+DEA FRAMEWORK

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The question this paper seeks to answer is how one might best model the true complexity of capital-intensive sewage systems, and importantly, the cost of operating them. A satisfactory answer that reflects the reality of the systems employed by service providers does not yet appear to exist - one issue continues to arise: the improper consideration of the complexity of the systems employed. It seems there is a significant data requirement in order to answer for the shortcomings. We have limited (in length) data and few companies, but the data contains a wide range of potential cost drivers – from traditional outputs, network characteristics, customer dynamics, quality standards, and technologies employed. In short, the dimension of the problem is greater than the sample size. The “curse of dimensionality” is a well-known limitation in non-parametric estimators like DEA, where the accuracy of the estimator is predicated on the dimension of the problem. Yet, solutions do exist. Machine learning techniques might be employed to perform data-driven variable selection. The apparent benefit of such techniques is the ability to select a sparse representation of the true model by identifying the most important characteristics, without sacrificing prediction accuracy. We employ the LASSO+DEA framework to answer the research question and assess the operating cost efficiency of the English and Welsh sewage network systems.

Wed|14:00-15:30|3B - Sustainability & Eco-efficiency I

Chair: Marijn Verschelde

DETERMINANTS OF ECO-EFFICIENCY OF LISTED FOOD AND BEVERAGE FIRMS: THE ROLE OF ENVIRONMENTAL MANAGEMENT, THE BOARD OF DIRECTOS AND SOCIAL PERFORMANCE

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The environmental performance of the food and beverage industry has come under increasing scrutiny in recent years. The industry is a significant user of resources, including water, energy and packaging material, and is also an important generator of wastewater, gas emissions, organic residues and packaging wastes. The industry also faces specific challenges, such as food safety controversies, demand for healthier food products, responsible sourcing of raw materials, supply chain management, labor standards and safety in the workplace. As such, companies in the industry face the challenge of using its resources efficiently while increasing the production to meet the demand for new consumption patterns and expected population increases.

The objective of this study is to assess the eco-efficiency of listed food and beverage firms using frontier techniques. With an unbalanced panel data set of listed firms observed over the period 2012-21 comprising 945 observations, we use the Simar and Wilson two-stage double-bootstrap DEA procedure to analyze the factor determining eco-efficiency. These include variables that represent different environmental management practices, as well as several characteristics of the board of directors including gender diversity, participation of independent directors and the existence of a corporate social responsibility (CSR) committee. We also investigate the possibility of trade-offs between the social dimension of sustainability and eco-efficiency.

WHEN ONE TONNE IS NOT ONE TONNE: SUSTAINABLE EFFICIENCY OF FIRMS WHEN DECARBONIZATION IS IMPERFECTLY OBSERVED

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The EU Emission Trading System (ETS), with gradually more binding carbon prices, forms a cornerstone of the EU policy towards decarbonization by firms and climate neutrality by 2050. Carbon market participants as well as competent authorities agree that the success of this large-scale cap-and-trade system crucially depends on the starting principle “a tonne must be a tonne”: one tonne CO2 equivalent emitted must be equivalent to one tonne reported (European Commission, 2015).

In this paper, we will relax the “one tonne is one tonne” assumption and study how this affects our insights on the relationship between decarbonization and the productive efficiency of firms. For this purpose, we adopt a multidimensional perspective on firm production that includes both economic and ecological output. We will follow the seminal work of Chung et al. (1997) on flexibly modelling undesirable outputs in the analysis of productive efficiency by using nonparametric techniques. More

specifically, we will extend the method of Cherchye et al. (2015) for multi- output efficiency measurement by including the possibility that the undesirable outputs are measured imperfectly (along the lines of Cherchye et al., forthcoming). Focusing on the joint production of economic and ecological output, we will not only define and compute sustainable efficiency, but also decompose it as a weighted sum of economic and ecological efficiency.

MEASURING AND MANAGING (UN)SUSTAINABLE WORKLOAD UNDER DIGITIZATION: A FRONTIER-BASED JOB DEMANDS-RESOURCES MODEL

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In this paper, we bridge the psychological Job Demands & Resources (JD-R) literature with the operations literature on activity analysis. The JD-R model provides a comprehensive framework, categorizing risk factors associated with different occupations. On one hand, resources positively affect performance, while on the other hand, demands relate to work conditions. Understanding the health impairment process (strain due to excessive demands) and the motivational process (resource-driven well-being enhancement) is essential in defining a sustainable level of workload. We apply a multidimensional nonparametric activity analysis on the JD-R model, to assess the relation between resources, demands, and mental well-being of employees. Using event-level data of railway control room operators, we construct a multidimensional JDR indicator for digital production, which we empirically validate by using proxies for operational risk and employee well-being.

FROM OUTLIER TO SUSTAINABILITY IDENTIFICATION IN NONPARAMETRIC FRONTIER ANALYSIS

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Managerial decision-making is increasingly supported by data-driven performance analytics. Nonparametric activity models have proven valuable in assessing the efficiency of decision-making units, yet they are susceptible to the influence of outliers. In this paper, we review the outlier identification literature and demonstrate that outliers can offer significant insights into unsustainable production practices.

Wed|14:00-15:30|3C - Education I

Chair: Lori Taylor

POLICY RESPONSES TO COVID-19 AND THE EFFICIENCY OF ITALIAN UNIVERSITIES

Authors: Gaetano Francesco Coppeta[1]; Tommaso Agasisti[2]; Alice Bertoletti[3]
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In response to the COVID-19 pandemic, the Italian government has increased public support for universities. While this influx of financial resources could partially mitigate some negative impacts of the pandemic on outputs, it also significantly increases inputs and costs for universities, potentially leading to a temporary loss of efficiency. This paper examines the policy effect of increased funding on universities' efficiency in Italy. By focusing on both production and cost efficiency, we utilize a panel dataset spanning five years (2017–2021) and employ the recently developed Generalized True Random Effect stochastic frontier model. This model enables us to decompose overall inefficiency into persistent and transient components while accounting for university heterogeneity. Our findings reveal that while production efficiency has remained relatively stable over the years, post-COVID-19 is characterized by a statistically significant decrease in cost efficiency. This result indicates a reversal of the positive efficiency trend observed in Italian universities in recent years. Moreover, we identify a homogeneous reduction in cost efficiency across geographic regions, suggesting that the negative effect is unrelated to specific initial conditions or management decisions in the short run.

MEASURING TECHNOLOGICAL CHANGE IN THE SPANISH UNIVERSITY SYSTEM (2013-2020)

Authors: Gemma Perez-Lopez[1]; Victor Gimenez[2]; Diego Prior[2]; Jose Luis Zafra-Gomez[1]
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Universities are one of the most important public institutions, given the multidimensionality of their activity (Sierra et al., 2009, García-Aracil, 2013) and because they manage a significant volume of financial resources and have many employees of very diverse categories. Specifically, the Spanish university system also must meet the demands of the European Higher Education Area (EHEA), that introduced the criterion of efficiency in university management, making European Higher Education Institutions more competitive at a global level (Wolszczak-Derlacz, 2017). In this sense, the management of universities takes on special relevance.

This work analyzes the efficiency of public spending on research in the Spanish university system, analyzing the national research plans received by Spanish universities in the period 2013-2020. A new methodology is proposed that allows analyzing the technical change, with the main advantage that it presents less volatility than the traditional measure offered by the Malmquist Index. We have a sample of 80 public and private universities and we consider the funding received annually by each university through the research plans is taken as input and as outputs the total number of annual publications in the WoS, total number of publications in the first quartile, citations received and number of patents. From the results the research plans represent an improvement in the efficiency of Spanish universities, caused by technological change.

TO FEED OR NOT TO FEED: TEXAS SCHOOLS' PARTICIPATION IN CEP

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For decades, the US Department of Agriculture (USDA) has funded school-based nutrition through the National School Lunch Program. However, the Community Eligibility Provision (CEP) program changed the funding model for participating schools. We examine Texas schools' decision to participate in CEP and the implications and efficiency consequences of that decision.

A school is eligible for CEP if at least 40% of the student population is identified as needy. A simple theoretical model shows that the decision to join CEP should not be considered exogenous. Rather, it is an endogenous decision based on the net costs under CEP; administrative burdens; and funding risks associated with undercounting the economically disadvantaged students.

Our empirical analysis demonstrates that school location and student demographics are positively related to CEP participation. Therefore, our panel stochastic frontier analysis treats CEP participation as endogenously affecting both costs and efficiency. We estimate a cost function using school-level administrative data on food service expenditures, payrolls, meals served and types. The model predicts compensated and uncompensated costs of participation, identifying bounds on the expected benefits from universal free meals.

Recently, the USDA lowered the ISP eligibility bound from 40 to 25%. We also explore the consequences of this policy change.

Thu|09:00-10:30|Aud. – Plenary 2

Chair/Discussant: Ana Lozano Vivas

INNOVATING EFFICIENCY: EMERGING THEMES TRANSFORMING BANKING

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The talk will examine how technological advancements, regulatory changes, emerging business models, customer-centric innovations, and sustainability initiatives are transforming banking. We will explore the integration of AI, blockchain, and automation in streamlining operations, the shift towards personalized and multi-channel banking, and the adoption of green financing and ESG practices. By highlighting these emerging themes, we provide insights into new standards for assessing bank efficiency in a rapidly evolving financial landscape.

Thu|11:00-12:30|Aud. - Agriculture II

Chair: Hervé Dakpo

THE ROLE OF AND EXTENSION PROGRAM FOR DIFFERENT CROPS: A STOCHASTIC METAFRONTIER PERSPECTIVE

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In Chile, Family Farm Agriculture (FFA) comprises around 260,000 agricultural plots, constituting 90% of total production units. The state, primarily through the Agricultural Development Institute (INDAP), plays a crucial role in extending support to FFA. INDAP administers key programs like PRODESAL (Local Development Program) and SAT (Technical Advisory Service), benefitting over 130,000 farmers. The SAT program, specifically, aims to enhance the capabilities of users and their families, with 13,546 farmers benefiting in 2017, supported by an approximate budget of US$ 1,200 per family (INDAP, 2018).

Focusing on a dataset comprising 170 vegetable producers and 222 berries producers, our analysis employs a Stochastic Meta-Frontier to assess technical efficiency (TE) and frontier output. Notably, vegetable producers exhibit statistically significant high TE compared berrie farmers and both crops show similar levels of frontier output. Furthermore, we delve into the role of the SAT program and technology adoption, revealing higher adoption rates among vegetable farmers. The intricate relationship between productivity, technology adoption, and the SAT program is thoroughly examined, aiming to provide insights for enhancing policy actions in support of family farm agriculture.

THE ROLE OF TECHNOLOGY AND TECHNICAL EFFICIENCY IN ITALIAN DAIRY FARMING ACROSS ALTITUDES: A STOCHASTIC META-FRONTIER ANALYSIS

Authors: Claudia Stefania Gondos[1]; Elena Castellari[1]; Alan Wall[2]; Boris E. Bravo-Ureta[3]
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Italy is one of the largest milk producers in the European Union (EU), and its unique geographical location and heterogeneous natural conditions have enabled the country to increase its competitiveness and become the EU's largest producer of Protected Designation of Origin (PDO) cheeses. Productivity and improved use of resources are crucial to remaining competitive. In this study, we use Italian FADN data to construct a panel dataset of 5,220 observations of 879 Italian dairy farms observed from 2011 to 2020. We implement the true random effects (TRE) model and the stochastic meta-frontier (SMF) to account for differences in technical efficiency and technology gap ratio across three altitude zones (lowland, hill, and mountain). The influences of weather variables (standard deviation from minimum and maximum temperature in cold and warm months and average precipitation) are also considered. Empirical evidence reveals different production technologies across altitude zones with significantly higher total factor productivity and technical efficiency for lowland farms. Regarding the weather variables, deviation from the minimum temperature in cold months negatively affects production in the mountain. Deviation from the maximum temperature in warm months and precipitation significantly affects production in all zones. Further research will focus on alternative definitions of climatic variables, including heat stress and climate normals.

TECHNICAL AND ENVIRONMENTAL PRODUCTIVITY OF SWISS DAIRY FARMS: A BY-PRODUCTION STOCHASTIC FRONTIER ANALYSIS

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This paper measures the technical and environmental productivity of desirable and undesirable outputs in Swiss dairy farming between 2009 and 2021. We estimate a by-production stochastic frontier model, allowing time varying technical and environmental inefficiencies to be explained by farm specific characteristics. The by-production process consists of the conventional production technology, in which desirable output (i.e. aggregate revenues from milk, meat products and crops sales) is expressed as a function of inputs and a time trend that reflects technical progress; and two environmental frontiers with respect to undesirable outputs, i.e. ammonia (NH3) and GHG emissions, where both are expressed as a function of desirable output and a time trend. This system of equations is estimated simultaneously in Bayesian inference. Then, we construct Technical and Environmental Productivity growth indicators, which are explained by the contribution of Technical progress and Efficiency Change. We find that farmers increased production volume while simultaneously lowered GHG and NH3 emissions through technical progress. Efficiency gains over time allowed farmers to catch up to their technical and environmental frontier improvements.

EXAMINING THE COMPETITIVENESS PRESSURE OF WINE PRODUCTION IN EU NATIONS: A LATENT CLASS BOUNDED INEFFICIENCY MODEL

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The European Union (EU) is prominent in the global wine industry as the world's largest producer, consumer, and exporter. Moreover, countries like France, Italy, and Spain account for seventy-five percent (75%) of the EU wine production. One of the significant challenges EU winemakers face is competition among EU countries and other global regions. This competition is even exacerbated by the changing consumer preferences towards more environmentally friendly wine, the evolving regulatory framework, and climate change. Our objective in this paper is to examine the competitiveness between six EU countries: France, Italy, Spain, Germany, Portugal, and Greece between 2004 and 2018. To this aim, we rely on the new class of stochastic frontier, which introduces bounds on the inefficiency distribution. From a practical point of view, this bound reflects competitive pressure as extremely inefficient farms are eliminated from the market by competition. This paper extends the model to include variables that may explain the bound level and account for production heterogeneity assessed through a latent class stochastic frontier model. For the estimation, we assume that producers maximize their profit per hectare. Using this behavioural objective, we derived a primal function that is neither a production nor a distance function but allows us to control for the endogenous nature of input and output choices.

Thu|11:00-12:30|-1A - Agriculture III

Chair: Miguel Alves Pereira

EFFICIENCY ANALYSIS IN THE AGRICULTURAL SECTOR: HETEROGENEITY MATTERS IN THE LAND OF MILK AND HONEY

Authors: Ludwig Lauwers[1]; Elizabeth Ahikiriza[2]; Guido Van Huylenbroeck[1]; Jef Van Meensel[3]; Wim Verbeke[1]
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Efficiency analysis in agriculture is abundantly done, not only for estimating the sector productivity improvement potential, but also for practitioners' purposes to identify peers and improvement paths for the inefficient farms. The search for appropriate peers is, however, to a large degree by heterogeneity in the farmers' population. The objective of the presentation is to discuss practical implications of sector heterogeneity on interpreting and dealing with efficiency analysis outcomes. The study uses cases of practitioners-oriented DEA research in two sectors, dairy farming and beekeeping. It further analyses the role played by various factors (such as heterogeneity detection, method choice (DEA-FDH), assuming convex technology or not, existence of outliers, using technology-specific or meta frontiers) when deriving peers for adequate benchmarking. Heterogeneity is discussed from the angle of farm classification and whether it should be done prior, concurrently and/or posterior to efficiency analysis. Special attention will be paid to two cases with low data availability, one linking animal welfare, productivity and cost efficiency in dairy farming, the other exploring the efficiency of honey production in a wide range from professional to pure hobbyists. The study concludes with meta lessons learnt on possibilities and pitfalls in searching for benchmarks in heterogeneous populations, and using them in practice for improving extension services.

ANALYSING WEATHER'S IMPACT ON TECHNICAL EFFICIENCY: A STUDY OF CROP FARMS IN NORWAY

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Crop production relies heavily on the fluctuating and consistent patterns of weather conditions. This study delves into the implications of rainfall and temperature variations on both persistent and transient technical efficiency within crop farms across Norway. Our analysis is grounded in unbalanced panel data spanning from 1991 to 2020, encompassing 1,397 observations of Norwegian farms specializing in crop production, particularly within the eastern regions of the country. Employing a four-component para metric model, we examine the intricate relationship between weather dynamics and farm efficiency. The findings underscore the significant influence of both weather and socioeconomic factors on the performance of crop farms. Notably, our analysis reveals that persistent inefficiency outweighs transient inefficiency, highlighting the critical need for policymakers to prioritize strategies aimed at addressing persistent inefficiencies within the agricultural sector.

FRONTIER ANALYSIS TECHNIQUES TO DERIVE ELIGIBLE CONTACT FARMS FOR TARGETED EXTENSION: EMPIRICAL EVIDENCE FROM UGANDAN DAIRY FARMING

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In sub-Saharan Africa, more effective extension is needed to support farmers to improve agricultural productivity without increasing input levels. Recently, using contact farms has gained popularity as an effective way for targeting extension services. Their selection, however, has remained subjective, hence the need to come up with more objective selection methods to maximize learning between the contact farms and their followers. Using well-known frontier analysis techniques i.e., Data Envelopment Analysis (DEA) and Free Disposable Hull (FDH), the study aims to characterize the generated peers for their eligibility as contact farms to the less and/or non-efficient farms. Data from 471 dairy farmers, "a priori" classified into three production systems, are analyzed with the afore-mentioned frontier techniques using three inputs, i.e., land, capital and labor and one output (monthly milk produced) in output-oriented models. DEA and FDH proved complementary to propose peers as eligible contact farms. For those with larger populations of followers, the study further analyzed their homogeneity and heterogeneity to gain extra insights on assigning appropriate contact farms. For learning to take place, contact farms and follower farms should share some similarities, but also differ in the way they allocate resources. While homogeneity aids willingness to follow/adopt, heterogeneity results in actual learning that improves productivity.

FROM GRAPES TO THE GLASS: A NETWORK DEA SIMULATION APPROACH FOR UNVEILING WINE SUPPLY CHAIN EFFICIENCY

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To estimate production or cost functions and technical efficiency (TE) of firms in the framework of stochastic frontier analysis (SFA), certain conditions must be met. One of the conditions is that errors in the measurement of the inputs, caused by the collection of proxy data, for example, should be negligible. This work develops an SFA framework that corrects for proxies to construct the correct likelihood function when this condition is violated, but all others are met. We apply a pseudo maximum likelihood approach to treat the auxiliary nuisance parameters in the model, and Monte-Carlo integration scheme to solve the non-analytically solvable integral. The SFA model is based on that of Battese and Coelli (1992), with a translog production function and time series (panel data) input. Finally, we present a simulation study to compare the corrected estimates to the uncorrected estimates. Results show that correcting for measurement error has an essential effect on the estimation results, both of the production function coefficients and the TE scores.

Thu|11:00-12:30|CC - Sustainability & Eco-efficiency II

Chair: Barnabe Walheer

UNDESIRABLE FACTORS IN THE RAW MATERIAL FLOW PROCESS: A COMPARISON BETWEEN INVERSE TRANSFORMATION APPROACHES

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The high rates of raw material consumption that are mainly responsible for the environmental crisis as well as disruptions caused in the global supply chain during the recent years, have urged the need for more efficient resource management and EU resource autonomy. Therefore, in this study, the raw material flow efficiency in the EU-27 is being assessed, where different types of waste and emissions as well as waste exports are considered as undesirable outputs. A very common approach to treat undesirable inputs/outputs in the DEA literature is by using the convex combination of their inverse value. In this study an alternative implementation of the inverse transformation is examined, where the inverse of the convex combination of the undesirable variables is being used instead. The differences between the corresponding efficient frontiers are investigated. This alternative formulation of the inverse transformation results in a non-linear programming DEA model, and an iterative procedure is suggested to solve it. Results indicate that countries that were efficient with the old model are efficient with the new model, but the opposite does not hold.

PERFORMANCE-BASED CARBON EMISSION ABATEMENT ALLOCATION

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The global sustainable development have become an important issue. In order to achieve sustainable development, the carbon emissions abatement policies and the goal of net zero emissions were accepted in the Paris Agreement in 2015. However, carbon emissions should be gradually reduced after the peak based on the requirement of economic development. In addition, how to allocate the amount of carbon emissions abatement among countries is a difficult task. This study proposes a carbon emissions abatement allocation model based on the performance of promoting sustainable development. This model is used to allocate the amount of carbon emissions abatement among countries under the consideration of the peak carbon dioxide emissions. Since carbon reduction is for global sustainable development, the allocation of carbon emissions abatement among countries should be based on the maximization of global performance. Therefore, this study uses the centralized data envelopment analysis approach to allocate the amount of carbon emissions abatement. This study will provide a performance-based method for the allocation of carbon emissions abatement among countries in pursuit of sustainable development.

ASSESSING SOCIOECONOMIC IMPACTS OF RENEWABLE ENERGY EXPANSION: A REGIONAL ANALYSIS IN BRAZIL

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The energy transition scenario imposes on countries the expansion of renewable sources in their electricity matrix. Brazil stands out with its relatively green electricity matrix, boasting 83.6% renewable electricity generation as of 2022, surpassing the global average. Renewable sources are gaining importance in Brazil as alternatives to hydro and fossil fuels. This study delves into the

socioeconomic effects of adopting renewable electricity sources in comparison with fossil fuels in Brazil. Using DEA, we assess Brazilian mesoregions' efficiency in enhancing socioeconomic and environmental indicators, considering the technology of installed power plants. Efficiency scores were analyzed for northern and southern regions alongside the national model to discern trends amidst regional disparities. Results show that regions hosting wind farms and small hydropower plants exhibit superior performance on socioeconomic metrics compared to those that host photovoltaic and biomass facilities. However, the direct socioeconomic impact of renewable energy plants is modest in contrast to fossil fuel-based mills, with negligible improvements in metrics such as direct job creation and median remuneration within the electricity sector. Welfare indicators proxies for HDI emerge as significant drivers of efficiency, aligning with the view that expanding renewable energy sources contributes to a systematic, rather than merely regional, approach to development.

A SEQUENTIAL BENEFIT-OF-THE-DOUBT COMPOSITE INDICATOR

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In many contexts, performances are measured by aggregating indicators. To do so, practitioners have to choose how to normalize and weight the selected indicators. A popular method is the benefit-of-the-doubt (BoD) which constructs composite indicators based on relative weights and avoids normalization. When dealing with panel data, the BoD computes composite indicators using contemporaneous data only. A consequence is that composite indicators are over-estimated because the accumulation of best practices is ignored. Inspired by the production economics literature, we suggest new sequential composite indicators keeping the BoD spirit. These indicators are not based on contemporaneous data but include current and past information. By comparing the two approaches, we define the new concept of knowledge accumulation ratio. We use the sequential composite indicators to evaluate the vulnerability, readiness, and resilience to climate change of more than 180 countries over the 1995--2020 period. Our results highlight two main groups of countries: those with great need of new investments and an urgency for adaptation, and those well positioned but with some adaptation challenges.

Thu|11:00-12:30|SA - Banking & Finance I

Chair: David Sherman

SENSITIVITY OF PORTFOLIO PERFORMANCES TO THE RANDOM NATURE OF THE DATA

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Nalpas, Simar and Vanhems (2017) have developed an efficient and numerically robust algorithm allowing the evaluation of the performance of portfolios of risky assets by nonparametric efficiency measurements. This is done in general inputs-outputs spaces where inputs can include variance and

kurtosis and outputs can include mean return and skewness. This algorithm is computed for a given set of observed inputs and outputs, but in practice, these are empirical estimates from a sample of historical returns, observed on a long period. This introduces randomness in the original data. This paper develop an easy way to handle this randomness and to analyze the variations of the performance measures relative to this randomness. In particular, we provide confidence intervals for these measures. We focus the presentation to the traditional "mean-variance" set-up. The methodology is based on subsampling approximations, adapted by Politis, Romano and Wolf (1997) to heteroskedastic time series, having inherent time dependence. The method is illustrated through some examples from finance portfolio management. In a more general setup of production theory our paper address the problem of the sensitivity of the estimated efficiency scores to random variations in the original inputs-outputs.

RISK-AVERSION VERSUS RISK-LOVING PREFERENCES IN NONPARAMETRIC FRONTIER-BASED FUND RATINGS: A BUY-AND-HOLD BACKTESTING STRATEGY

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The eventual risk-loving nature of preferences of investors has largely been ignored in the existing frontier-based fund rating literature. This contribution develops a series of nonparametric frontier-based methods to rate mutual funds accounting for both mixed risk-loving and mixed risk-aversion preferences. These new methods are proposed by defining the corresponding shortage functions that can allow for increases in all moments, or increases in odd moments and reductions in even moments. The empirical part designs a buy-and-hold backtesting to test the out-of-sample performance of the proposed rating method corresponding different risk preferences on the actual MF selection. The evidence indicates that the backtesting strategies based on the output frontier-based rating models with risk-loving preferences exhibit an overwhelming dominance compared to most existing frontier-based and traditional financial ratings.

SUSTAINABLE PERFORMANCE OF BANK BUSINESS MODELS IN ARGENTINA: A COST FRONTIER APPROACH

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Since the financial crisis in 2001, Argentinian commercial banks have had to operate in difficult economic conditions, and have been subject to severe restrictions on their activity during various periods. Moreover, recent difficulties with inflation are threatening their most common source of income namely public securities. Surprisingly, however, no attention has been devoted to assessing the efficiency of Argentinian banks in recent decades. This study attempts to fill this gap by analyzing the ability of Argentinian banks to achieve a sustainable business model.

It is acknowledged that banks' business models may be systematically associated with differences in their performances and, ultimately, their survival. To explore the relationship between business models and performance, we use a novel panel data set of 79 Argentinian commercial banks observed from 2001-2022. We estimate a stochastic cost frontier, incorporating diversification measures of assets and liabilities portfolios and controls for different types of bank ownership to capture the bank business model. This analysis aims to ascertain the extent to which the sustainable performance of Argentinian banks in a difficult economic environment depends on their business model.

Preliminary findings underscore the significance of appropriate business models for achieving cost efficiency in Argentinian banks and sustainable performance.

DEA AS AN AUDIT TOOL TO IDENTIFY ABNORMAL FINANCIAL TRANSACTIONS FOR REVIEW AND VALIDATION

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Independent auditors of financial statements are charged with determining if financial reports are prepared in accordance with U.S. or International accounting standards (GAAP or IFRS). Current procedures test the accuracy of financial accounts by analyzing samples of transactions to determine if they are handled in accordance with the proper accounting treatment. Recently, efforts to develop and use advanced data analytic and data mining methods to expand the audit coverage to review all the transactions, particularly in cases where there is a high volume of substantial transactions. The objective is to use such techniques to identify cases which are abnormal or atypical. Suspicious relationships would be evaluated to determine if they are reasonable exceptions in accordance with accounting standards. If not reasonable, the auditor would determine whether it represents an error or some unacceptable treatment of a transaction requiring investigation as to whether it is a one-time or more systemic error. This analysis could result in adjustments to the financial statements before the auditor can support the statement as meeting financial reporting standards. The study objective is to determine if DEA can be applied to accounting data (a retail business) to locate unusual abnormal relationships that require auditor follow-up and evaluation. Results are subject to evaluation by practicing financial auditors to evaluate the potential of DEA in financial audits.

Thu|11:00-12:30|3E - Productivity Analysis III

Chair: Christopher O'Donnell

UNDERSTANDING THE IMPACT OF ENVIRONMENTAL FACTORS ON PRODUCTIVITY: INTRODUCING THE CONDITIONAL ORDER-M MALMQUIST INDEX

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In traditional productivity assessments, such as those employing the Malmquist index, non-parametric frontiers play a central role in estimating efficiency change and technological change. However, this

index often fails to adequately account for outliers and external variables, especially if it operates under the assumption of separability, which may not hold true in many real-world scenarios. To mitigate these limitations, this paper presents three key contributions to the literature. Firstly, we introduce the Conditional Order-m Malmquist Index, which corrects for the influence of outliers and extreme values avoiding the deterministic nature of its frontiers, enhancing the robustness of productivity analysis. It is designed to address situations where the separability assumption does not hold, and environmental factors significantly affect frontier shape. Secondly, we propose an index to discern the directional impact of environmental variables on productivity change, whether progressive, regressive, or neutral. Finally, we validate our model empirically in the healthcare sector, where external environmental variables often challenge separability assumptions.

TECHNICAL EFFICIENCY AND PRODUCTIVITY GAINS IN 38 OECD COUNTRIES 1995-2019. A STOCHASTIC PRODUCTION FRONTIER ANALYSIS

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We estimate an aggregated country-level translog stochastic production function and derive technical efficiency for a panel of 38 OECD countries for the period of 25 years (1995-2019). The output is the real GDP at constant dollars and the inputs used are capital stock, labour force and human capital. The panel dataset allows for the application of a robust stochastic frontier analysis, which controls for noise, inefficiency component, and country-specific heterogeneity. We found that the average country-level technical efficiency is relatively high at 91% and that efficiency scores differ little between the constant and variable returns to scale production technology. However, a large spread between strong-performing and weak-performing countries is observed. The Global financial crisis had also a profound negative effect on efficiency and productivity with some countries being affected more than others. This study also evaluates robust determinants to understand the main drivers of technical efficiency and hence productivity growth in OECD countries. Among other factors, the total government expenditure has a positive effect on technical efficiency, but this effect will differ depending on the type of public expenditures, and inequality will decrease the country-level productive performance. The total factor productivity index (TFP) is also computed to assess the proportion of the growth which is coming from technical efficiency, scale efficiency and technological change.

SUSTAINABLE PRODUCTIVITY INDICATORS: PRIVATE OR SOCIETAL PERSPECTIVE?

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Amidst limited natural resources, environmental threats, and a climate crisis, global policies and initiatives, exemplified by the UN's Sustainable Development Goals, strive for "sustainable productivity growth" to ensure ample food and goods provision for a growing population with minimal environmental harm. Evaluating sustainable productivity across various scales, from farms to entire

nations or the planet, requires reliable measurement methods. However, a clear definition or suitable method for measuring sustainable productivity is lacking, despite traditional productivity being well-defined as outputs divided by inputs. This study reviews current approaches for measuring "environmentally adjusted" productivity extending them to include the social pillar. While existing studies typically adopt the producer's perspective, societal considerations are crucial. The suggested framework integrates societal perspectives, demonstrated with country-level agricultural sector data from 52 countries between 1990 to 2019, encompassing inputs, outputs, and greenhouse gas emissions. This comprehensive approach aids in policy assessment for global sustainable growth addressing all the three pillars of environment, economy and society.

GHG EMISSIONS AND PRODUCTIVITY CHANGE IN SELECTED SECTORS OF THE AUSTRALIAN ECONOMY

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Measures of productivity change are measures of output volume change divided by measures of input volume change. There are three problems with the measures of productivity change computed by most statistical agencies: 1) they cannot generally be viewed as measures of output volume change divided by measures of input volume change; 2) they cannot be used to make productivity comparisons across both space and time; and 3) they ignore bad outputs (e.g., GHG emissions). This paper overcomes these problems. It uses publicly-available state-level panel data on selected sectors of the Australian economy to compute what the OECD calls Environmentally Sustainable Productivity Index (ESPI) numbers. Among other things, it finds that productivity in NSW agriculture increased by 44% between 1990 and 2021, and that productivity in NSW agriculture in 1990 was 23% lower than productivity in Victorian agriculture in 1990. The paper then uses a combination of economic theory and statistical methods to estimate the drivers of productivity change. The main drivers are found to be technical progress and economies of scale and substitution. Finally, the paper identifies government policies that have the potential to improve environmentally-sustainable productivity.

Thu|11:00-12:30|3D - Health I

Chair: Minyan Zhu

EFFICIENCY OF ADDRESSING COVID-19 PANDEMIC BY THE STATES OF INDIA IN THE PRE-AS WELL AS POST VACCINATION PERIODS AND DIFFERENTIAL IMPACT ON EFFICIENCY OF UNION'S AND STATES' POLITICAL PARTY ALLIGNMENT

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In order to study how efficiently various Indian states addressed covid19 pandemic management in pre-vaccination (PRV) and post-vaccination (POV) periods, a DEA technique with VRS approach was adopted with DMU being an Indian state (28 no.). Four input variables (area of state per capita,

doctors, nurses and beds separately per ten thousand people) and one output variable (no of persons per unit death) were selected for PRV period. In POV period, the only change was one input variable (number of vaccinations per capita) was added. After estimating efficiencies of the Indian states in PRV and POV periods, analyses were done to find if there was increase in efficiency during PRV/POV stage; for that, the PRV/POV period was divided into two equal sub-periods, and efficiencies were computed for the sub-periods. It was found that latter half of PRV/POV period show statistically higher efficiency than earlier half of the PRV/POV stage. This shows that it was possible that learning was taking place in both periods. Further, grouping states into two groups, namely, those which had the same political formation governing them as that prevailing at Union Government level (say party A) and those states which are not (party B), it was found that during POV period increase in efficiency in latter half compared to earlier half of those states governed by party A is statistically more than that of the states which belonged to B. This may indicate vaccine distribution biases during POV stage.

ASSESSMENT OF CONTAINMENT PERFORMANCE POLICIES AGAINST COVID-19 USING A BENEFIT-OF-THE-DOUBT APPROACH

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During the COVID-19 pandemic, most governments tried to contain the virus transmissions. Many stringent non-pharmaceutical interventions have been established, such as lockdowns, social distancing, cancellation or suspension of public events, international travel restrictions, and online contact tracing. These efforts affect the short-term society and economy, leading to a long-term impact with socioeconomic consequences. Evaluating the containment performance can assist in identifying good policies and optimizing the public system to contain future health shocks, such as pandemics.

Our objective is to assess the containment policies against COVID-19 which are related to the preparedness and capacity of the healthcare systems. We build composite indicators and apply a Benefit-of-the-doubt approach to evaluate the health system's performance against the pandemic. The data are collected from Our World in Data and The Oxford COVID-19 Government Response Tracker (OxCGRT) databases for 180 countries during the pandemic.

QUANTIFYING THE TRADE-OFF BETWEEN CAPACITY UTILISATION AND PATIENT WAITING TIME: THE CASE OF AMBULANCE SERVICES IN THE UK

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Ambulance services respond to calls that need to be processed in a given time frame. We propose a production model that is able to quantify the trade-off between the service response time (averaged across incidents, referred to as average response time) and the number of incidents that can be dealt with. Based on this production model, we are able to show there is a trade-off between the capacity utilization of ambulance services and their average response time in the following sense: the minimum average response time that can be achieved by utilising all variable resources efficiently reaches a limit

when ambulance service units hit full capacity; response time can only be further reduced when capacity is optimised. We apply the model to the UK data that cover monthly observations from 2017 to 2023 across a number of ambulance service units and provide a measure to quantify the above trade-off between average response time delivered by ambulance services for different categories of incidents (depending on the degree of urgency) and their utilisation of capacity which has been severely constrained by bed availability at hospitals for handover.

Thu|11:00-12:30|3B - Water and Sewage

Chair: Ana Camanho

WATER WASTE: A PRODUCTIVITY ANALYSIS OF THE WATER SUPPLY IN PORTUGAL

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Environmental concerns have been increasingly present in production processes for decades and have become a major preoccupation in recent years. Production processes require natural resources that are becoming increasingly scarce. One of these natural resources is water. With greenhouse gas emissions leading to climate change, water has become a precious resource, and this is even more true for countries and regions with a warm climate. It is, therefore, important to save clean water at all levels. Moreover, some mild-climate regions are beginning to suffer from climate change with more frequent periods of drought. This is the case in Southern Europe, including Portugal. This document, therefore, aims to provide an analysis of the performance of the water supply sector in Portugal. The study analyses a sample of 116 Portuguese water supply companies between 2013 and 2021. These companies are in Portuguese territory and have different management structures. The water supply production process is considered a non-linear joint-production process with wasted water as an undesirable output to implement the performance assessment. The performance of these companies is evaluated using an exponential Malmquist index in a non-parametric framework - i.e., based on Data Envelopment Analysis (DEA). Results will have implications regarding methodology innovation and practical implications for policymakers and public managers interested in more efficient water supply management.

HOW DOES THE PLANT LEVEL FRAGMENTATION IN SEWAGE TREATMENT INFLUENCE MUNICIPAL LEVEL ECONOMIES OF SCALE?

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Japanese sewerage industry is operated by municipalities. It is expected to face difficulty in operation in the future because of population decline, increasing capital investment for renewal of aged facilities and disaster prevention measures, and so on. The Japanese government has promoted broadening

the operation of sewerage. One of the ways to broaden operation is to merge multiple municipalities and operate sewerage in an integrated manner. When municipalities are merged, they can operate all existing sewage treatment plants without reducing the number of sewage treatment plants. This means that the number of sewage treatment plants increase in one municipality and is called fragmentation of sewage treatment plants.

This study adopts the panel data of Japanese sewerage companies, estimate input distance function, and predict returns to scale, the measure of economies of scale. When estimating input distance function, we account for fragmentation of sewage treatment plants as well as area, sewer connections, and volume of sewage.

We found that returns to scale from the model which consider fragmentation is larger than those from the model which does not consider fragmentation for almost all municipalities. Using the results from the model which consider fragmentation, we also found that returns to scale converges to one as the number of sewage treatment plants increases. This suggests that economies of scale diminish as fragmentation of sewage treatment plants is promoted.

BENCHMARKING ANALYSIS IN THE BRAZILIAN WATER AND SEWAGE SECTOR: A DIRECTIONAL BENEFIT-OF-THE-DOUBT APPROACH

Authors: Andréia May[1]; Carlos Ernani Fries[1]; Hermílio Vilarinho[2]; Ana S. Camanho[2]
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This study applies the Benefit-of-the-Doubt (BoD) approach, a framework derived from Data Envelopment Analysis (DEA), to estimate the performance of the Water Supply and Sewage (WSS) sector in the most populous municipalities in Brazil, from 2019 to 2021, serving approximately 86 million people.

The application of this technique offers an alternative solution to the benchmarking study presented annually by a civil organization formed by companies that operate in the Brazilian WSS sector, called Instituto Trata Brasil (ITB).

ITB carries out its study based on information made available by the National System for Water and Sanitation Data (SNIS), which is the official source of WSS data in Brazil.

Following the BoD approach, the inputs were replaced by a dummy equal to one and, the twelve outputs were aggregated as a Composite Indicator (CI). A Directional Distance Function (DDF) was used to allows the simultaneous analysis of desirable and undesirable indicators.

The BoD results show an increasing average performance from 2019 to 2021, but still unsatisfactory in meeting efficiency goals and universal access to services imposed by Brazilian Basic Sanitation Guideline. The productivity frontier was only spanned by 11% of the municipalities in 2021 and, 7% in 2019 and 2020. The comparison of the municipalities' positions in the ITB ranking and in the BoD ranking had consistencies, but there were also cases of sixty position variation between the two classifications.

EVOLUTION OF PERFORMANCE IN THE WATER AND SEWAGE SECTOR IN BRAZIL: A ROBUST DIRECTIONAL BENEFIT-OF-THE-DOUBT ASSESSMENT OF MUNICIPALITIES FROM SANTA CATARINA STATE

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The water supply and sewage sector (WSS) is essential for promoting health and providing the population with drinking water and the adequate disposal of effluents. Assessing the evolution of performance in WSS allows for highlighting the best and worst results achieved, identifying benchmarks, and pinpointing sources of improvement for water services. Brazil has a large population and immense freshwater reserves that are unevenly distributed throughout the territory. This situation emanates a challenge that requires the efficient management of water resources. This study develops a composite indicator framework based on the robust Benefit-of-the-Doubt (BoD) approach to estimate the performance of municipalities of the Brazilian State of Santa Catarina from 2009 to 2021, considering financial, operational, and quality dimensions associated with the provision of WSS services. Subsequently, the Global Malmquist Index (GMI) is applied to assess the performance evolution of the municipalities over time. The BoD results enable the quantification of the relative contribution of each sub-indicator to the performance score, allowing the assessment of the strengths and weaknesses of each municipality. The GMI results show an average performance loss of 3.3% in Santa Catarina state and considerable variability among municipalities, with scores ranging from losses of 54.2% to gains of 109.3% in the period analysed.

Thu|11:00-12:30|3C - Education II

Chair: Oleg Badunenko

MEASURING OPTIMAL TUITION IN TAIWAN USING A STOCHASTIC FRONTIER HEDONIC FUNCTION APPROACH

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Taiwan's higher education sector faces challenges due to government-imposed caps and intense competition amid declining birth rates. To enhance competitiveness and quality, universities require significant investment. Limited government subsidies push institutions towards tuition liberalization. Yet, no comprehensive study on optimal tuition under a cap policy exists. This paper aims to fill this gap by estimating optimal tuitions for universities of varying qualities. Using the hedonic price method, we construct a tuition function considering various school characteristics and propose a stochastic frontier hedonic price model to address market inefficiencies. Empirical analysis suggests potential tuition increases of up to 10% if market inefficiencies are eliminated. Higher quality public schools tend to have higher tuitions than private ones. Moving towards tuition liberalization could benefit schools with superior qualities, but improving market efficiency is crucial for all institutions. Additionally, the study addresses the allocation of public subsidies to support quality enhancement, especially for underfunded private universities. Optimal subsidy allocation will be explored further despite its complexity.

PERFORMANCE TRENDS IN EDUCATIONAL EQUITY IN THE OECD: AN INTERNATIONAL ASSESSMENT USING MALMQUIST INDICES

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In this research we assess the performance trends of the OECD education systems in terms of equity. To do that, we apply a novel methodology that combines a robust conditional Benefit of the Doubt (BoD) model with Malmquist indexes. This approach allows us to compare the performance of education systems over time based on a comprehensive indicator, without losing its multidimensional nature and respecting the different priorities and peculiarities of each educational system, making fairer the comparison between countries. This assessment enables us to identify which educational systems have improved their performance in equity over time (best practices) and which countries have a greater room for improvement. In addition, we assess the impact of different institutional factors and educational policies (e.g. early tracking, school choice systems, ability grouping and retention grade practices, scholarship and vouchers programs, among others) on equity performance, in order to identify effective interventions to promote more equitable education systems.

EXAMINING LABOR PRODUCTIVITY GAPS IN DIFFERENT EDUCATIONAL SYSTEMS: A COMPARATIVE ANALYSIS OF SPANISH REGIONS

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In this paper we assess the performance of schools belonging to different educational systems within the same country from a dynamic perspective. This approach makes sense in Spain, where regional governments are responsible for the educational process and the management and allocation of educational resources within their territory. Given that teachers are the main resources available to schools, we focused on analyzing changes in labor productivity using data from PISA 2018 and PISA 2022, so that we can explore potential divergences in the effects of COVID-19-related school closures in different regions. We use a nonparametric production frontier approach to decompose labor productivity to explore the changes in labor productivity between regions and over time. As such, we explain the gaps in terms of efficiency changes (catching-up effect), technological change, change in the quality of students (proxied by their socioeconomic status) and equity. The results obtained provide a full picture of the performance of Spanish regional educational systems from a comparative perspective.

Thu|14:00-15:30|Aud. - Agriculture session in honor of Gudbrand Lien

Chair: Subal Kumbhakar (online)

WHO BENEFITS MOST FROM KNOWLEDGE SPILLOVERS AND TECHNOLOGY DIFFUSION? AN ANALYSIS OF DAIRY FARMS USING A HETEROSKEDASTIC SPATIAL STOCHASTIC FRONTIER

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Stochastic frontier models that allow for cross-sectional (spatial) correlation in both noise and inefficiency terms are useful in agricultural efficiency analyses when farms sharing a common technician (consultant) benefit from best practices implemented in other farms in the same group. Being part of the same advisory group will be expected to intensify knowledge spillovers and technology diffusion among farms in that group. To identify these knowledge spillovers, we should control for spatially correlated cost/production drivers that are not observed. On the other hand, in agriculture, unobserved variables such as, among others, soil characteristics and geographical conditions can be expected to cause spatial correlation in the noise term. This calls for the estimation of a frontier model accounting for both types of spatial correlation.
We test for these effects in a sample of 108 Spanish dairy farms observed over the period 2006-2014 which contains information on production variables as well as farms' consultants. We present a novel heteroskedastic spatial stochastic frontier model that permits us to identify whether knowledge spillovers and technical diffusion depend on characteristics of the farms in a given advisory group. We find consultants have a differential impact on efficiency and that smaller, family-owned, intensive dairy farms take greater advantage of knowledge spillovers.

SHADOW PRICES OF AGRICULTURAL CARBON SEQUESTRATION AND GREENHOUSE GAS EMISSIONS

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We develop an agricultural production model where the productive and the emissions-generating sub-technologies are part of the agricultural production technology. The productive sub-technology produces revenue and carbon sequestration, and the emissions-generating sub-technology generates GHG emissions. We calculate carbon sequestration and GHG emissions shadow prices by quantifying the willingness to accept to increase sequestration and to reduce GHG emissions further, respectively. Growing cover crops is a widely accepted sustainable agricultural practice; thus, we classify fields into cover crop fields and non-cover fields and compare shadow prices between these categories. Our findings reveal that carbon sequestration shadow prices are lower for cover crop fields, reflecting the carbon benefits from the adoption of sequestration-enhancing practices. In contrast, GHG emissions shadow prices are higher for cover crop fields, suggesting increasing marginal costs of GHG emissions reduction after adopting environmentally friendly practices. This shows that implementing uniform regulations for both field types may lead to unfair financial burdens on early adopters of conservation practices.

TALKING ABOUT THE WEATHER – FARM-LEVEL INEFFICIENCY AND CLIMATE EXTREMES

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High productivity in the agri-food sector is pivotal for a sustainable future under rising food demand, a transition towards circular economies, and limited natural resources. To effectively support high productivity levels, accurate sector, land, and farm productivity measures are essential. With climate change, however, agro-climatic conditions change and alter production conditions. For instance, more frequent climate extremes lower the potential output and increase production risks. This poses a challenge in maintaining high productivity levels but also in the adequate measurement of productivity and related drivers. To quantify to which extent farms' productivity can be attributed to climate extremes, e.g., losses due to waterlogging or droughts, farms' management, or policy, we explicitly account for agro-climatic conditions in productivity measurement. Therefore, we propose a four-component SF to disentangle weather-related, managerial, and policy-induced and overall farm inefficiency but distinguish between transient and persistent components. Using an unbalanced panel of 3,401 specialized crop farms in Germany for 2004-2020 from the EU Farm Accountancy Data Network, we account for farm and regional heterogeneity and technological progress. We select relevant weather variables using machine learning and assign weather realizations based on probabilistic farm locations. Our research will contribute to the productivity analysis and climate change economics literature.

INTEGRATED CROP-LIVESTOCK VS. SPECIALIZED FARMING SYSTEMS IN THE GREAT PLAINS: WHAT SCOPE FOR SUSTAINABLE INTENSIFICATION OF FOOD PRODUCTION?

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Sustainable food production intensification is crucial for meeting rising global food demand. Integrated crop-livestock systems are advocated for improving soil health, sustaining crop productivity, and intensifying food production sustainably. This study compares integrated crop-livestock systems with specialized cropping and specialized livestock systems in terms of technical efficiency and the determinants of this efficiency. The objective is to measure and compare the technical efficiency of these systems in the US Great Plains using USDA data from the Cow-Calf 2018, Soybean 2018, and Corn 2018 surveys. We applied a Non-parametric Data Envelopment Analysis (DEA) for in-system technical efficiency measurement and a parametric stochastic frontier analysis (SFA) for the cross-system comparison. The functional form of the SFA is a quadratic translog. The findings reveal disparities in efficiency levels, with integrated systems showing higher efficiency. Labor investment positively impacts production, while the relationship with capital investment is complex. Farming experience reduces technical inefficiency. Currently, our analysis is further exploring the roles of exogenous variables such as education, government programs, and farming system types in defining the efficiency of farming systems.

Thu|14:00-15:30|-1A - Agriculture IV

Chair: Raluca Parvulescu

MEASURING THE SUSTAINABILITY EFFICIENCY OF DAIRY FARMS IN MEXICO: A PRODUCTIVE EFFCIENCY APPROACH

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Sound implementation of sustainability practices requires appropriate tools to measure farms' successes in achieving the sustainability development goals. This study evaluates the sustainability performance of Mexican dairy farms that differ in size using a data envelopment analysis approach. We model farms' production technology as the interaction of three main types of sub-technologies that govern, respectively, the production of agricultural commodities, environmental (manure and methane emissions) pollution and social outputs of milk production. To do so, we use data from a face-to-face survey carried out in 2023 for the specific purpose of assessing the sustainability performance of 100 dairy farms in Mexico. The empirical findings show that dairy farming, for our sample, operates with high technical and social performance while exhibits a relatively low environmental performance. Policymakers should promote the best-performing dairy farms to share practices on increasing productivity while considering environmental concerns to achieve better social and agricultural development. It is worth stressing that the present study only focus on livestock methane emissions and further research may consider other environmental factors.

HOW CAN AGRICULTURAL PRODUCTION BE RECONCILED WITH ENVIRONMENTAL PRESERVATION: 'LAND SPARING' VERSUS 'LAND SHARING'?

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Reconciling agricultural production with environmental preservation is one of the most challenging issues in the agricultural sector. We address this issue by considering two strategies for land management: 'land sharing' and 'land sparing'. Taking into account farm categories, we use an efficiency analysis utilising the DEA method to measure the potential for implementing these two strategies. Fam categories are defined according to two criteria: the level of agricultural land productivity measured by the yield index and the level of subsidies received by farms. Applied to farm data from the Meuse department for the period 2006–2016, the results show that agricultural production can be reconciled with environmental preservation by sparing 16 % of farmland for the environment or by reducing the use intensity of intermediate inputs by 13 % on all farmlands. Considering our farm categorisation, regarding the criterion of land productivity, our findings suggest that land sparing would be more appropriate for less productive farms and land sharing for more productive farms; regarding the level of subsidies, both land sparing and land sharing would be more appropriate for large farms that receive less subsidies. The more farms increase in size and receive subsidies, the less they contribute to the two strategies. Our results underline the importance of considering farms' characteristics in implementing an agricultural land management strategy for environmental preservation.

ENVIRONMENTALLY ADJUSTED EFFICIENCY OF RAIN-FED AND IRRIGATED ENTERPRISES IN THE SAN SALVADOR BASIN, URUGUAY

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Agricultural enterprises are often detrimental to water quality in terms of nitrogen and phosphorus nutrient pollution. Supplemental irrigation, while economically beneficial, could augment these environmental impacts due to increased nutrient runoff and percolation. In this study we evaluate the environmentally adjusted efficiency of rain-fed and irrigated enterprises in the San Salvador Basin in Uruguay. We use biophysical and production data simulated using the Soil and Water Assessment Tool (SWAT) calibrated for this basin. We consider inputs, desirable outputs (crop yields), and undesirable outputs (nitrogen and phosphorous loading in streams). We then use DEA to estimate directional distance functions, and construct environmentally adjusted Luenberger indicators of the enterprises. This gives us a relative efficiency ranking for each of the considered agricultural areas. For a given economic outcome (profit), the enterprise that has a low nitrogen and phosphorous loading is more environmentally efficient compared to enterprises that have high loadings. By correlating the environmentally adjusted efficiency scores of the enterprises with attributes such as land category, soil, cropping patterns, and fertiliser application rates, we can identify factors that are affecting the efficiency. Using our findings, policymakers can construct a relative ranking system to best determine policy directions to achieve economic and environmental objectives.

BALANCING PROFITABILITY, PROTEIN PRODUCTION, AND PESTICIDE REDUCTION: WHAT ARE THE LEVERS FOR ACTION FOR FRENCH ARABLE FARMS?

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This work investigates ways to balance farmers' profitability with environmental preservation and food supply goals. Our contribution to the academic literature is threefold. Firstly, we provide a detailed examination of three agricultural strategies — maximizing profitability, enhancing protein production, and minimizing pesticide usage — assessing their impact on farmers' income, operational expenses, and environmental sustainability. Secondly, we conduct an opportunity cost analysis using the profitability maximization scenario as a reference point, highlighting the financial trade-offs inherent in pursuing varied agricultural objectives. Thirdly, we employ an innovative methodology that considers prices as an optimization variable within activity models, offering a more comprehensive and realistic evaluation of agricultural economics. We apply data envelopment analysis to panel data from the Meuse department in France for the period 1991-2017. We show that optimal profitability is achieved by increasing farmers' income while simultaneously reducing operational costs, including pesticide use. In contrast, while the protein maximization strategy leads to an increase in pesticide costs, the pesticide minimization strategy slightly diminishes protein yield.

Thu|14:00-15:30|SA - Banking & Finance II

Chair: Robin Sickles

ISLAMIC BANKS, SQUARE PEG IN A ROUND HOLE? EVIDENCE FROM MENA REGION USING METAFRONTIER DIRECTIONAL DISTANCE FUNCTIONS

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This paper contributes to the empirical literature comparing Islamic and conventional banks by employing a new methodology to assess comparative performance in the MENA region from 2000 to 2019, using microdata of banks. Utilizing the Metafrontier Directional Distance function, it considers a multi-output production process with non-performing loans (NpLs) as undesirable output, acknowledging different technologies between bank groups. The study aims to empirically evaluate the effect of Risk-Sharing, as claimed by Islamic Finance literature, on banking efficiency. While conventional banks showed more resilience regarding NPLs, there was no significant difference in terms of Technological Gap between the two bank categories, except between 2011 and 2016, coinciding with the rise of Islamic political parties post-Arab Spring when Islamic banks have widely outranged their conventional competitors.

A MULTIDIMENSIONAL ASSESSMENT OF FINTECH COMPANIES: FINANCIAL INDICATORS, ACHIEVEMENT OF SUSTAINABILITY GOALS AND THE USE OF NEW TECHNOLOGIES

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FinTech companies have revolutionized the financial services industry with their innovative use of technology. They have not only disrupted traditional banking processes but also expanded financial inclusion and provided efficient services to a broader range of users. Thus, the assessment of Fintech companies cannot be limited to just their economic impact, since there are other relevant dimensions that must be considered as they are front and center.

We evaluate an overall performance of Fintech companies from a multidimensional perspective, considering (i) economic and financial indicators, (ii) the achievement of UN sustainability goals, and (iii) the adoption of new technologies. To do so, we define an algorithm that allows to rank the performance of DMUs by applying a Pareto dominance rule. This method takes into account both the company's influence over others and its relative performance across multiple dimensions. Priority is given based on the number of units dominated, with tiebreakers determined by the quantity of units dominating. Its main advantage is that it mitigates the common issue faced by non-parametric methods, which often yields an extensive list of efficient units. Additionally, it circumvents computational challenges associated with the inclusion of binary variables.

Through this study, we endeavor to enrich the existing literatures on Fintech and performance, by providing a comprehensive understanding of the assessment and potential of Fintech companies.

REVISITING THE IMPACT OF BANKING COMPETITION WITH NONCOVEX TECHNOLOGY

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In this contribution, we build upon recent results obtained by Kerstens and Van de Woestyne (2021) on nonconvex cost functions to investigate the impact of the convexity assumption on the Lerner index, the traditional measure of competition. Obtaining the Lerner index involves estimating marginal costs, which in turn depends on the shape of the cost function. When technology includes only one output and exhibits constant returns to scale (CRS), then convex and nonconvex cost functions coincide. In all other cases the convex or nonconvex cost functions are different. This study devises a way to obtain marginal costs for the convex and nonconvex cost functions alike, offering an updated Lerner Index. We also include a scale analysis conducted under both convexity and nonconvexity assumptions. This allows us to identify banks in three stages of production: (i) those experiencing economies of scale, (ii) those operating at optimal scale, and (iii) those facing diseconomies of scale. We use call reports on a large panel of US commercial banks to demonstrate the effect of convexity on the analysis of competition. We combine our new measure of competition under nonconvex assumptions with the scale analysis to examine the evolution of banking competition in the United States and to highlight potential issues associated with relying solely on studies conducted under convexity assumptions. This offer new insights for policymakers on the extent and impact of banking competition.

DIRECT AND INDIRECT IMPACTS OF NATURAL DISASTERS ON BANKS: A SPATIAL FRAMEWORK

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We examine the direct and indirect impacts of natural disasters on deposit rates of U.S. bank branches from 2008 to 2017. We capture the indirect impact by the spatial spillover effects of disasters, from branches directly exposed to such disasters to neighboring branches. We theoretically motivate our spatial framework by local competition for deposits among branches and provide empirical evidence consistent with this model. We find that indirect effects contribute to at least two-thirds of the total impact for deposit rate-setting branches. Rate-setting branches in affected counties, on average, raise their deposit rates on 12-month CDs by 1.5 basis points directly due to the disaster shock. However, there is an additional indirect increase of 2.7 – 4.3 basis points for all rate-setting branches, including those in adjacent but unaffected counties, due to the local geographical competition for deposits. We also confirm that the spillover effect occurs among branches across counties via an overlooked social connectedness. Moreover, and importantly, online and one-county banks are more likely to rely on the information channel embedded in the social connectedness effect in response to natural disasters. Branches in less concentrated local markets also respond more to the nature disaster and rate adjustments of neighboring branches.

Thu|14:00-15:30|3E - Productivity Analysis IV

Chair: Emili Grifell-Tatjé

U.S. FIELD CROP FARM PRODUCTIVITY: CLIMATIC EFFECTS, TECHNOLOGY, AND FARM PRACTICES

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This study considers a multi-input multi-output production technology. We apply an input-oriented stochastic distance function approach to measure farm-level technical efficiency with climatic effects using 2006-2020 USDA Agriculture Resource and Management Survey (ARMS) Phase 3 data. We further investigate the determinants of field crop farm productivity using the ARMS phase 2 data and our productivity estimates. The results show that the higher moisture condition can narrow down the distance between crop farm's productivity level and their best performances. On the other hand, farms' reactions to unexpected weather shocks oscillate from year to year, with the scale of variation converging. Overall, the mean climatic-effects-adjusted crop farm productivity is higher than the unadjusted productivity, indicating that the farm productivity could be higher if there was less adverse weather (or more beneficial weather). According to the regression results, farms who adopted yield monitors technology, fallowing in previous years, add or improve tile drainage and contour farming practices could advance their productivity levels. However, the results also show the impacts can vary between the north and the south regions.

ENVIRONMENTAL REGULATION AND LABOR EFFICIENCY

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Environmental regulation can restrict the production technology, both by restricting the quantity of allowable emissions and by making emissions reductions costly. These restrictions on the technology can also lead to a change in input demand and relative input factor shares, including labor. We construct an input-oriented labor productivity indicator to assess the change in efficient labor input levels for an environmentally regulated production technology. We compare this change to the corresponding change in efficient labor for the unregulated counterpart technology. Both indicators can be decomposed into separate efficiency and technology change components, as well as input and output mix components. Our indicator builds on previous work by extending the labor input-oriented productivity index and employment change decomposition to a directional distance framework. We apply our indicator framework to a panel of firms from the Sweden pulp and paper manufacturing sector for the years 2000-2016.

ARTIFICIAL INTELLIGENCE AND FIRM PRODUCTIVITY

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This paper examines the adoption and diffusion of Artificial Intelligence (AI) across enterprises and the relationship between using AI and firm productivity. The data used in the empirical analysis are linked firm-level data sets from Ireland over 2020-2021. Our results indicate that using AI is not widely spread across firms and it is concentrated in large firms and knowledge-intensive sectors. Descriptive statistics indicate that the adopters of AI differ systematically from non-adopters: they are larger, younger, have higher productivity and a larger market share within industry; they use a larger number of other digital technologies such as Internet of Things (IoT), cloud computing services, and software for sharing electronic information within the firm; and AI adopters have a larger share of sales linked to e-commerce. Estimation results indicate that the propensity of firms to adopt AI is positively associated with firm size, within industry market share and the adoption of other digital technologies. Estimates obtained with a production function econometric model indicate that using AI and the intensity of using AI are positively associated with firm productivity over and above other capital inputs. However, when additional factors that influence productivity are taken into account the statistical significance of this relationship holds only for the intensity of using AI.

WHAT POLICY LEVER TO PULL?: ANALYSIS OF DIRECTED TECHNICAL CHANGE FOR IDENTIFYING EFFICIENT CONFIGURATIONS OF ENTREPRENEURIAL ECOSYSTEMS

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We propose an index number, which is a special case of the Malmquist productivity index, to describe the temporal performance of the entrepreneurial ecosystem at the global scale, paying close attention to the role of directed technical change as a means for identifying changes in the configuration of this ecosystem that produce informed policy. With an application to the Global Entrepreneurship Index (GEI), our index number—the entrepreneurial ecosystem index (EEI)—is estimated on a sample of 80 countries during 2006-2015. Results reveal the importance of identifying the factors explaining variations in the configuration of entrepreneurial ecosystems. We rationalize this observation by analyzing the shifts in the ecosystem's configuration among the sampled countries: the technical change term affecting the EEI is not neutral, and actions shaping countries' entrepreneurial ecosystem follow a very irregular trajectory which might dilute the effects of ecosystem-enhancing policies. For developing countries, the generally negative result of the technical change term of the EEI suggests a mismatch between support measures and the characteristics of their ecosystem; whereas the positive and persistent directed technical change effect reported for developed economies constitutes a sign of coherence between interventions and the properties of countries' ecosystem. The methodology can produce valuable information for developing entrepreneurship policy.

Thu|14:00-15:30|3D - Health II

Chair: Camilla Mastromarco

EFFICIENCY AND FINANCIAL SOLIDITY OF HEALTHCARE SERVICE PROVIDER INSTITUTIONS (IPS) IN COLOMBIA

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Health systems worldwide are confronted with substantial financial challenges stemming from constrained public budgets, an aging population, the prevalence of chronic diseases, and an increasing demand for medical services. Thus, it is crucial to prioritize the efficient use of limited resources in healthcare systems to generate savings in public expenditure and meet the growing demands of the system. We conducted an analysis to assess the efficiency of a sample of Colombian IPS (Healthcare Provider Institutions) from 2017 to 2021. Using a stochastic frontier approach and an input-oriented distance function, we accounted for the multi-product nature of IPS. Results indicate an average technical efficiency of 75% with no observed efficiency gains over the analyzed period. The estimates also reveal significant heterogeneity in the technical efficiency of IPS, ranging from 11% to 96%, suggesting that IPS could improve service delivery by enhancing resource management and optimizing operational scale. Additionally, using the CAMEL methodology, we conducted an analysis to evaluate the financial health of IPS and its relationship with efficiency estimates. Results indicate a positive association between efficiency, profitability, and liquidity indicators, suggesting that institutions with greater financial stability and effective resource management are more efficient. These findings are relevant given the challenges faced by the sector and the fiscal constraints of the country.

PURCHASE PRODUCTIVITY IN DUTCH YOUTH CARE: LOCALLY LEAST SQUARES FRONTIER METHOD APPLIED TO MUNICIPALITY DATA

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This paper analyzes the efficiency of youth care In the Netherlands. The frontier model includes explanatory variables for efficiency based on the scaling property. In order to mirror municipalities to adequate peers the method of Locally Least Squares is applied. The method is conducted on 352 municipalities in 2021. The empirical analysis reveals significant variations in the cost efficiency. On average across all municipalities, the cost efficiency is 80 percent. These efficiency differences can only be partially attributed to differences in the design of procurement policies. Various characteristics have been examined, such as the type of outsourcing, procurement procedures, or funding methods. The most striking result is the negative effect of a framework agreement with intermediate access (compared to without) on cost efficiency. Furthermore, the so-called open house procedure has a positive effect on cost efficiency. This procedure involves a municipality having contracts with multiple providers, and citizens can choose their own provider. The analyses also show that the other procurement characteristics do not have consistent effects. An interesting side-effect of the analysis is that available quality indicators show no or a positive correlation with efficiency. This implies that

the commonly asserted claim that cost efficiency comes at the expense of quality cannot be supported.

PERFORMANCE OF ITALIAN HOSPITALS, 2015–2019

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This paper evaluates the cost efficiency of 451 general hospitals in Italy over the period from 2015 to 2019, employing fully non-parametric methods to estimate the technical efficiencies of these hospitals. This is achieved through the use of recently developed statistical methodologies, which allow us to draw inferences and quantify insights gained from the data beyond simply providing point estimates. Our findings suggest the presence of non-convexities within hospital operations, calling into question the validity of previous efficiency studies that did not account for non-convexity. Additionally, we explore productivity changes and their determinants using Malmquist indices and various decompositions. Our analysis reveals significant differences in production sets across different temporal and spatial dimensions, as well as institutional types - notably between hospitals in Central-Northern and Southern Italian regions, those engaged in research and teaching activities versus those that are not, and private versus public hospitals, including those under government recovery plans. The study conclusively demonstrates that hospitals located in Central-Northern Italy and those involved in research and teaching consistently outperform others in terms of efficiency and productivity.

Thu|16:00-17:30|Aud. - Session in honour of Finn Førsund

Chair: Robin Sickles

Special Guest, "Words to Honor Colleague Lennart Hjalmarsson".
Sverre Kittelsen, "Scale economies and capacity utilization in somatic hospitals in Norway".
Kenneth Løvold Rødseth, "Estimating and decomposing environmental efficiency using a generalized materials balance model: Application to U.S. power plants".
Victor Podinovski, "Scale and marginal characteristics of nonparametric production frontiers".
Rolf Färe and Shawna Grosskopf, "Production under physical constraints" (online participation).

Fri|09:00-10:30|Aud. - SFA Methods I

Chair: Alex Stead

THE DOUBLE HURDLE STOCHASTIC FRONTIER MODEL WITH ORDERED MULTIPLE CHOICES

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This paper combines the double hurdle model and stochastic frontier model with endogenous switching between multiple regimes, allowing for the two choices in the second selection stage to be expanded to multiple possible choices. By doing so, we can correct for the sample selection bias that may arise from a one-stage selection instead of a two-stage selection, and also take into account heterogeneous observations, further to make heterogeneous observations fall into groups with reasonable production technologies randomly. For the proposed model, I derived the closed form of the likelihood function and the estimator of the technical efficiency index based on the sample selection information. In the empirical study, I studied the production efficiency of the labor market in the United States. Evidence suggests that considering two selection stages is necessary when observations are heterogeneous. Otherwise, the estimated production structure and technical efficiency indices would be invalid.

A BAYESIAN, SEMI-PARAMETRIC APPROACH TO INEFFICIENCY HETEROGENEITY IN SFA

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We introduce a new, semi-parametric approach to estimation for stochastic frontier analysis in the presence of inefficiency heterogeneity. Although the frontier is estimated parametrically, the inefficiency term is fitted nonparametrically using a Dirichlet process mixture of regressions approach. Under this approach, no specific distributional form for the inefficiency distribution is imposed, neither is it assumed that the variables influencing the inefficiency do this in a linear way. All inference is carried out in a Bayesian way. Our approach is illustrated with real data examples.

ESTABLISHING A LINK BETWEEN QUANTILE REGRESSION AND THE MAXIMUM LIKELIHOOD ESTIMATION IN STOCHASTIC FRONTIER ANALYSIS

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Recently, there has been a growing interest among researchers in utilizing quantile regression for stochastic frontier analysis (SFA). However, despite the progress made in this area, there remain several issues yet to be resolved. These include determining a correct link between SFA as a parametric model and quantile regression as a maximum likelihood estimation of parametric models, establishing a solid foundation for estimating frontier's location, and developing parametrically sound conditional estimators of unit inefficiency. This study argues that with the conventional properties of stochastic components in parametric SFA, quantile regression cannot be considered as a maximum likelihood estimation. The study proposes a new parametric SFA model and ensures that quantile regression is equivalent to its maximum likelihood estimation. Further, it suggests a maximum likelihood estimator for the location of the frontier, and it develops the conditional estimators of unit inefficiencies. Additionally, it contains a simulation study and an application of the methodology to actual data.

A ROBUST ESTIMATION APPROACH TO SOLVING THE 'WRONG SKEW' PROBLEM

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The 'wrong skew' problem in stochastic frontier analysis is one that occurs frequently in empirical applications. The problem is generally treated as either a model misspecification problem or as a small sample issue. We propose approaching the problem from a robustness perspective, which suggests the use of robust estimation methods as a possible solution. This is attractive since it offers a way of dealing with (small) departures from distributional assumptions, whatever the cause. We explore the use of a Student's t based M-estimator which has been shown to have good robustness properties. In applications to simulated data, we show that this approach is effective in dealing with the 'wrong skew' problem whether it arises by chance in small samples or as a result of data contamination, yielding improved parameter estimates and efficiency predictions. Tuning of the estimator, bias correction, and approaches to efficiency prediction are discussed.

Fri|09:00-10:30|-1A - Agriculture V

Chair: Stefen Seifert

INVESTIGATING PESTICIDE-SPECIFIC USE INEFFICIENCY IN THE PRESENCE OF ENVIRONMENTAL SPILLOVERS

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Studies assessing farmers' pesticide use performance have traditionally suggested uniformly reducing all types of pesticides. However, this approach overlooks significant distinctions among various pesticide categories, such as fungicides, insecticides, herbicides, and others. By employing a non-parametric directional distance function, our preliminary analysis reveals statistically distinct levels of technical inefficiency across these pesticide groups. By applying a dynamic data envelopment analysis (DEA) and a by-production model, we expect to find increased pesticide use efficiency when pesticide impacts are considered. Subsequently, truncated bootstrap regression is used to investigate associations between pesticide-specific and environmental inefficiency and farmer socio-economic characteristics. The study results are expected to inform decision-making to enhance agricultural productivity while minimizing environmental impacts from pesticide use.

CAN WE OBSERVE RELATION BETWEEN ENVIRONMENTAL SUBSIDIES, BIODIVERSITY AND ECONOMIES OF SCOPE IN CZECH AGRICULTURE?

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The paper deals with an analysis of the relation among environmental subsidies, biodiversity and economies of scope in Czech agriculture. The analysis is carried out using the FADN database and the

micro level perspective. We use the stochastic input distance frontier models that are applied on the main agricultural sectors to provide the inter- as well as intra sectoral comparison of Czech farmers. The study hypothesized that farm agri-environmental commitments such as adoption of conservation practices generally prerequisite substantial changes in production technology and are therefore supposed to influence economies of scope and scale effects, and to impact farm practices addressing resource scarcity. That is, to better understand the determinants of structural adjustments in agriculture considering farm agri-environmental commitments and economies of scope and cost complementarities may provide evidence on the motivation of farmers to produce both environmental and marketed outputs. The preliminary results show that there are significant differences among the sectors. Moreover, due to the dual structure of Czech agricultural we found significant differences in the cost flexibility between small and large farmers or agricultural companies, respectively. In particular, the small farmers have higher cost flexibility than the large ones. However, more systematic research is still required to understand the potential for improving local eco-system resilience and productivity.

LAND FRAGMENTATION AND FARM PERFORMANCE: THE CASE OF AUSTRIAN CROP FARMS

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Using a 2007-2014 panel of Austrian crop farms we analyze the effect of multiple dimensions of land fragmentation (LF) on farms' production efficiency and risk performance. We use Data Envelopment Analysis (DEA), a non-parametric linear programming approach, to estimate efficiencies. Technical efficiency is decomposed into i) scale efficiency, ii) pure technical efficiency, and iii) input-mix efficiency. Risk efficiency, a concept borrowed from modern portfolio theory, measures the performance of a farm relative to a mean-variance frontier. A second-stage DEA analysis reveals that farms with fewer plots and shorter average farmstead-plot distance tend to be more technically efficient. The scattering of plots has no statistically significant effect on technical efficiency but provides benefits in terms of higher risk efficiency. Larger plots allow for better exploitation of returns to scale. Land consolidation projects should carefully weigh out costs and benefits associated with different dimensions of LF.

ALGORITHMS KILLED THE TRIAL CONDUCTOR: A PROPOSAL FOR A FRONTIER APPROACH TO DIGITALIZE THE SEED VARIETY ADMISSION

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Climate change necessitates new crop breeding objectives to address temperature and precipitation shifts, including tolerances against climate extremes such as droughts, winter kills, and floods. Using digital technologies in plant breeding aims to aid in reducing climatic stresses on crops. Yet, using digital technologies requires identifying improvements in yields and other crop variety evaluation criteria without endangering the underlying crop genetic resources. Focusing on winter wheat (Triticum aestivum), this paper evaluates whether new varieties shift the breeding frontier by adding

improved traits. We base our analysis on a unique and detailed unbalanced panel dataset of the German variety admission of 229 winter wheat varieties for 2008-2016, where we observe 32 variety-specific characteristics related to cultivation, yield, and quality. Using non-parametric FDH and skyline algorithms, we benchmark newly admitted against existing wheat varieties. Preliminary results indicate that throughout the observation period, nearly all new varieties have pushed the frontier, although the observed frontier shift is small. To improve further our analysis, we plan to address concerns related to the high dimensionality of the wheat characteristics, considering dimension reduction tools such as principal component analysis. Our procedure may serve as a first step towards developing a decision support system selecting varieties during variety admission processes.

Fri|09:00-10:30|CC - Gender (in)equality

Chair: Antonio Alvarez

MEASURING TOTAL GENDER PAY GAP WITH HICKS-MOORSTEEN INDEX

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The adjusted gender pay gap (GPG) is typically measured with the Blinder-Oaxaca (1973) decomposition, comparing the average wages of males and females. However, gender inequalities are also due to men having greater access to senior positions and being more prevalent in top-wage roles. Thus, an efficiency approach appears particularly relevant as it compares the distance of males and females to the frontier, which represents the highest potential wages based on human capital characteristics. Efficiency approach using DEA for measuring GPG is rather scant (Mohan et al., 2003 & 2007; Bowlin et al., 2003 & 2008). Amado et al. (2018) are pioneers in suggesting a Malmquist Index that separates the wage frontier for females and males. Their study computes an output-oriented Malmquist with Constant Returns to Scale (CRS). Nonetheless, CRS is a strong assumption for wage structure. Secondly, gender inequality is also due to differences in human capital investments and an input-oriented Malmquist would also be relevant. Thirdly, several studies (O'Donnell, 2012; Peyrache, 2014; Kerstens et al., 2018) have shown that the Hicks-Moorsteen Index (HMI) is better than a Malmquist Index alone, as it combines both output and input-oriented Malmquist indices. Thus, we employ the HMI using the 2019 French Labour Force Survey to assess the overall GPG. Given that our comparison involves distinct samples (women and men) we calculate an original HMI that evaluates each woman against every man.

LOOKING FOR UNITY IN EQUALITY: EVALUATING FEMALE DISADVANTAGE AND ACHIEVEMENT IN EU REGIONS

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This paper examines gender (in)equality in the EU regions across the core life domains, ‘Work & Money’, ‘Knowledge’, ‘Power’, ‘Health’, ‘Safety, Security & Trust’, and ‘Life Satisfaction’ in 2019. The

paper advocates different versions of the non-parametric (Benefit-of-the-Doubt) frontier estimation approach for estimating gender inequality across these six domains. The results reveal considerable differences across the domains with larger gender inequalities towards women being observed in the domains 'Power' and 'Work & Money'. However, overall, gender gaps seem to have decreased over the years. Results show a geographical pattern with northern EU regions being more gender-equal and attaining higher achievement scores across the domains, followed by western and then southern EU regions.

GENDER DIFFERENCES IN PRODUCTIVITY IN THE BANKING SECTOR

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The existence of gender wage differentials has been widely documented, and these differences have been attributed to differences in human capital accumulation, preferences and discrimination. The traditional approach to test theories of wage determination is to estimate wage regressions. However, without an accurate measure of worker productivity, it is difficult to determine whether wage differentials reflect productivity differences or other factors, such as discrimination. Several studies have estimated differences in productivity between men and women using productivity analysis techniques (Hellerstein & Neumark, 2007).

In this paper we test for the existence of gender differences in productivity in the banking sector using a stochastic frontier approach. We base our estimation on a Translog modification, where the labour input is defined as a weighted sum of male and female workers; the weights are estimated from the empirical specification. Moreover, we test whether the proportion of female managers affects firm efficiency. This is relevant as many countries are adopting policies aimed at increasing the presence of females in decision-making.

We use data from the Statistical Yearbook of the Spanish Banking Association for the years 2005-2021. We have an incomplete panel covering 63 unique firms over 17 years, corresponding to 563 observations. We consider 2 outputs: loans and deposits and 4 inputs; capital and three labour categories disaggregated by gender.

MEASURING THE GENDER WAGE GAP USING STOCHASTIC FRONTIERS: SOME MODELLING ISSUES

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This work proposes to estimate the extent of the gender wage gap in Italy, using a wage stochastic frontier (SF) model. Our empirical setting follows the SF specification of Caudill et al. (1995). While we do not make any significant methodological contribution, we make a thorough discussion of the modelling issues which surround the specification of wage frontiers in order to estimate the gender wage gap. Obviously, when the empirical strategy involves estimating a pooled model for men and women, the gender wage gap depends on the sign and size of the estimated parameter for a gender dummy variable. Since we estimate a model that allows us to include inefficiency determinants, some

specification alternatives arise regarding the inclusion of the gender dummy. In fact, it can be included in the frontier, in the inefficiency term, or in both. While previous literature has adopted one of this three options, we compare the three of them and show the differences not only on the results obtained but also on the interpretation of the three options.

An additional feature of our paper that is worth noting is the computation of the gender wage gap in a stochastic frontier framework. Previous literature has estimated earnings frontiers using a dummy variable for gender and they have checked the significance of this dummy in order to identify the existence of a gender wage gap but they have not quantified it.

Fri|09:00-10:30|SA - DEA Methods III

Chair: Antonio Peyrache

A SINGLE-STAGE SOLUTION PROCEDURE WITHOUT A SMALL EPSILON

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In DEA, the assessment of efficiency of a decision making unit (DMU) is typically performed in two stages. At the first stage, the DMU is projected on the boundary of technology, in either the input or output orientation. This defines its radial projection and radial target. The second stage maximises the sum of input and output slacks, which results in the identification of an efficient target of the DMU. A traditional alternative is a combination of the two stages into one in which the sum of input and output slacks is multiplied by a small constant epsilon and incorporated into the objective function of the first-stage model. In this paper, we show that the two-stage procedure can be replaced by a single linear programme which does not require the use of a small value epsilon. The idea is to substitute the input or output improvement factor, which is fixed in the conventional second-stage model, by the objective function of the first-stage model taken in the dual form. The resulting single-stage linear program is equivalent to the two separate stages and does not use the small value epsilon.

DECOMPOSITION WEIGHTS AND STAGE EFFICIENCIES IN THE ADDITIVE NETWORK DEA MODEL WITH SHARED RESOURCES

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This paper investigates issues regarding the decomposition weights in the additive two-stage network Data Envelopment Analysis model with shared resources. In the input-oriented two-stage additive NDEA model with shared resources and constant returns to scale, Wang, Wu and Chen (2019) found that the relationship between the decomposition weights is uncertain. Thus, the bias towards the first stage inherent in the elementary two-stage additive NDEA model (i.e., resources are used only in the first stage), as seen in Ang and Chen (2016) and Despotis, Koronakos and Sotiros (2016), does not exist. In this paper, we first challenge this result by providing necessary conditions for decreasing decomposition weights. However, we demonstrate that Wang, Wu and Chen (2019)'s result holds for

the output-oriented model under constant returns to scale. We then examine the relationship between the decomposition weights in the case of variable returns to scale and provide sufficient conditions for non-increasing decomposition weights. In these cases, it is crucial to consider how the shadow value of resources relates to the value of the free parameter of one of the two stages. Additionally, we investigate the relation between the decomposition weights under different variants of the model, namely, (1) when both shared and dedicated resources are used at the first stage, (2) when external inputs are use in the second stage, and (3) when final outputs are produced at the first stage.

THE PARALLEL MULTI-COMPONENT NETWORK DEA WITH VARIABLE RETURNS TO SCALE

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This paper presents the parallel multi-component network DEA model in the case of variable returns to scale. It turns out that the convexity constraint in the proposed model is different from that in the conventional variable-returns-to-scale DEA model as it accounts for the number of sub-DMUs, i.e., components, is each DMU. This is in accordance with the centralised resource allocation structure of the model, where DMUs supervise a number (not necessarily equal) of sub-DMUs and they are allowed to reallocate resources and activities across them. We demonstrate that optimising the model with a parallel multi-component structure, as proposed by Kao (2017), is equivalent to finding weights that maximise the relative efficiency of virtual DMUs with average inputs and outputs values of the constituent sub-DMUs in a conventional DEA model. This has important implications as we can solve a problem having a parallel network structure using a conventional DEA model, which includes average productions units. The results hold both for the case of constant and variable returns to scale. We investigate these cases using data on national forest districts in Taiwan, each with multiple subdistricts.

HOMOTHETIC DATA GENERATED PRODUCTION METATECHNOLOGIES

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In this paper I consider a set of group technologies (for example time or period specific) and their metafrontier built as the union of these group technologies. I propose a method to build group technologies that satisfy homotheticity and Hicks neutrality (input sets are radial shifts of each other, i.e. they are homothetic to each other). The union of these neutral homothetic group technologies returns a metatechnology that is homothetic. This homothetic metatechnology coincides with the pooled homothetic metatechnology. I show that the neutral homothetic group technologies so constructed are the minimal technologies that will return the homothetic metafrontier as their union.

Fri|09:00-10:30|3E - Productivity Analysis V

Chair: Hideyuki Mizobuchi

LEVERAGING INNOVATION FOR IMPROVED SERVICE PRODUCTIVITY: INSIGHTS FROM STOCHASTIC FRONTIER MODELS WITH ENDOGENEITY

Authors: Fikru Alemayehu[1]; Kai Sun[2]; Subal Kumbhakar[3]
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This paper examines the impacts of innovation on productivity and technical efficiency in the service sector. We employ a unique methodological approach, combining a control function and a stochastic frontier model that accounts for the endogeneity of environmental variables within a semiparametric smooth coefficient framework implemented based on data drawn from the Community Innovation Survey and firm accounting records spanning from 2003 to 2020. The results show that innovation appears to have a U-shaped direct impact on productivity and positive indirect effects (through input factors). In addition, innovation decreases the technical efficiency of firms in the Norwegian service sector, contrary to our expectations. The study also reveals heterogeneity between firms and industries within the service industry, emphasizing the need to consider firm-specific characteristics and market conditions when analyzing the effects of innovation. The findings of this study serve as a catalyst for organizations, policymakers, and researchers to promote innovation, improve service productivity, and support innovation-driven growth in the services sector.

HOW DOES RURAL GENTRIFICATION AFFECT FARMING EFFICIENCY? APPLYING RENT GAP THEORY TO AGRICULTURE

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Capital flowing into rural areas results in gentrification. Among the channels of capital inflow, the key processes are peri-urbanisation, investment in renewable energy sources, development of tourism and recreation. In these processes, land is a key factor. As a result, the potential income capitalised into farmland prices detaches from the current net return to farmland expressed in rental fees or operating surpluses, which creates a rent gap. Such a perceived rent gap may discourage farmers from investing in agricultural activities, especially in countries with a fragmented agrarian structure, where farm size growth and land concentration are crucial in farm development. Farmers must systematically improve production efficiency to keep up with runaway land prices or withdraw from this race, which may decrease efficiency. It is therefore unclear how the rent gap affects the efficiency of agricultural production and the main purpose of this article is to answer this question. An analysis was performed at the farm level using Polish Farm Accountancy Data Network panel dataset (2009–2019, 3,560 observations), stochastic frontier analysis and a true random effects model. The results show that the rent gap is so discouraging for farmers that it decreases agricultural production efficiency. Unused economies of scale and technological regress were also observed. This situation may exacerbate trade-offs between global food security objectives and renewable energy production.

A THEORETICAL MODEL OF EFFICIENCY DISTRIBUTIONS

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To understand the allocation of inputs, the growth of output(s) and the drivers of changes in both, we need theories of distribution. A theory of the distribution of the size of firms helps us understand the dynamics of growth (Gabaix, 2016). A theory of the distribution of networks helps us to understand how small shocks can have large effects (Acemoglu et al., 2012). A theory of the distribution of investment helps us to understand how the allocation of resources affects aggregate output (Caballero and Engel, 1999).

In this paper, we take as a premise that the technical inefficiency distribution is a function of the counteracting forces of technical change and technical convergence over time. Building upon this premise, we seek to improve our understanding of the relationship between the counteracting force of technical change and technical convergence and the formation of the technical inefficiency distribution. Thereby, we ask:

• What is the relationship between the processes of technical convergence/technical change and the behaviour of the inefficiency distribution?

• What additional assumptions do we need to impose on our modelling framework to attain the distributional shapes imposed in stochastic frontier models?

We aim to identify whether the inefficiency distribution exhibits any regularities across different economic markets, and if so, which. Based on the results of our model we formulate a theory about the distribution of technical inefficiency.

LASPEYRES-PAASCHE BOUNDS FOR PRODUCTIVITY INDEX

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The Laspeyres and Paasche indices are two widely used empirical indices. Among their important features is their ability to provide the upper and lower bounds, respectively, for the cost-of-living index, which is the representative theoretical consumer price index. In this paper, we demonstrate that the Laspeyres and Paasche indices can also provide bounds in the context of productivity measurement. However, their role changes such that the Laspeyres and Paasche productivity indices provide the lower and upper bounds, respectively, for theoretical productivity indices. Furthermore, we also prove that the Laspeyres productivity index is necessarily lower than the Paasche index under Hicks-neutral technological change. Finally, by applying this inequality to the US industry data, we reveal that its annual technological changes from 1987 to 2021 can be regarded as non-Hicks-neutral, i.e., biased towards certain inputs.

Fri|09:00-10:30|3D - Electricity Regulation II

Chair: Kjartan Rasmussen

HOW DOES THE CEO'S GENDER AFFECT PUBLIC UTILITIES' ECONOMIC DECISIONS?

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The impact CEOs' gender has on firms' financial performance has received a great deal of attention in the finance and economics literature. There is also an emerging literature on whether female decision makers are more socially responsible. We add to both these streams of literature by investigating how the gender of Swedish public utility CEOs affect the price, quality, and cost of electricity distribution. We use an unbalanced panel data set from 1998-2022 and both a difference-in-difference (DiD) and synthetic control approach to estimate the treatment effect. The data is staggered, i.e. changing the CEO from a male to female, has occurred at different points in time. This can bias DiD, unless the treatment effect is homogenous across time. Due to the few treatments each year, the heterogeneous DiD methods recently developed are not applicable and, consequently, we use synthetic control as our preferred method. Each change from male to female is estimated separately and we arrive at the overall effect by pooling all the individual, potentially heterogeneous effects.

A COMPARISON OF DATA ENVELOPMENT ANALYSIS, STOCHASTIC FRONTIER MODELS AND MODEL COMBINATION APPROACHES USING PANEL DATA

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Agencies that regulate local, natural monopoly markets often apply nonparametric data envelopment analysis (DEA) and stochastic frontier analysis (SFA), as well as combinations of the two approaches. Even though they typically have access to panel data, they often use simple averages of a few years which they treat as cross-sectional data. These methods have recently been evaluated in simulation studies and it is shown that they often underestimate the true efficiency values. We contribute to this literature by investigating the performance of the four random-components SFA panel model relative to other approaches using DEA, SFA, or a combination of DEA and SFA, either using data that is averaged over a set of years prior to estimation or using averages of estimates over the years from cross-sectional estimates obtained for each year. The data is generated according to a panel data stochastic frontier model that has either a piecewise or a translog basis and that allows for both persistent and transient inefficiencies along with random firm effects and statistical noise. The results indicate that the methods based on the four random-components SFA model perform relatively well, especially in having low mean square error, so we suggest more regulators should consider its use in their calculations of technical efficiencies. Finally, we illustrate the methods using 5 years of data for 135 firms from the Swedish Energy Markets Inspectorate.

CROSSING NON-PARAMETRIC AND PARAMETRIC TECHNIQUES FOR MEASURING THE EFFICIENCY: EVIDENCE FROM THE IBERIAN GAS DISTRIBUTION SYSTEM OPERATORS

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This study presents a benchmarking analysis performed by the Portuguese Energy Services Regulatory Authority (ERSE) to support the decision on efficiency targets for the gas distribution activity for regulatory period from 2024 to 2027. ERSE applied an incentive regulation methodology on this activity. The collaborative process between ERSE and its Spanish counterpart (CNMC) allowed to set an Iberian sample of gas distribution operators.

To achieve the study's aim, we applied two non-parametric methodologies, Data Envelopment Analysis (DEA) and Malmquist Index, and one parametric methodology, the Stochastic Frontier Analysis (SFA), in particular, the Ray Frontier Production Model. The efficiency analysis models included two outputs related to the gas distribution activity: supply points and energy distributed. Regarding inputs, operating expenses (OPEX) are considered the proxy for operational activity.

For analysing the companies' efficiency performance, we followed a specific procedure. Firstly, we estimated the efficiency values using the Ray Frontier Production Model and the DEA. Next, we defined efficiency groups based on the percentile ranges derived from the global scores. Then, we applied the efficiency of technological progress (from the Malmquist Index Analysis) to the most efficient group and heightening the following groups according to the level of efficiency. Finally, we set the goal efficiency for each company, considering its position in the respective groups.

TIME-VARYING AND TIME-INVARIANT EFFICIENCY AMONG THE ELECTRICITY DISTRIBUTION COMPANIES IN SCANDINAVIAN COUNTRIES – A PANEL DATA STOCHASTIC FRONTIER APPROACH

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Electricity Distribution System Operators (DSOs) in Denmark, Norway, Sweden, Finland, and Iceland, along with numerous other nations, operate as local natural monopolies. Regulatory bodies in each of the five countries are responsible for overseeing and regulating the market to offset this inherent market failure. Methodologies employed in each country to achieve this task share significant similarities, encompassing the data generation process (including data collection and description) as well as regulatory methods of applying some variation of revenue caps. Yet, microeconomic cross-country studies on DSO performance are mostly absence in the literature. Arguably, this scarcity partly stems from challenges in distinguishing endogenous DSO performance from exogenous influences. This study addresses this gap by employing a panel data Stochastic Frontier Analysis (SFA) to examine efficiency components, including short-term adjustable time-varying efficiency endogenous to each DSO and short-term unadjustable time-invariant efficiency exogenous to the DSO. The latter is further categorized into DSO-specific and country-specific measures, capturing environmental and regulatory effects, respectively. This framework enables examination of efficiency impacts due to regulatory variation, which could be influenced and optimized by regulators, versus those arising from environmental differences which are largely beyond the control of both DSOs and regulators.

Fri|09:00-10:30|3B - Manufacturing I

Chair: Mohsen Afsharian

TECHNICAL AND STRUCTURAL EFFICIENCY IN ENERGY USE IN INDIAN MANUFACTURING: AN INTER-STATE ANALYSIS

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In light of the rising energy costs one the one hand and the threat of catastrophic climate changes on the other, efficient utilization of energy has become a top priority in Indian manufacturing. This paper uses state-level data for total manufacturing from the Annual Survey of Industries, India for the years 2013-14 through 2019-20 to examine to what extent it would be possible to reduce energy consumption without reducing the (aggregate value of) industrial production or increasing any of the non-energy inputs (labor, materials, and capital). For each state, the free disposal convex hull of the output and inputs per firm is used to construct the production possibility set. First, an energy-oriented measure of technical efficiency is obtained for the average unit in each state. The implied reduction in energy use per firm is then scaled to measure the state-level reduction in energy use. Next, the optimal number of units in any state is endogenously determined from a mixed integer programming problem. The potential reduction in energy use with the number of firms held unchanged is an indicator of technical efficiency of the average firm. Any further reduction achievable by altering the number of firms (and thereby the size of an average firm) is an indicator of the structural efficiency of the manufacturing sector in a state. Our empirical analysis shows considerable extent of both technical and structural inefficiency in multiple states over the years.

DIGITALIZATION AND FIRMS MARKUPS: EVIDENCE FROM SPANISH MANUFACTURING FIRMS

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We aim to study the impact of digitalisation on firms' total factor productivity (TFP) and profit margins, while identifying characteristics that enable firms to exploit the digitalisation benefits, using the Spanish Survey of Business Strategies, 2001-2018. Digitalisation requires a multidimensional approach to its measurement. Hence, we construct a synthetic firm level index of digitalisation using different dimensions.

Second, we estimate the impact digitalisation on TFP, estimating a Cobb-Douglas production function and assuming that TFP evolves according to an endogenous Markov process that depends on firms digitalisation. Estimating the production function allows to recover TFP and to estimate profit margins according to De Loecker and Warzynski (2012). When investigating the causal role of digitalisation on margins, we control for the potential endogeneity of digitalisation. To establish causal relationships, we exploit variations in telecommunications regulation as determinants of digitalisation by using OECD data on telecommunications.

This paper contributes to the literature by providing empirical evidence on the role of digitalisation on TFP and profit margins as a measure of market power. These findings are crucial for understanding macroeconomic phenomena like slow productivity growth, declining labour force participation, rising income inequality and limited technology diffusion. They inform debates on global resource allocation and the competitive order.

LEVERAGING BENCHMARKING FOR DEMAND PREDICTION AND PRODUCT EVALUATION IN SUPPLY CHAIN MANAGEMENT

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This paper explores the application of benchmarking in the context of supply chain management, focusing on its use for both evaluating existing product alternatives and predicting the demand for new products. Specifically, it investigates the challenges and complexities associated with polytope volume computation within this domain. We investigate the challenges associated with this approach, including computational intensity, scalability issues, sensitivity to data quality, interpretability concerns, and complexity in finding similar alternatives. In response, we propose leveraging modern benchmarking methods to provide a more user-friendly and transparent framework for assessing and predicting demands. By adopting modern benchmarking techniques, organizations can overcome the computational intricacies and opacity associated with the revealed preferences approach, thus facilitating more informed decision-making processes and enhancing overall supply chain efficiency.

Fri|09:00-10:30|3C - Education III

Chair: Dimitrios Sotiros

INCORPORATING PERCENTAGES IN THE ASSESSMENT OF SCHOOL EFFICIENCY: AN EMPIRICAL STUDY

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Inputs and outputs together describe the production process of organisations. Although the choice of inputs and outputs is well-discussed, the data form of variables is less attended. There are two forms of data: absolute volume measures (e.g., production or service levels) and ratio measures (e.g., averages, percentages, and rates). The latter are often used in DEA applications; however, they breach the underlying assumptions of standard DEA models (e.g., the assumption of convexity). Olesen, Petersen, and Podinovski (2015) developed ratio variable and constant returns-to-scale (R-VRS and R-CRS) models to allow the use of ratio measures along with volume measures in DEA models. In this paper, we use an application to secondary schools in England to examine the difference between using the standard DEA models and ratio DEA models. We also use a Monte Carlo simulation to show the difference of these two types of models.

THE EFFECTS OF HIGHER EDUCATION SYSTEMS' EFFICIENCY IN REGIONAL ECONOMIC GROWTH AND INEQUALITY REDUCTION: THE CASE OF THE MEXICAN STATES

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With more than 3,000 institutions and interesting public-private dynamics, the Mexican higher education system is one of the most complex in the world. Mexico is a country in which regional inequalities are relevant; higher education policy has been an important leverage to create human capital, innovation and technological progress that can be helpful to overcome these regional differences. This paper explores the impact of higher education systems' efficiency of the Mexican states in their economic growth during the period 2016-2022 and seeks to understand their role in reducing inequality. We compute efficiency scores using DEA VRS models with enrolment, FTE Faculty and FTE non-academic staff as inputs, and graduates, papers and patents and outputs to build a and decompose a Malmquist Index in Technical Change, Scale Efficiency Change and Frontier Shift that are used as explanatory variables. We ran econometric models with GDP per capita growth and GINI Index reductions as dependent variables. We included control variables such as lagged labor productivity, physical investment rate and variables that describe state's productive structure to capture disparities. To deal with some endogeneity sources we used a generalized method of moments (GMM). Preliminary results show a general positive link, but regional differences seem to be very important; states with higher GDP per capita and labor productivity levels, take more advantage from their higher education system's efficiency while states with lower levels, struggle to have efficient higher education systems and are unable to translate the in economic growth and inequality reduction despite growing levels of enrolment and the growing number of institutions.

A GENERALIZED COMPOSITION APPROACH IN NETWORK DATA ENVELOPMENT ANALYSIS FOR COMPLEX STRUCTURES: AN APPLICATION TO HIGHER EDUCATION INSTITUTIONS IN POLAND

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Network Data Envelopment Analysis (NDEA) is an extension of Data Envelopment Analysis (DEA) that takes into consideration the internal structure of Decision Making Units (DMUs) in the efficiency assessment. In NDEA, every DMU is conceived as a network of several sub-processes arranged into a series, parallel or mix of series and parallel (complex) structures. In the literature, most of the studies focus on series structures while the drawbacks of the methods developed for the efficiency assessment of parallel structures are neglected. In this paper, we discuss the pitfalls of the most established NDEA method for parallel structures, and we develop a new method to treat these issues. Our method relies on Multi-Objective Programming (MOP) techniques and can be generalized to any type of internal structure. We compare the introduced method with other prominent methods in the literature highlighting the differences and the advantages of the proposed method. Finally, we employ this method to evaluate the teaching and research efficiency of Polish higher education institutions.

Fri|11:00-12:30|Aud. - SFA Methods II

Chair: Christopher Parmeter

THE MOTIVATION FOR APPLICATION OF ROBUST STOCHASTIC FRONTIER ANALYSIS IN REGULATORY BENCHMARKING

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Stochastic frontier analysis has a venerable history in the academic literature, having been formulated and developed for over 45 years. In addition, over this period, many countries have implemented reforms to delivery and ownership of public services and infrastructure which necessitates some form of economic regulation, ergo requiring measurement of firm efficiency. With this context, it is perhaps surprising and disheartening that adoption of SFA is relatively limited in the policy and regulatory space. In this presentation we consider why adoption is so low in such settings, with simpler analysis often adopted. We then consider the models and estimation techniques emergent from recent work on Robust SFA e.g. Wheat et al 2019 JPA and Stead et al 2023 EJOR, and implications for regulatory settings. We consider three features: 1) The models yield efficiency predictions which are not constrained to be monotonic with residuals recognising the that uncertainty increases towards the tail of the residual distribution; the implication this has for incentives on firms to reveal true data on their costs and production, 2) The robustness properties of the estimated frontier parameters and the constrained influence of erroneous data, 3) The lack of sensitivity of inefficiency variance estimates to "wrong skew" in the residuals. Taken together the presentation argues that robust SFA provides a substantial point of difference to other techniques that should appeal to regulators.

THREE-WAY RANDOM EFFECTS STOCHASTIC FRONTIER MODEL

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We propose a general random effects stochastic frontier model, which controls heterogeneity in the frontier and the distribution of the composed error error term. Our model controls the heterogeneity in the frontier via a random effects term; and the heterogeneity in the distribution of the composed error term via random variances. We also generalize our model to allow endogeneity. We estimate our model via the maximum simulated likelihood method. Our Monte Carlo experiments illustrate that our estimator performs well. Using our model, we estimated the efficiencies of US banks between 1976-2007. The median estimated efficiency in this time period is 92.3%.

LASSO+SFA AND XISTENCE OF INEFFICIENCY

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We revisit the classic debate between Stigler (1976) and Liebenstein (1978) about the notion of inefficiency of economic agents--whether it exists and if and how it can be explained using some economic variables in practice. Unlike the original debate of Stigler and Leibenstein, our articulation of this topic is based on statistical approach. Specifically, we try to get insights onto the problem of

observing (or not) the inefficiency in the presence of a high number of conditioning (or so-called `environmental') variables. We focus on the post-single LASSO and post-double LASSO under different scenarios but the arguments can be extended to other model selection tools from machine learning. We start by exploring whether inefficiency can arise spuriously as a result of a large number of irrelevant environmental factors present in a simple SFA model estimated by COLS. We then show that LASSO can effectively detect irrelevant variables and re-establish the true skewness of the error term. We then discuss the impact that application of the LASSO has on the estimates stemming from maximum likelihood estimation of the stochastic frontier model. Not surprisingly we see that the same issues in the regression setting with direct application of the LASSO prior to MLE lead to a bias in the estimation of ``fixed'' parameters of the frontier model. We propose a post-double LASSO estimator for the stochastic frontier model which helps resolve this issue.

INFERENCE IN THE NONPARAMETRIC STOCHASTIC FRONTIER MODEL

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This paper is the first in the literature to discuss in detail how to conduct various types of inference in the stochastic frontier model when it is estimated using nonparametric methods. We discuss a general and versatile inferential technique that allows for a range of practical hypotheses of interest to be tested. We also discuss several challenges that currently exist in this framework in an effort to alert researchers to potential pitfalls. Namely, it appears that when one wishes to estimate a stochastic frontier in a fully nonparametric framework, separability between inputs and determinants of inefficiency is an essential ingredient for the correct empirical size of a test. We showcase the performance of the test with a variety of Monte Carlo simulations.

Fri|11:00-12:30|-1A - Agriculture VI

Chair: Orlando Rodriguez

IMPACTS OF DEFORESTATION ON BRAZILIAN AGRICULTURAL PRODUCTIVITY

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The present study estimates the impact of deforestation on agricultural productivity in Brazil. We assume that primary forests can contribute to agricultural production through natural capital and by mitigating negative random shocks in production.

The impact on those two components was econometrically estimated using a Cobb-Douglas Output Distance Function (ODF) with variable parameters. We assume the dynamics of forests can cause relative shifts in the supply curve of goods, and model it based on the work of Lilyan Fulginiti, who demonstrated that the Griliches' k-Shifts can be estimated from an ODF.

Using municipality-level pooled data from the 2006 and 2017 Brazilian Agricultural Censuses, we estimate the productive impacts of deforestation on 4 groups of activities: livestock, permanent crops, temporary crops, and other activities.

We estimate that a 1% decrease in deforestation positively impacts productivity for all outputs in most of the municipalities, except for the group of other activities (which includes extracted wood and is negative for the North and Northeast regions). National estimates for 2017 are that a 1% decrease in deforestation in the last 5 years would have increased overall Brazilian agricultural productivity by 0.028%, due to increasing productivity by 0.05% on livestock, 0.03% on temporary and 0.009% on permanent crops, and 0.006% for other activities. These estimates consider a 5-year cumulated lag, representing a medium-run effect.

TOWARDS FOSSIL-INDEPENDENT AGRICULTURE? USE EFFICIENCY OF FOSSIL-BASED INPUTS IN SWEDISH AGRICULTURE

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Transition to a fossil-free society in Sweden is underway, supported by national and international policies. But the current energy shortage in the EU because of the pandemic and war has dramatically reduced supply and increased the price of fossil-based production inputs such as fuels and mineral fertilisers, which are still critical for agricultural production. This has underlined the urgency of transition to fossil-independent farming to ensure a more resilient food supply. The use efficiency of fossil-based production inputs in agriculture needs to be increased, as part of an overall transition to a fossil-free Sweden. Using Swedish Farm Accountancy Data Network (FADN) 2004-2021 and a stochastic meta-frontier function, this study estimated technical efficiency (TE) and fossil-based input use efficiency (energy use efficiency (EUE) and fertilizer use efficiency (FUE)) on Swedish crop, dairy, and livestock grazing farms. Energy input was estimated to play a key role for all three farm types. TE increased more over time on dairy farms (0.956) than on crop and livestock grazing farms (0.777 and 0.855, respectively). Crop farms had the highest technical gap ratio (0.983), while livestock grazing farms had the lowest (0.725), which indicates that crop farms have a higher potential technology gap. EUE and FUE were low overall and highest on dairy farms. There is thus substantial room for improving EUE and FUE in Swedish agriculture.

EXPLANATION OF PERSISTENT AND TRANSIENT EFFICIENCY IN THE PRESENCE OF ENDOGENEITY – A ONE STEP APPROACH WITHOUT DISTRIBUTIONAL ASSUMPTION

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In this paper we combine advances from two recent paper to explain persistent (PTE) and transient (TTE) efficiency in the presence of endogeneity. Earlier methods applied either a multi-step or a one step procedure to estimate PTE and TTE. The novelty of our proposed method that it allows the estimation of the determinants of PTE and TTE in the presence of different sources of endogeneity applying a one step approach without distributional assumption on the one-sided error term. The

paper also contributes to the empirical literature examining the impact of crop diversity and size of farms on TTE and PTE using Farm Accountancy Data Network (FADN) data for Hungarian crop producers for the period (2013 - 2021). Preliminary results show that the proposed method give reasonable estimates of the production technology and persistent and transient efficiency determinants. In addition, the results suggest that in order to get consistent estimates it is important to account for different sources of endogeneity in the case of Hungarian crop producing farms.

EFFICIENCY WITHIN HETEROGENOUS TECHNOLOGIES FOR SUSTAINABLE COFFEE PRODUCTION: A LATENT CLASS FRONTIER MODEL IN COLOMBIA

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Coffee growers face uncertainty about coffee income due to high volatility in coffee prices. Tackling the price crisis, coffee producers face the tradeoff between higher coffee yield and higher quality through heterogenous technologies like intensive/extensive production and environmental management. Our aim is to find to what extent do heterogenous technologies in sustainable management affect efficiency in Colombian coffee farms. The Latent Class Stochastic Frontier Model (LCSFM) provides empirical evidence of unobserved differences in technologies among coffee farms seeking higher production efficiency. We collected data in site from 300 Colombian coffee farms in The Andes. Our results show that coffee farms closer to sustainable standards reported an efficiency of 57,17%. Coffee farms with intensive use of chemical pesticides reported a mean efficiency of 54,62%. Sustainable management could be included in coffee production without diminishing efficiency. Our main findings contribute to the increase of efficiency in sustainable coffee production by giving specific suggestions to the differentiated groups of coffee growers.

Fri|11:00-12:30|CC - Sustainability & Eco-efficiency III

Chair: Magdalena Kapelko

ESTIMATING ECO-EFFICIENCIES OF FOOD RETAILERS – A BILEVEL OPTIMIZATION PROBLEM

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A bilevel optimization problem contains a secondary optimization problem – namely a sub-problem or follower problem – embedded within the constraints. This branch of optimization problems has its roots in game theory and goes back to the German economist Heinrich von Stackelberg (von Stackelberg, 1934); and it is currently gaining more attention in the field of data envelopment analysis as, e.g., in the context of counterfactual analysis à la Bogetoft et al. (2022), in which costs are minimized at the upper level and efficiency is optimized at the lower level.

In this talk, we develop an eco-efficiency approach that combines pollution-generating technologies and the idea of counterfactual analysis to evaluate the environmental performance of grocery stores.

Likewise, the results of this approach are related to so-called temperature alignment scores, which are measured in degrees Celsius. These scores enable a direct reference to the Paris Agreement and thus provide a comprehensible and impact-oriented management tool.

The applicability and effectiveness of the new tool is demonstrated through numerical analysis of 25 grocery stores.

AN ANALYSIS OF SUSTAINABLE WASTE EFFICIENCY AT EUROPEAN LEVEL

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Waste management is a global issue that demands innovative and sustainable solutions. Specifically, reducing landfilling is a top priority due to its negative impact on the environment and human health. Europe offers fertile ground for analyzing municipal waste management efficiency due to the diversity of its countries and richness of its policies. In 2008, the European Union started issuing directives to its members to promote the proper and efficient management of municipal waste and extended them in 2018 by introducing various targets for countries to achieve, including the reduction of waste disposal. In this work we analyze 30 European countries. We carry out an efficiency analysis employing a directional Data Envelopment Analysis to assess the relative efficiency of European countries in managing municipal waste. We apply the approach proposed by Daraio and Simar (2016) to determine the direction towards the efficient frontier conditioned by external factors that may affect the efficiency. With this approach, we estimate sustainable efficiency targets that each country may reach. The analysis is conducted for two-time windows: the pre-reform period and the post-reform period. We consider waste treated as input, waste recycled and recovered as output, and waste landfilled and incinerated as bad output. This analysis allows for a better understanding of the effects of the reform and provides sustainable targets for each country based on the conditional directions.

MEASURING ENVIRONMENTAL INEFFICIENCY THROUGH MACHINE LEARNING TECHNIQUES

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The main objective of this study is to introduce machine learning-type extensions for the measurement of environmental inefficiency based on regression trees under shape constraints. The new methods developed are implemented using a by-production approach that distinguishes two technologies, one related to the generation of pollution and the other to the production of good outputs. In particular, we define two alternative approaches to measuring environmental inefficiency: by-production Efficiency Analysis Trees (by-production EAT) and by-production Convexified Efficiency Analysis Trees (by-production CEAT). The main advantage of the methods developed is that they do not suffer from the typical statistical problem of overfitting connected to Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA). The performance of the new models is evaluated through a simulation study which shows that the new approaches outperform FDH and DEA in terms of mean squared error and bias. We also illustrate the practical usefulness of the new techniques through empirical application to 43 developing and developed countries over a fifteen-year period - from 2000

to 2014. Our empirical findings using real data clearly indicate the higher discriminating power of the by-production EAT and CEAT models as compared respectively to FDH and DEA.

Fri|11:00-12:30|SA - Efficiency Methods

Chair: Daniel J. Henderson

A FAST METHOD FOR IMPLEMENTING HYPOTHESIS TESTS WITH MULTIPLE SAMPLE SPLITS IN NONPARAMETRIC MODELS OF PRODUCTION

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Kneip, Simar and Wilson (Journal of Business and Economic Statistics, 2016) and Daraio, Simar and Wilson (The Econometrics Journal, 2018) provide non-parametric tests of (i) convexity versus non-convexity of the production set, (ii) constant versus non-constant returns-to-scale of the frontier, and (iii) separability versus non-separability of the frontier with respect to environmental variables. Among other uses, these tests are essential for deciding which non-parametric efficiency estimator should be used to estimate technical efficiency. Each test requires randomly splitting the sample. Although the tests are valid for any random split, results can vary with different splits. This paper provides a computationally efficient method to aggregate test outcomes across multiple sample-splits using ideas from the statistical literature on controlling false discovery rates in multiple testing situations. We provide tests using multiple sample-splits (to remove the ambiguity resulting from a single sample-split) and extensive Monte Carlo evidence on the size and power of our tests. The computational time required by the new tests is about 0.001 times the computational time required by the bootstrap method proposed by Simar and Wilson (Journal of Productivity Analysis, 2020).

REGULATING MULTIPLE RELATED EXTERNALITIES

Authors: Mette Asmild[1]; Trine Krogh Boomsma[1]; Frank Jensen[1]; Rasmus Nielsen[1]
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Economic activities, such as food production, most often generate multiple externalities. If these externalities are not taken into account by producers, regulatory interventions might be necessary. In theory, as well as in practice, the convention has largely been to regulate each externality separately. In this paper, we first argue (and show empirically) that this fragmented approach to regulating multiple externalities is suboptimal, in cases where the externalities are related. We then formulate a set of models for the regulation of multiple related externalities that can be operationalized using DEA-related methods and solve them using bi-level optimization. Finally, we illustrate the (impact of the) suggested approach using empirical data on aquaculture production.

COMBINING BI-LEVEL OPTIMIZATION WITH DEA TO HANDLE PROFIT MAXIMIZATION AND EFFICIENCY EVALUATION UNDER A STOCHASTIC FRAMEWORK

Authors: Andreas C. Georgiou[1]; Eleni-Maria Vretta[1]; Konstantinos Kaparis[1]; Kyriakos Bitsis[1]; George Paltayian[1]; Fenia Mavrodi[1]; Emmanuel Thanassoulis[2]
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Resource allocation and target setting are pivotal aspects in large enterprises and organizations influencing the operational effectiveness. Due to data uncertainty the administration aims in an optimal strategy that tackles the parameter fluctuations in order to maximize their profit and hence the organizational effectiveness. Often, there is a centralized decision-making scheme that manages multiple decision-making-units (DMUs). In this paper organizational effectiveness is evaluated by a bi-level DEA model taking into consideration some uncertainty aspects. These aspects are incorporated through discrete scenarios which are accompanied by occurrence probabilities accounting for every uncertain parameter. The approach accommodates recourse actions after the revelation of scenario contributing to an overall efficiency. Based on the bi-level formulation the upper-level pursue to maximize the profits while at the same time the lower-level program seeks to optimize the efficiency of each individual DMU. Efficiency lower bounds and capacity constraints were also taken into account. The paper concludes by presenting results derived from the banking or healthcare sector.

The research project was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I) under the "2nd Call for H.F.R.I. Research Projects to support Faculty Members & Researchers". (Project Number: 3154).

LABOR INCOME TAX SHOCKS AND LARGE FIRMS' RD

Authors: Daniel Henderson[1]; Soroush Ghazi[1]; Alexandra Soberon[2]; Taining Wang[3]
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In this paper we develop a semiparametric panel data production function estimator which shows how tax shocks impact research and development (both initially and over time). We develop estimators which do not exist in the literature and show both their asymptotic and finite sample properties. Using a novel dataset, we find that exogenous tax shocks impact firms with patents more than firms without patents. Further, we find a quadratic relationship of the impact with respect to the degree of competitive markets.

Fri|11:00-12:30|3E - Multi-methods

Chair: Thyago Nepomuceno

COMBINING MARKOVIAN AND DATA ENVELOPMENT ANALYSIS MODELLING IN MANAGING THE EVOLUTION OF POPULATION COHORTS

Authors: Andreas Georgiou[1]; Emmanuel Thanassoulis[2]; George Tsaples[1]; Konstantinos Kaparis[1]

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This paper reports on recent research on Markovian and Data Envelopment Analysis (DEA) models in managing the evolution of cohorts (e.g. personnel of an organisation or patients suffering from a chronic disease). The status of such cohorts evolves over time in response to a combination of internal organisational initiatives and external to the organisation forces. The research explores the dynamics of the cohorts over time, tracking their progression through various states under the influence of internal policies such as recruitment, promotion or heath treatments. These interventions are designed to ensure the attainment of a target or attainment of certain objectives. Effective interventions are identified which are evaluated for their efficacy in achieving the goals. The Markov model captures the stochastic nature of the problem which is then handled in a deterministic DEA environment. This effort leads to a descriptive framework on a discrete time frame. Models include single or two-stage configurations in single or multiple targeting environments with fixed or free time control alternatives. The paper concludes by deliberating on the advantages and limitations inherent in these models.

The research project was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I) under the "2nd Call for H.F.R.I. Research Projects to support Faculty Members & Researchers". (Project Number: 3154).

CAUSAL EFFECTS OF POLICY INTERVENTIONS ON PRODUCTIVE PERFORMANCE: INTEGRATING SYNTHETIC CONTROL METHODS INTO THE NONPARAMETRIC APPROACH

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Examining the causal effects of policy interventions on productive performance is critical for policy analysis and managerial decision-making. A typical method in the nonparametric approach is to regress efficiency estimates on policy interventions and contextual variables. However, this method has been criticized for ignoring the correlations between inputs and policy interventions and/or contextual variables and hence subject to endogeneity in the efficiency estimation. To address this issue, this study proposes to integrate synthetic control methods (SCM), a data-driven causal inference technique, into the nonparametric approach. SCM estimates the causal effect by constructing a counterfactual of the treated unit (i.e., synthetic control) using a convex combination of control units, analogous to the rationale in DEA. In the integrated framework, 1) SCM ensures the treated unit and the synthetic control closely match before the treatment, with respect to the input, output, and contextual variables; 2) the nonparametric approach estimates the post-treatment efficiency both for the original sample of units and for the synthetic sample where the treated unit is replaced by the synthetic control while retaining all the control units. The causal impact of the policy intervention is then estimated by comparing the efficiency of the treated unit with that of the synthetic control, that is, the counterfactual efficiency of the treated unit in the absence of the intervention.

EVALUATING PONDS AS NATURE-BASED SOLUTIONS: EFFECTIVENESS VS EFFICIENCY

Authors: Pietro Sala[1]; Maria Vrachioli[1]; Fabian Frick[1]; Johannes Sauer[1]
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Nature-based Solutions (NbS) are strategies inspired by nature that address major societal challenges, such as Climate Change, and Food Security, by providing several socio-economic and environmental benefits. Despite widespread adoption, evaluating their impacts poses challenges within the field of quantitative economics. We focus on Pondscapes (i.e. landscapes abundant with ponds) as NbS; these water systems contribute to carbon storage, improve habitats' biodiversity, and provide leisure, business, and cultural opportunities. We assess them in terms of both effectiveness, which describes the benefit delivery capacity aligned with stakeholder expectations, and eco-efficiency, which measures input-output performance in environmental economic terms.

First, we aggregate indicators into criteria with the Benefit-of-the-Doubt methodology, reducing heterogeneity. Then, we quantify the effectiveness of several Pondscapes with a Multi-Criteria Decision Analysis, including stakeholder preferences through Analytic Hierarchy Process. Data Envelopment Analysis investigates Pondscapes' efficiency. Finally, we compare these complementary metrics, seeking to confirm the hypothesis that effective Pondscapes can also be efficient NbS. Furthermore, we elaborate on the potential extensions of our analysis to other NbS strategies. Consequently, our method becomes a powerful tool for policy makers having to make context-specific, informed decisions with respect to which measure to implement.

MULTICRITERIA METHODS AND DIRECTIONAL DISTANCES IN PUBLIC ADMINISTRATIONS: STATE OF THE ART WITH A NEW APPROACH

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The values and priorities of public institutions may change depending on the outcome of elections for most democracies in the world. For this reason, there is a recurrent need for incorporating subjective policies and different preference structures in assessments of efficiency and productivity of public administrations and public services. This research explores the evolving landscape of Multicriteria Methods combined with Efficiency Analysis, with a specific emphasis on addressing challenges encountered in the public sector evaluation. Building upon the existing literature, we identify the most significant contributions and current gaps in the empirical assessments related to the incorporation of subjective and policy preferences. In response to these challenges, we introduce a novel Malmquist directional framework that extends the current directional approaches by considering changes in subjective perspectives and the dynamic nature of efficiency and technological changes over time. The proposed approach aims to account for dynamic changes in subjective efficiency measurements, offering a flexible approach particularly suited for the context of public institutions.

Fri|11:00-12:30|3D – Fishing

Chair: Kenneth Løvold Rødseth

DISENTANGLING TWO DECADES OF INEFFICIENCY TRENDS AND DYNAMICS IN THE GERMAN BROWN SHRIMP FISHERY BY PANEL STOCHASTIC FRONTIER ANALYSIS

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The fishery targeting brown shrimp is one of the most valuable fisheries in the EU and the single most valuable coastal fishery in Germany. Besides the direct economic importance for coastal communities and local suppliers, it is also a central factor of fishing tradition and local culture, attracting millions of tourists. However, the strong dependence on a wholesaler duopsony, fleet overaging, supply chain bottlenecks, the reduction of fishing grounds, escalating fuel prices, and other factors question the long-term economic perspective. To support management and decision-making, we estimate German brown shrimp fishers' production function and technical efficiency (~33% of production) based on a dataset containing all active ships between 2002 and 2021. We employ a TRE panel SFA approach to account for the unobserved heterogeneity within the fishing fleet. The dataset contains 3997 observations on 252 unique ships. Results show that overaging reduced production possibilities and that the fishery operated under IRS. The average efficiency was 77%, with substantial annual changes in averages and distributions. Several determinants of inefficiency explained the found heterogeneities. Among them were ship characteristics, participation in producer's organizations, input and product prices, as well as other factors. The results emphasize the need to invest in advanced production technologies but also highlight the challenging production environment faced by the producers.

IMPACT OF PRODUCTION ENVIRONMENT ON THE PRODUCTIVITY GROWTH OF NORWEGIAN TRAWLERS

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The Atlantic cod fishery in Norway boasts a rich history and holds significant economic and cultural importance. Modern fishing vessels are equipped with advanced navigation systems, echo sounders, and sonar technology to locate fish effectively. Vessel Monitoring Systems (VMS) are mandated to electronically track fishing activities at sea. Trawlers and demersal seine vessels typically operate offshore in the Barents Sea, while vessels with traditional gears focus on nearshore areas. This study utilizes the Färe-Primont index to assess Total Factor Productivity (TFP) and decompose it into its components: technical change, pure technical efficiency, mix efficiency, and scale efficiency for Norwegian trawlers using VMS data spanning from 2011 to 2022. The findings reveal that the geometric mean of TFP values for trawlers consistently remains small, regardless of the considered year. Technical progress, measured by TFP*, and residual scale efficiency (ROSE), emerge as the primary factors maintaining TFP stability over the period. Larger trawlers consistently exhibit higher

technical efficiency, while medium and smaller trawlers experience fluctuations in their technical efficiencies. Additionally, the results indicate that fishing grounds and the Total Allowable Catch (TAC) of cod have an impact on technical efficiency throughout the study period.

GREEN SCENARIOS FOR THE FISHING INDUSTRY: USING NON-PARAMETRIC PRODUCTION ANALYSIS TO MODEL STRATEGIC RENEWAL OF THE NORWEGIAN FISHING FLEET

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The fishing industry contributes to about 2 percent of Norway's greenhouse gas (GHG) emissions. As the Norwegian government is committed to reducing GHG emission from non-ETS sectors by 40% by 2030 and aims for a zero-emission society by 2050 fisheries may undergo a rapid green transition. However, decision support regarding technical and economic feasibilities of decarbonizing the fishing fleet is currently lacking.

This paper proposes a novel model framework for identifying cost-effective fleet renewal and abatement costs of GHG control that combines linear programming (LP), network technologies implemented by convex non-parametric least squares (CNLS) and survival analysis. While operations research on fleet renewal studies technical measures for decarbonization, we use non-parametric frontier analysis to also consider operational measures in terms of input substitution and resource allocation among fishing vessels.

The model is implemented for 13 vessel groups, 13 age classes and 9 energy carriers, and makes optimal decisions every 5 years until 2050. To reduce the problem size, a mixed-integer programming (MIP) model is proposed to identify the minimum number of hyperplanes needed to span CNLS frontiers. We find that the diffusion of alternative fuels will be moderate if conventional vessels can use drop-in fuels. Abatement costs are robustly estimated at 200 Euros per ton of CO2, close to the Norwegian government's estimate of the social cost of carbon.

Fri|11:00-12:30|3B - Manufacturing II

Chair: Alfons Oude Lansink

FIRMS' DIGITALIZATION AND TFP PERFORMANCE FOR SPANISH MANUFACTURING

Authors: Dolores Añon Higon[1]; Juan A. Máñez[1]; Amparo Sanchis[1]; Juan Sanchis[1]
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In this study, we analyse the impact of the firms' adoption of digital technologies on total factor productivity (TFP). To do so, we first construct a synthetic index of digitalization at the firm level that considers the complex and multi-faceted phenomenon of digitalization. We also consider the relative importance of four dimensions of digitalization: IT capital equipment, digital-related human capital, automation, and the way firms use digital technologies to interact with their stakeholders. Using a

sample of Spanish manufacturing firms for the period 2001 to 2018, we assess the contribution of digitalization and its dimensions to firm performance through an empirical model that relates digitalization and TFP at the firm level. We assume a Cobb-Douglas technology production function that combines intermediate inputs with a translog function of capital and labour. We further assume that TFP evolves over time according to a Markov process that depends on the extent of digitalization. Our findings indicate that digitalization is a key driver of firm's TFP, especially relevant among firms in highly digitalized industries. Additionally, the impact of the different components of the digitalization index on TFP varies, with the IT dimension having the greatest influence. We show that the four dimensions play a different role for SMEs and large firms.

EFFICIENCY ANALYSIS UNDER CYBER THREAT: THE CASE OF EUROPEAN FOOD MANUFACTURERS

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In the current era of digital transformation, cyber threats increasingly play an important role for economic decision-making in businesses. Efficiency analysis is widely used to benchmark business performance, but has not yet taken into account cyber risk. As a result, companies that allocate resources to improve cybersecurity have an underestimated efficiency score because these resources are considered waste if only the marketed outputs are taken into account. To address this problem, I introduce a production framework that axiomatically characterizes cybersecurity, which allows for cybersecurity-adjusted efficiency analysis. Cybersecurity is treated as a strongly disposable output that is part of the production technology. This proposal recognizes that some (unobserved) share of the inputs is allocated to cybersecurity rather than to the marketed outputs. Combining accountancy data with unique cybersecurity data provided by the company "Bitsight", I apply data envelopment analysis to a sample of 2,381 food manufacturers in the European Union for the year 2022. I use a homogeneous bootstrap to estimate confidence intervals of the cybersecurity-adjusted efficiency scores. The results show that the bias-corrected cybersecurity-adjusted efficiency ranges from 0.468 to 0.999, and is on average 0.833. They suggest that European food security could be improved by simultaneously increasing production and cybersecurity, given the input use.

RISK AND RETURN EFFICIENCY OF MANUFACTURING FIRMS: INTEGRATING CORPORATE SOCIAL RESPONSIBILITY PERFORMANCE

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This paper uses Data Envelopment Analysis to assess the performance of stocks in terms of return on assets, risk and their Environmental-Social-Governance score. Next, Latent Class Analysis (LCA) is used to determine groups with similar performances and relates group membership to a set of covariates. The empirical application focuses on a set of 139 European Manufacturing companies in the period from 2016 to 2021. The results suggest stocks on average perform 25% below their potential in each of the three dimensions. The results of the Latent Class Analysis suggests five groups of firms with

distinguishing performance charactersitics. Membership of lower performance groups significantly relates with lower size, R&D expenses and Tobin's Q.

Fri|11:00-12:30|3C - Education IV

Chair: Audrone Jakaitiene

A BENEFIT-OF-THE-DOUBT MODEL FOR COUNTRY PERFORMANCE ASSESSMENT AND TARGET SETTING ALIGNED WITH THE EUROPEAN UNION 2030 EDUCATION AND TRAINING STRATEGY

Authors: Fernando Osório[1]; Flávia Barbosa[1]; Giovanna D´Inverno[2]; Ana Camanho[1]
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This study proposes a two-stage approach to assess the performance of 27 European countries and to set country-specific targets in line with the European Union 2030 strategic goals for Education and Training (ET). In the first stage, we propose a directional BoD model that follows two principles to search for the goals. First, countries will only seek improvements in the direction of the indicators that have yet to reach the ET 2030 goals. Second, when a country reaches the ET2030 goal for a particular indicator in the movement towards the observed `best practice frontier' (BPF), but the frontier has not yet been met for other dimensions, the directional vector is readjusted to disregard that indicator from that moment onwards, and the process continues until reaching the observed frontier. By the end of this stage, the country targets at the BPF may still have indicators missing the ET2030 goals. Therefore, in the second stage, countries seek improvements beyond the frontier of the production possibility set (i.e., the BPF). The performance assessment proceeds with an evaluation against an `ideal frontier' defined by a single ideal target. This ideal target represents the ET2030 goal or the best value observed for each indicator in the sample (in case the ET2030 goal does not dominate the observations in the sample). Both principles that guide the search for improvements in the first stage still apply to the second stage. Consequently, the Ideal Frontier is only reached by a country when the best values observed in the sample for each indicator are met and the EU strategy becomes fulfilled. We propose a framework for estimating composite indicator scores considering the measurement of performance against the frontier of the Production Possibility Set, an adjusted frontier considering ET2030 goals, as well as the ideal frontier. The results indicate that Sweden, Ireland and the Netherlands are the top three performers, while Romania, Serbia, Greece, and Italy were the worst-performing countries when evaluated against the EU strategy.

BENCHMARKING IN EDUCATION: IMPROVING PERFORMANCE TOWARD THE DEFINED GOALS INSTEAD OF (RE)PRODUCING SOCIAL CATEGORIES OF WINNERS AND LOSERS

Authors: Dovile Stumbriene[1]; Jose L. Ruiz[2]; Inmaculada Sirvent[2]
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The European Education Area (EEA) strategic framework is the outcome of the continuous construction of European cooperation in education. It sets seven internationally comparable

indicators to monitor progress toward achieving strategic objectives. For each of these indicators, the EU-level goals are identified, which should be achieved within a given timeframe. Previous researchers have shown that the national capacity of some EU countries to implement measurement standards can lag behind the ambition of EU-level goals and the differentiation between countries that have met EU-level goals and countries that do not could reproduce social categories of winners and losers. This paper aims to propose a benchmarking approach to set goal-adjusted targets and identify strategies for improving national performance toward the EEA strategic framework. We proposed a Benefit-of-Doubt approach that incorporates information on EU-level goals and employed it with the most recent data currently available in Eurostat and OECD databases for 29 European countries. The model solves a bi-objective problem that imposes two objectives of closeness, namely that between actual performances and targets (effort) and that between targets and EU-level goals (adjustment). This research contributes to the literature by providing a benchmarking approach that instead of dividing countries into winners and losers, identifies best practices that could be directed to improve national performance.

DOES ACHIEVEMENT GAP CORRELATE WITH AVERAGE PERFORMANCE? CASE OF PIRLS

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The term "achievement gap" in education refers to the difference in academic performance between various students. Previous studies have examined racial and socioeconomic achievement gaps of students, achievement gaps between boys and girls, school types, etc. But none of these contributions specifically focused on the cross-country and longitudinal comparison in the reading achievement gap. Longitudinal studies provide the opportunity to observe patterns of change and to measure changes in outcomes.

In our longitudinal study, we used student achievement data from five periods (from 2001 to 2021) of the PIRLS. PIRLS measures students' reading achievement based on two main purposes: literary experience and acquiring and using information. Although 33 EU countries participated in at least one PIRLS, we examined 12 EU countries that participated in all five PIRLS during the period considered. We calculate and compare achievement gaps in reading literacy and estimate the correlation with average performance in PIRLS.

We observe declining trend for England only in literary experience and upward trend for Hungary in the acquisition and use of information. All other countries could be classified into clusters according to different pattern of achievement gaps: V-shaped, U-shaped, W-shaped. Calculated correlation was not significant for almost all countries. However for some countries we obtain positive and for some negative correlation values.

Fri|14:00-15:30|Aud. - Session in honor of Mike Tsionas

Chair: Chris Parmeter

TWO-TIER STOCHASTIC FRONTIER ANALYSIS: HETEROGENEOUS ERROR DISTRIBUTIONS AND MODEL SELECTION

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We develop two-tier stochastic frontier models where the two one-sided error components follow different marginal distributions. As estimation methods, we present both Simulated Maximum Likelihood and Corrected Ordinary Least Squares coupled with Generalized Method of Moments. We propose a formal statistical test as well as informal diagnostics to choose between specifications. An application illustrates the use of these new tools.

CORPORATE SOCIAL RESPONSIBILITY (CSR) IN THE UK: WHO PAYS THE PRICE?

Authors: Ioannis Bournakis[1]; Marwan Izzeldin[2]; Mike Tsionas[2]; Olivier Cardi[2]
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The paper investigates who pays the cost of Corporate Social Responsibility Activities in 360 UK firms. So far, we only have evidence on how CSR impacts various aspects of firm performance (marketing, human resources, finance), but this voluminous literature does not address the most fundamental issue of who is burdened with the cost of this investment and at what proportions. This is the first paper that endeavours to offer welfare insights concerning the cost of CSR by measuring how much CSR increases the marginal cost of production and what percentage of this increase passes through to consumers. In the absence of data for unit prices, final prices can be decomposed into marginal costs and markups. The latter represents the burden that falls upon consumers, which is nonetheless unrelated to cost increases. We estimate how CSR impacts each of these components using panel vector autoregression models with firm-specific parameters. Our econometric approach addresses heterogeneity and establishes causal effects between CSR and price components. We found that consumers pay 31% to 38% of the cost of one one-pound increase in CSR, with producers paying the rest.

BAYESIAN ESTIMATION OF CES-CET PRODUCTION TECHNOLOGY PARAMETERS TO IMPROVE CGE MODELS

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Economic simulation models such as Computable General Equilibrium (CGE) models are frequently used for ex-ante evaluations of policies. These models frequently use Constant Elasticity of Substitution (CES) - Constant Elasticity of Transformation (CET) functions to model production technologies with multiple inputs and multiple outputs. Using CES-CET functions in simulation models has the important advantage that these functions are globally consistent with economic theory (if their parameters are in given intervals). However, these functions are rarely used in empirical analyses so that the parameters of these functions that are used in simulation models are usually not based on

empirical evidence. This compromises the reliability of these simulation models and, hence, creates the risk of inefficient and ineffective policies. Hence, it is indispensible to empirically estimate the parameters of CES-CET functions but their estimation faces multiple challenges, e.g., non-linearity in parameters, discontinuities and numerical inaccuracies at elasticities of substitution close to one, large flat areas of the objective function, and parameter restrictions. We develop and implement a Bayesian estimation method for estimating CES-CET functions that addresses these challenges. We empirical illustrate this method by estimating a CES-CET function for modelling the multiple-input multiple-output production technology of the farming sector in Tanzania for the DEMETRA CGE model.

REVENUE FUNCTIONS ARE NONCONCAVE IN THE INPUTS WHEN THE TECHNOLOGY IS NONCONVEX: THE UNBEARABLE LIGHTNESS OF CONVEXIFICATION.

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Revenue functions are studied under the assumption that the technology is nonconvex. More specifically, we show theoretically that the convex revenue functions are larger or equal to the nonconvex revenue functions. However, with one input and constant returns to scale (CRS) technologies, both these revenue functions coincide. Including more inputs or varying returns to scale assumption (e.g., variable returns to scale, VRS) results in differences between the convex and nonconvex revenue functions. We use USA state-level agricultural data to showcase our theoretical result empirically. We first visualize the revenue functions under constant and variable returns to scale assumptions and demonstrate that the former is identical irrespective of whether technology is convex or nonconvex while the latter revenue functions are different. We further show graphically that the convex or nonconvex revenue functions are different both under CRS and VRS with 4 inputs. Additionally, we use statistical tests (equality of densities and stochastic dominance) to show that the convex or nonconvex revenue functions are statistically different. Finally, we perform scale efficiency analysis to show how using the convexity assumption may result in false policy implications.

Fri|14:00-15:30|-1A - Agriculture VII

Chair: Simone Russo

LAND RENTAL AND ARABLE FARMERS' ECO-EFFICIENCY IN CHINA

Authors: Jiajun Zhou[1]
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The use of chemical inputs such as mineral fertilizers and pesticides has significantly increased the agricultural yields in China and worldwide, but its heavy use also causes severe environmental problems and threats global health. Finding sustainable solutions to reduce the use of chemical inputs while producing sufficient farm yields to feed 1.4 billion population is a big challenge for China. Eco-efficiency, as a performance indicator, reflects the ability to make efficient use of resources and

minimize environmental pressures while achieving economic outcomes, has become a useful measure regards sustainability analysis. The objective of this paper is to investigate the effect of land renting-in behavior on farm-level eco-efficiency which serves as a useful proxy for understanding the extent to which farmers are adjusting their agricultural operations under the agricultural policy changes in China. To the best of our knowledge, this is the first paper that combines parametric stochastic eco-efficiency frontier approach with endogenous treatment models to assess whether land transfer improves farm-level eco-efficiency in China, and its underlying mechanism. Using representative farm survey data cover 29 provinces in 2015, results show that the effect of tenancy on eco-efficiency is significantly negative. Results imply that tenant arable farmers in China maximizing short-term economic benefits leading to overuse of chemical inputs. Potential mechanism channels are tested.

DOES COMPENSATION FOR REDUCED NITROGEN LEAKAGE AFFECT ECO-EFFICIENCY: EVIDENCE FROM SWEDISH CROP FARMS

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The nitrogen leakage from arable land has been increased in parallel with the use of synthetic fertilizer, leading to nitrate contamination of the groundwater aquifers and eutrophication. To achieve environmental target of "no eutrophication", special attention has been directed toward the southern and central areas in Sweden. These areas have been classified as nitrate-sensitive area because local waterways and lakes are particularly vulnerable to nitrogen pollutions from agriculture. Swedish farmers can apply for two specific direct subsidies for catch crops and spring cultivation. This study examines presence and degree of spatial spillovers of subsides on farms' eco-efficiency performance by applying a stochastic frontier model and a second-stage spatial econometric model. The nitrogen leakage are quantified at farm levels by use NLeCCS calculation system and it is treated as undesirable output in the directional distance function to measure farms' eco-efficiency performance. The existence of spatial spillover of subsidies are tested by employing a spatial truncated bootstrap model in which inefficiency is determined by farm-specific as well as neighbours' characteristic. The results indicated that subsidies positively impact individual economic and environmental performance on farms. Furthermore, the analysis confirmed the existence of spatial spillovers effects originating from neighbours' subsidies.

SOCIAL CAPITAL AND SMALLHOLDERS´ OIL PALM PRODUCTION IN COSTA RICA

Authors: Gabriela Enma Carbajo Alvarez[1]; Bernhard Brümmer[1]
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We delve into the dynamics of social capital in smallholder oil palm production in Costa Rica. The study aims to find the production technology and determinants of technical efficiency (TE) among oil palm smallholders, assess the role of cooperative membership in production and TE, and explore the benefits associated with active participation in cooperatives. Employing parametric Stochastic Frontier Analysis (SFA), the research reveals insights gleaned from data from 390 palm oil smallholders. The findings underscore that oil palm producers operate under conditions of increasing

returns to scale and could enhance efficiency by 50%, where cooperative participation, land ownership, and technical assistance are key to reducing inefficiency. The complex interplay between social capital and cooperative governance highlights the need for transparent management, democratic processes, and accountability to ensure equitable distribution of resources and benefits among members. Disentangling the mechanisms by which social capital improves farm productivity and technical efficiency is critical to promote more inclusive institutions.

DOES INSURANCE INCREASE THE PERSISTENT AND TRANSIENT TECHNICAL EFFICIENCY OF FARMS? EVIDENCE FROM ITALY

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This paper aims to analyze the impact of insurance on persistent (PTE) and transient (TTE) efficiency in agricultural production. To achieve this, first, we estimate an IDF model that breaks down the error term into four components: individual farm effect, PTE and TTE, and random shocks. Then, we estimate two SF models to investigate the determinants of these four components (i.e., we make their variances functions of some determinant variables). We also allow some of the inputs/determinant variables to be endogenous. By separating these components, the model allows us to clarify some of the ambiguity of previous results and provide appropriate policy recommendations to enhance farm efficiency. In fact, PTE and TTE call for different policy solutions.

The analysis revealed that insurance significantly reduces both the mean and the variance of persistent technical inefficiency, while it does not have a significant effect on both the mean and the variance of transient technical inefficiency. Furthermore, we found that insurance significantly reduces the variance of the errors of both SF models.

In conclusion, insurance contributes to the performance of farms in the long run by reducing the variance of PTE and farm-specific factors. Additionally, insurance spending reduces exposure to production shocks in the short term. Therefore, these results, combined with the rise in the mean PTE, highlight the importance of promoting the diffusion of insurance, which is still lowly adopted.

Fri|14:00-15:30|SA - Banking & Finance III

Chair: Takayoshi Nakaoka

PERFORMANCE MEASUREMENT OF EUROPEAN MUTUAL FUNDS UNDER THE SUSTAINABLE FINANCE DISCLOSURE REGULATION

Authors: Albane Tarnaud[1]; Alfons Oude Lansink[1]
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The implementation of the Sustainable Finance Disclosure Regulation for financial market participants in the European Union has recently made sustainability risks, ESG measures and Principal Adverse

Impacts (PAI) key components of performance measurement for Article 8 or 9 mutual funds. This paper uses the Benefit of the Doubt approach to develop an overall performance index for a sample of European mutual funds. The performance index integrates measures of the funds' mean returns, variance of returns and ESG scores using DEA. We compare the overall performance of mutual funds with a sustainable investment objective with that of other mutual funds. In addition, we analyze differences in the relative weights for the ESG, risk and return dimensions between sustainable funds and other funds. Doing so provides insight into the relative importance investment managers attach to each of these criteria. Finally, we test the sensitivity of the overall performance to changes in the value of the ESG scores, the variance and return on investment.

DYNAMICS OF OPERATIONAL EFFICIENCY IN CREDIT LENDING AND RECOVERY OF STRESSED ASSETS: AN ALTERNATIVE APPROACH WITH UNDESIRABLE BY-PRODUCTS

Authors: Gargi Sanati[1]; Anup Kumar Bhandari[2]
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Our study estimates the operational efficiency of Indian banks during 2009-10 to 2017-18, considering advances, and recovery of stressed assets as desirable outputs, while NPAs and slippages are undesirable by-products. Our first stage DEA analyses conclude that public sector banks have significant scope to improve their lending and recovery efficiency, while also reducing their stressed assets. Our analyses also reveal that banks are more efficient in managing credit risks for shorter-term loan portfolios and secured loans, while positive economic externalities are more prominent in determining the efficiency of banks in priority sector lending. We also observe that a competitive scenario within the banking sector, overall macroeconomic growth, and low cost of funds play vital roles in improving banks' operational efficiency and reducing credit risk. Our findings suggest that liquid assets might be more beneficial than illiquid collaterals in improving the recovery of stressed assets.

OPERATIONAL EFFICIENCY IN THE PRESENCE OF UNDESIRABLE BYPRODUCTS: AN ANALYSIS OF INDIAN BANKING SECTOR UNDER TRADITIONAL AND MARKET-BASED BANKING FRAMEWORK

Authors: Anup Kumar Bhandari[1]; Gargi Sanati[2]
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In the backdrop of increasing market-based activities, we study operational efficiency of Indian banking sector during 2009-10 through 2017-18 while considering gains from the financial markets as additional desirable outputs beside the traditional one, i.e., advances. We also consider Slippage as undesirable by-product.

We observe that the private sector banks as a group outperform those under public ownership. Moreover, although the private sector banks could maintain a consistent efficiency over the sample period, public sector banks clearly show a declining trend. Our second stage econometric estimation results show that the priority sector lending has a negative effect on TES. Interestingly, we get varying results for the relationship between maturity and TES depending on banks' strategies for stressed assets management. Furthermore, our analyses result that banks are not so efficient in managing

relatively larger-volume loans. We also observe that banks' TES positively depends on the Credit-to-Deposit (CD) ratio. We find that the overall operational efficiency of the banks to manage their credit risk portfolio improves with a reduction in the lending rate (LR). We conclude that, with the increase in LR, corporate borrowers may switch to capital market to access funds, which may induce the banking sector to invest more in capital markets and create a positive market sentiment.

ANALYZING THE EFFECTS OF QUANTITATIVE EASING POLICY ON PRODUCTIVITY CHANGE UNDER CAPITAL ADEQUACY CONSTRAINT: EVIDENCE FROM JAPANESE BANKING INDUSTRY

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The Quantitative easing (QE) policy has been introduced by central banks around the world after the financial crisis in 2008. Under the QE policy, banks play an important intermediary role in the transmission of the policy effects on the economy through the two potential channels, that is, the credit channel and the portfolio rebalancing channel. Moreover, QE policy could change the bank's risk preference or asset allocation, and it also could have an influence on the bank's performance itself. In this study, we investigate the bank's productivity change that is caused by changing the managerial decision that responded to the QE policy under the capital adequacy requirement. Applying the directional distance function model with capital adequacy constraints and the Luenberger productivity index for the Japanese regional bank sample, we show that the banks had improved their productivity by increasing securities in the first QE policy, which was started from 2001 to 2005. This result implies that the portfolio rebalancing channel worked effectively on the bank's asset allocation in the first QE policy. On the other hand, we also find that the second QE policy, launched in 2013, does not significantly contribute to improving the bank's productivity.

Fri|14:00-15:30|3E - DEA Applications

Chair: Charles-Henri Dimaria

OPTIMIZING BUILDING DESIGN USING FRONTIER ESTIMATION

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We analyze data from a set of real-life building designs in the form of Building Information Models (BIM). These are in an international open standard ("IFC") that contains 3D models with rich object properties. This format is widely used in a large number of construction projects.

We want to optimize the net usable area since that is the core purpose of a building. At the same time we want to keep the quantity of building elements (walls, windows, doors etc) low. The latter both because of construction costs, but also because of the running cost of heating or cooling proportional

to the outer building elements. The number of rooms is also important, not only the total area. We also want to avoid the amount of daylight per room becoming too low.

This can be done analytically by optimizing simple volumes with computational geometry or by AI, but here we use DEA to keep it simple to understand and visualize (DEA core is mathy, but easy to explain and visualize in lower dimensions).

We also want to explore if convex combinations of existing building designs can identify designs that are not only optimal for the low numbers of dimensions that we optimize on, but if they are also architecturally sound.

We will also investigate the returns-to-scale properties of the frontier that we estimate to see if larger buildings can have scale advantages (or the opposite). Bootstrapping will be used for tests of statistical significance. Cost efficiency will also be calculated.

SETTING GOALS FOR CASE RESOLUTION TIMES OF POLICE FORCES IN BRAZIL: A STUDY OF THE EFFICIENCY OF PERNAMBUCO STATE POLICE

Authors: Lucio Silva[1]; Josenildo Ferreira da Silva Junior[1]; Ednael Francisco Vieira da Silva[1]; Thyago Celso Cavalcanti Nepomuceno[2]; Flavia Barbosa[3]; Ana Maria Cunha Ribeiro dos Santos Ponces Camanho[4]
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The response time for the conclusion of police investigations is a commonly overlooked output in efficiency analyses in public security. Nevertheless, public managers of police units routinely set goals for the time to finalize investigations, especially for cases that attract particular attention from society. This paper introduces an approach for analyzing the efficiency and effectiveness of Police Departments, with the objective of setting appropriate goals for completion time. This analysis uses data from the Secretariat of Social Defense of Pernambuco, Brazil, containing criminal occurrences, clear-ups and organizational resources from 2018 to 2021. The Data Envelopment Analysis model is specified considering as input the total number of police officers, with the outputs being the average resolution time, in months, in each Integrated Security Area. The approach involves exploring scale efficiency and the returns to scale associated with the services provided by the Police Investigation Units. The results provide an overview of the investigation police services in terms of efficiency and effectiveness, and suggest potential improvements for critical units in the state of Pernambuco in Brazil.

GROUP- AND METATECHNOLOGY EFFICIENCIES AND TECHNOLOGY GAP OF AIRLINES: A UNION METAFRONTIER DYNAMICS NETWORK DEA FRAMEWORK

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Airline performance evaluation provides an objective basis to stakeholders and managers for decision making. In the conventional meta-frontier dynamic data envelopment analysis (DEA) framework,

there is possibility may lead to unreasonable results of technology gap ratio (TGR) values greater than 1 in dealing with undesirable outputs under non-radial measurement with network production structure. This study proposes union dynamic network DEA model, which integrates group technology and meta-technology into a union model, which not only solves the above unreasonable TGR problem, but also takes into account the technological heterogeneity (whether or not to participate in a strategic alliance) and the dynamic efficiency of different airlines in the network structure in different operation periods. A sample of 24 global airlines in 2017-2019 is used in the study. The empirical results show that (1) the dynamic total meta efficiency of the alliance group is significantly higher than that of the non-alliance group over the three years, indicating that joining a strategic alliance has a certain effect on the operational efficiency of the airlines; (2) the alliance group is technology-leading in 2017 and 2019 while the non-alliance group owns the advanced operational technology in 2018.

LET'S ALL GET PESSIMISTIC WITH ILL-BEING

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Unemployment, job vulnerability, and inflation are among the economic events that generate stress and anxiety in the population. People express their anxiety by reporting ill-being. We evaluate the extent to which negative economic events translate into reported ill-being for the European countries between 2005 and 2019. Our objective is to identify countries that produce the lowest level of ill-being at a given level of negative economic events. We utilize a benchmarking technique called data envelopment analysis. While the standard version of this technique has been used to understand well-being, the standard version cannot explain ill-being. Therefore, we are the first to employ the non-standard version of this technique in the well-being literature. We find that Nordic countries tend to perform best in mitigating the influence of negative economic events on ill-being. Additionally, we discover that countries with well-organized public administration are better at containing ill-being.

Fri|16:00-17:30|Aud. - Special Memorial Tribute to R. Robert Russell

Chair: Dan Henderson

Dan Henderson, "A Micro Theorists Contribution to Macroeconomics".
Rolf Färe and Shawna Grosskopf, "R.R. Russell: Our Friend in Duality: Professional and Personal".
Robin Sickles, "From Karlsruhe and Newark to Porto: 40 Productive Years Learning from R. R. Russell".

Also with contributions from **Robert Chambers** and **Knox Lovell**.

Fri|16:00-17:30|-1A - Agriculture VIII

Chair: Gaofei Yang

ASSESSING THE COST-EFFECTIVENESS OF PROMOTING MIXED AGRICULTURAL REGIONS IN EUROPE

Authors: Murilo de Almeida Furtado[1]; Miranda P M Meuwissen[1]; Frederic Ang[1]
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Mixed agricultural regions, integrating crops and livestock, are often proposed as a solution to improve the sustainability and resilience of the agricultural sector. Therefore, their promotion is currently high on the European agricultural policy agenda. However, little is known about how to achieve such a transition in a cost-effective manner. Our study addresses this gap by analysing the costs associated with promoting mixed regions through three distinct scenarios: (1) all farms become mixed, (2) all farms specialise in either crop or livestock production, and (3) a combination of the two. Using Data Envelopment Analysis (DEA), we compute a restricted profit function for each scenario and compare them with the status quo. We assess their relative cost-effectiveness by quantifying the foregone profits associated with each scenario. The application uses over one million farm observations from 28 European countries between 2004 and 2018, sourced from the Farm Accountancy Data Network (FADN). The third scenario, which imposes fewer restrictions, is anticipated to be the most cost-effective way to achieve mixed regions. However, we expect that the cost-effectiveness of the scenario in which all farms specialise is better than the scenario where all farms become mixed. Our study contributes by focusing on the regional scale to achieve mixedness, which contrasts with the prevailing literature that focuses on farm-level analysis.

ECO-EFFICIENCY AND ENVIRONMENTAL EFFICIENCY IN FARMING: QUANTITATIVE SYSTEMATIC SYNTHESIS AND META-REGRESSION ANALYSIS

Authors: Olha Halytsia[1]; Maria Vrachioli[1]; Johannes Sauer[1]
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Environmental impacts of agricultural production evoke increasing interest and concern among researchers, policy-makers, and the public. Consequently, numerous studies have focused on eco-efficiency and environmental efficiency in farming in recent decades. Existing meta-regression analysis studies, which have investigated efficiency estimates in agriculture focus on the technical efficiency of producers, while our study is the first one to provide a quantitative synthesis of the empirical literature on eco-efficiency and environmental efficiency in farming. We apply a random-effects meta-regression model with an iterative REML estimator to understand the variation in mean efficiency estimates (MEE) due to study heterogeneity and publication bias. Our findings reveal evidence of publication bias, which should be taken into account by policymakers since this bias can lead to misleading recommendations for decision-making. The obtained empirical results suggest a statistically significant relationship between the variability in MEE and such study-specific characteristics as types of environmental indicators, product type, and region. Thus, practitioners and policy-makers should carefully consider these study design attributes when interpreting and comparing empirical results. The relevance of our study is supported by the growing environmental concerns, increasing interest in sustainable production, and the important role of the agricultural sector in mitigating climate change.

SUSTAINABLE POLICY IMPACT ON AGRICULTURAL PRODUCTIVITY AND GREENHOUSE GAS EMISSIONS IN CHINA?

Authors: Gaofei Yang[1]; Maria Vrachioli[1]; Johannes Sauer[1]
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The agricultural sector is currently facing the dual challenge to reduce greenhouse gas (GHG) emissions while maintaining or increasing production. Sustainable agricultural policies (i.e. Action Plans in this study), aimed at reducing the use of pollution-generating (bad) inputs, are often proposed as one of solutions to the above challenge. In a non-parametric framework, this article utilizes the by-production approach to evaluate the partial productivity for bad inputs and GHG intensity separately, which could provide comprehensive insights on the interplay between agricultural production, polluting inputs (i.e. chemical fertilizer and pesticide) and GHG emissions. A Hicks-Moorsteen productivity index is applied to assess the agricultural productivity change and GHG emission intensity change in maize sector between 2004 and 2021 in China. Initial findings reveal that in maize production, chemical fertilizer productivity rises while pesticide productivity initially declines, followed by an increase post the sustainable policy implementation. the implementation of the Action Plan is positively associated with the growth of GHG emission intensity (2015-2021), challenging the efficacy of input-reducing strategies in reducing GHG intensity. This study sheds light on the dynamics between sustainable agricultural policies, productivity shifts, and GHG emissions in the Chinese agricultural sector.

Fri|16:00-17:30|CC - Climate Impacts on Agricultural Productivity

Chair: Eric Njuki

CLIMATE CHANGE COULD BRING DOWN GLOBAL AGRICULTURAL YIELDS AND RESHAPE FOOD MARKETS IN THE NEAR TERM

Authors: Simone Pieralli[1]; Ignacio Pérez-Domínguez[1]; Christian Elleby[1]
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Climate change has led to higher average temperatures and modified rainfall patterns around the world. This paper takes a look at its potential impacts on agricultural yields and the resulting effects on food markets. The analysis utilizes FAOSTAT crop and animal yield data covering 165 countries and more than 175 products from 1961 until present. Yield statistics are matched to gridded data on yearly mean temperature and total precipitation from the Princeton Global Meteorological Forcing Dataset. The effects of climate change on agricultural yields are estimated with a first-difference regionally-specific econometric model based on latitudinal classes.

Estimates, coupled with near-term changes from the Intergovernmental Panel on climate Change (IPCC) imply future country yield changes ranging from -10% to +10%. These changes in yields are subsequently used in a large-scale recursive-dynamic partial equilibrium agricultural model (Aglink-Cosimo from OECD-FAO) to project changes in production, trade, and consumption of world agricultural commodities until 2040. The effects on production worlwide are moderately strong and

differentiated (from -7 to +11%), depending on the country and the commodity, given shifts in production patterns due to climate change and competitive advantage. Moreover, increases in exports correlate to increases in production and drops in consumption, while the opposite is true when imports increase.

RD NEEDS TO OFFSET CLIMATE CHANGE IMPACTS ON US AGRICULTURAL PRODUCTIVITY

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Recent evidence indicates anthropogenic climate change has reduced global agricultural productivity (Ortiz-Bobea et al., 2021). There are also indications that US productivity growth is slowing (Ball et al. 2013; Andersen et al. 2018). But US agriculture remains among the most productive in the world due relatively high historical investments in research and development (R&D). However, the adequacy of current R&D spending in the face of rapid climate change is not well understood.

We quantify the R&D needs necessary to offset the emerging impacts of climate change on US agricultural productivity. Our approach is based on an econometric model estimating the effect of R&D and weather fluctuations on Total Factor Productivity (TFP) coupled with counterfactual climate simulations from the Coupled Model Intercomparison Project Phase 6 (CMIP6).

We will share preliminary findings during the conference.

CLIMATE, AND WEATHER IMPACTS ON AGRICULTURAL TOTAL FACTOR PRODUCTIVITY

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Weather, climate, and agriculture are inextricably linked. Climate change alters weather outcomes, and these have a direct biophysical effect on agricultural production (Nelson et al. 2014). Climate refers to a distribution of outcomes over a long realization—running several years or decades—whereas weather describes a realization from that distribution. Therefore, causal identification of these two effects will vary depending on whether one is modeling short-run weather or long-run climate effects (Dell, Jones and Olken 2014). The primary objective of this study is to summarize methodological approaches and highlight recent research trajectories in the measurement of weather and climate impacts on agricultural productivity. We begin by highlighting the conceptual framework, analytical techniques, and key literature. We review the channels by which weather and climate impacts are transmitted to agricultural production. We provide an overview of data requirements and identification strategies when modeling weather, expectations and adaptation, and climate. We demonstrate how to model a production technology incorporating weather, and climate, and to construct and decompose a total factor productivity index. We also show how to model producer expectations and adaptation strategies. Finally, we highlight the transition from the short-run to the long-run. In a nutshell, we idealize the right approach to measuring and estimating climate and weather effects on agricultural TFP.

Fri|16:00-17:30|SA – Sports

Chair: Gabriel Villa

DO FOOTBALL TEAMS INVEST INEFFICIENTLY IN PLAYERS WHEN COMPETITIVE BALANCE IS LOWER?

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This paper analyses the impact of competitive balance on the inefficient spending by football teams in the top five European football leagues in 2005/06-2021/22. It is assumed that teams feel lower competitive pressure and spend resources on players less efficiently when competitive balance is lower. The efficiency of investments in football talents is measured with input-oriented DEA with VRS, where the only input is the value of players, and the three outputs are the number of points, the number of goals, and the inverse of the number of goals received. This input-oriented DEA provides the coefficient of pure technical efficiency (PTE). Input slack is calculated as 1-PTE times the value of players. Teams in each league are divided into five subgroups based on their rank at the end of the season, and relative input slack is calculated for each group and each season. Relative input slack is the ratio of the input slack and the value of players in that group of teams in one season. Competitive balance is measured by the adjusted HHI index that provides comparable levels of competitive balance across football leagues with different number of teams. The VAR model is used to specify the variables before the Granger causality test. A lower competitive balance causes larger relative input slacks for the top five teams in Serie A and for teams ranked between 11th and 15th position. The same holds for teams ranked between 11th and 15th position in Ligue 1.

EVALUATING THE RELATIONSHIP BETWEEN ON-COURT PERFORMANCE AND SALARY CREATION OF NBA PLAYERS USING A TWO-STAGE NETWORK DEA MODEL

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Significant salary differences exist among NBA players, but do these variations accurately reflect their on-court performance? Prior studies mainly used regression or DEA models to analyze the relationship between on-court performance and salary creation, but none have considered the internal structure of on-court performance when assessing such relationship. This paper intent to fill up such research gap by proposing a two-stage Network Data Envelopment Analysis (NDEA). We first measure the efficiencies of on-court performance with considering Offensive and Defensive systems and then evaluate their efficiencies of Salary Creation in the second stage. The dataset includes 192 players who signed new contracts in 2022. Results reveal a strong positive correlation among Offense, Defense, and Salary Creation. Defensive performance is more critical in Salary Creation than Offense performance. Additionally, Defensive performance has higher variability, and players with superior Defensive efficiency achieve better Salary Creation. Hence, players should prioritize defense during games. These findings demonstrate NDEA's effectiveness in evaluating player performance and determining suitable salary treatment. Profile Analysis shows starting players' efficiency advantages

in minutes played, field goal attempts, and salary compared to bench players. Despite more turnovers, players with higher Salary Creation efficiency maintain strong Offensive performance.

A STONEZD ANALYSIS OF FOOTBALL TEAMS WAGES

Authors: Gabriel Villa[1]; Sebastian Lozano[1]
Affiliation: [1]Universidad de Sevilla
Email: gvilla@us.es

The team wage function of European football teams has been estimated using data from the five major European football leagues in season 2022-2023. The methodology used is stochastic semi-parametric envelopment of data with contextual variables (StoNEZD). Team wages are considered a function of the sports results in the national league, using the national competition and the participation in international competitions as contextual variables. The marginal costs of the sports results of each team as well as the marginal effects of the contextual variables considered have been computed. The inefficiency score, scale efficiency, scale elasticity and returns to scale of the different teams are also estimated. Also, those clubs that operate in the decreasing returns to scale region of the wage frontier have been identified. We have found significant wage differences between the leagues as well as higher wages for teams that participate in the international competitions (higher in the case of the Champions League than in the Europa League). In particular, the Italian, Spanish and German leagues have similar wages, much lower than those in the Premier league but higher than those of the French league. The total rent dissipation (i.e., excess wages) in each these five leagues are in the hundreds of million euros.

Fri|16:00-17:30|3E - SFA Applications

Chair: Araceli Ortega

EXPLORING THE ROLE OF GOVERNANCE AND AGRICULTURAL INTENSIFICATION IN LAND USE CHANGE

Authors: Gabriel Rosero[1]; Jessie Lin[2]
Affiliation: [1]Georg-August-University Göttingen; [2]USDA-Economic Research Service
Email: gabriel.rosero@uni-goettingen.de

The escalating global demand for food has led farmers to intensify agricultural practices and expand land use, resulting in ecological degradation and reduced natural forests. Recent studies have examined the effects of land supply elasticity, land price elasticity, and governance institutions — such as property rights and political stability— on overall land use change. However, how governance institutions or agricultural intensification interact with land expansion and reduction is unclear. This paper adopts a two-stage analytical approach to address this gap. We first estimate the total factor productivity change (TFPC) using a stochastic frontier analysis and then assess how TFPC and governance institutions affect cropland expansion and reduction. We use the World Bank's World Governance Infrastructure Index (WGII), the International Agricultural Productivity dataset compiled by USDA-ERS, and Global Land Analysis and Discovery satellite data on cropland expansion and

reduction to create a panel dataset of 172 countries from 2000-2019. We found a negative association between TFPC and new cropland expansion, supporting Borlaug's hypothesis that agricultural intensification promotes land reduction. Effective governance might mitigate cropland expansion and reduction. Yet, we found a positive correlation between TFPC and old cropland reduction, implying that agricultural intensification can lead to the conversion of cropland into pasture, abandoned land, or tree plantations.

ARE SMART TOURIST DESTINATIONS MORE PRODUCTIVE EFFICIENT?

Authors: David Boto Garcia[1]; Jose Francisco Baños Pino[1]; Ines Sustacha[1]; Eduardo Del Valle[1]
Affiliation: [1]University of Oviedo
Email: botodavid@uniovi.es

The widespread adoption of information and communication technologies has brought about significant changes in tourist behaviors and travel experiences, leading to the emergence of new business models and increased competition among destinations. In recent years, Smart Destinations (SDs) have started to leverage information and communication technologies (ICTs) to enhance the overall tourist experience, improving operational efficiency. The goal of this study is to empirically examine whether transforming a destination into a SD influences its productive efficiency, understood as achieving a higher volume of overnights stays given a set of inputs. The analysis is performed using panel data from 137 tourist sites in Spain in the period 2005-2021. We estimate various Stochastic Frontier models to study the potential change in inefficiency levels after the tourist site joins the Spanish SD Network. Our results indicate that SDs are indeed more productive efficient. Importantly, among SDs, destinations that meet at least 80% of the criteria to be considered a SD are comparatively more efficient. However, no differences in productive efficiency are found based on the years of experience as a SD.

GROWTH, CO2 EMISSIONS AND CONVERGENCE: AN ENHANCED HYPERBOLIC DISTANCE FUNCTION APPROACH

Authors: Roberto Balado-Naves[1]; Jose Baños-Pino[1]; Ana Rodriguez-Alvarez[1]
Affiliation: [1]University of Oviedo
Email: baladoroberto@uniovi.es

The present study expands the small number of works that look into the economic and environmental performance of countries in the long term. To that end, we link the standard Neoclassical economic growth model to the generation of bad outputs from the standpoint of the enhanced hyperbolic distance function for the economy. This presents an advantage with respect to previous models since we include the importance of CO2 emissions without making any parametric assumption on the relationship between aggregate production and pollution. Long-term growth rates and convergence functions are shown to be functions of the usual determinants of growth as well as the growth rates of the distance to the production possibility frontier and per capita CO2 levels. We estimate growth rates and the speed of convergence to the steady state for a panel of 156 countries between 1995 and 2019. These functions are estimated using a stochastic frontier analysis approach, including standard control variables such as private and public saving rates, population growth, human capital indexes or the relative consumption of renewable energies. Our results show that average efficiency has

improved over time, and growth accelerates with improvements in efficiency levels. Furthermore, we find that speeds of convergence increase after taking into account the distance to the frontier and the growth rates of per capita CO2 emissions.

EVALUATION OF THE PROGRAM "PRODUCCIÓN PARA EL BIENESTAR" USING A STOCHASTIC PRODUCTION META-FRONTIER

Authors: Araceli Ortega-Diaz[1]
Affiliation: [1]EQUIDE-Universidad Iberoamericana
Email: araortega@gmail.com

The Production para el Bienestar (PpB) program was implemented in 2019 with the goal of increasing the production and productivity of grains, coffee and sugarcane to contribute to increase the degree of national food self-sufficiency and the competitiveness of these crops in small and medium-sized Mexican producers. This research performs a PpB assessment for sugarcane and white corn using microdata from the 2019 National Agricultural Survey, through estimating a stochastic frontier and meta-frontier models in an impact assessment context. The results of the evaluation show that the program has not been sufficient to improve the productivity of the cultivation of the two products.

EWEPA Algarve 2024

XVIII EUROPEAN WORKSHOP
ON EFFICIENCY AND
PRODUCTIVITY ANALYSIS
FARO, JUNE 18-21 2024

CONFERENCE PROGRAMME

UAlg FE
UNIVERSIDADE DO ALGARVE
FACULDADE DE ECONOMIA

Welcome to EWEPA XVIII

The Organising Committee welcomes you to the Eighteenth European Workshop on Efficiency and Productivity Analysis (EWEPA XVIII), held at the University of Algarve in Faro, Portugal. Following the seventeenth workshop organized in Porto, in the north of Portugal, we now move to the south of the country, to the beautiful city of Faro. The south of Portugal is renowned for its beaches, and the Faro region boasts some of the finest. Indeed, Faro is bordered to the south by the Ria Formosa lagoon, a 19 km long system of barrier islands that connect with the sea through six inlets.

The conference will host more than 240 delegates from around the world. We will start the conference with an early career day dedicated to PhD student presentations and discussions. The conference itself will span 3 days, filled with interesting plenaries, parallel sessions, and specially organized sessions. EWEPA traditionally honours a prominent scholar in our field with the lifetime achievement award. This year, this prize will be attributed to Finn Førsund, one of the giants on whose shoulders the field of efficiency and productivity analysis lies. Some other giants in the field unfortunately passed away, and we have decided to use this moment where we gather together to honour their contributions to the field and share memories of their lives and achievements.

We have also arranged some social events in Faro that we believe will be unforgettable. In particular, we would like to highlight a boat trip to Deserta Island, which, as the name implies, is a deserted island near Faro within the Ria Formosa.

The Organising Committee wishes all participants an enjoyable time in Faro, both in social and research activities, as they immerse themselves in this vibrant community.

Enjoy the conference

Enjoy Faro

Enjoy Portugal

And most of all, Enjoy LIFE

COMMITEES AND SPONSORS

Organising Committee

Carla Amado, Universidade do Algarve, PORTUGAL (local coordinator)

Sérgio Santos, Universidade do Algarve, PORTUGAL (local coordinator)

Maria Conceição Silva, Católica Porto Business School, PORTUGAL

Ana Camanho, Universidade do Porto, PORTUGAL

Scientific Committee

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Jaap Bos - Maastricht University, THE NETHERLANDS

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Cinzia Daraio - Sapienza University Rome, ITALY

Massimo Filipini - ETH Zurich, SWITZERLAND

Tsu-tan Fu - Soochow University, TAIWAN

William Greene - New York University, USA

Jill Johnes - Huddersfield Business School, UK

Luis Orea - Universidad de Oviedo, SPAIN

Robin Sickles - Rice University, USA

Maria Silva - Católica Porto Business School, PORTUGAL

Léopold Simar - Université Catholique de Louvain, BELGIUM

Timo Sipiläinen - University of Helsinki, FINLAND

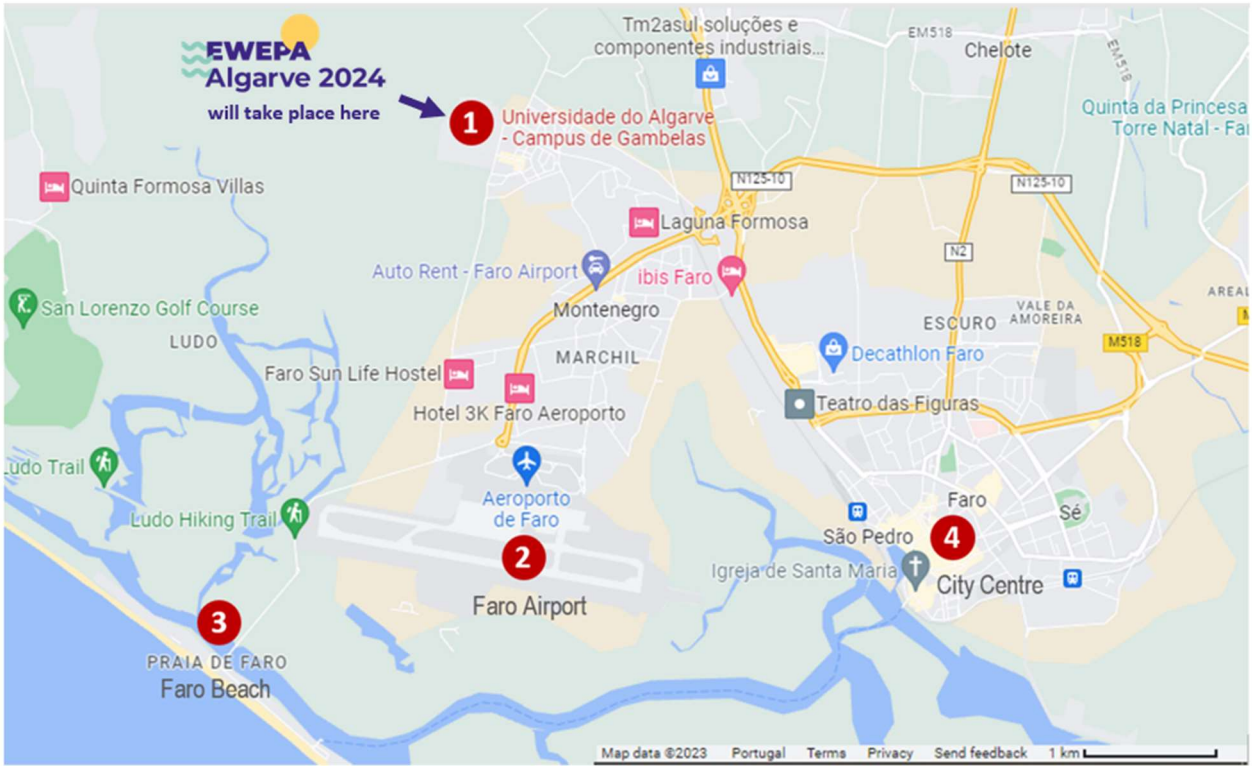
Victor Podinovski - Loughborough University, UK

Sponsors

CONFERENCE MECHANICS

The venue

The EWEPA 2024 workshop is taking place at the University of Algarve, Faculty of Economics, located in the Gambelas Campus, as illustrated in the map below.



Map 1 – Location of the University of Algarve, Gambelas Campus (1)

Registration and Plants of Building 8

Registration and most sessions take place in the building of the Faculty of Economics (Building 8) as indicated in Map 2. The Opening Session and Plenary 1, however, will take place in the Grande Auditório (see location in the Map below).

Map 2 – Faculty of Economics and Refectory Location

Registration will be open on June, 18th from 11.00 to 18.00 and on June 19th, 20th and 21st from 8:30 to 17:00 in the foyer on Level -1 of Building 8 (please see Figure 1 below). The registration desk will also be available to help each day throughout the conference.

All sessions and coffee breaks take place in the Faculty of Economics, Building 8, except for the coffee break on the morning of June 19, which will take place in the Hall of the Grande Auditório. The plants of Building 8 below show where the rooms of the plenary and parallel sessions are located as well as some of the toilets nearby.

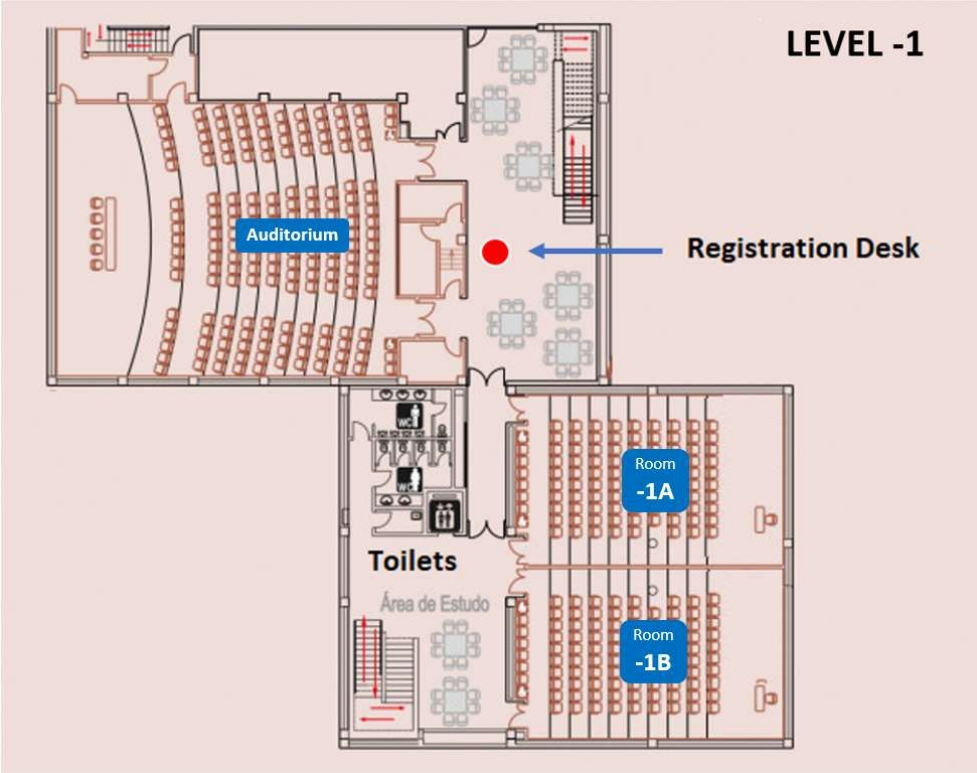


Figure 1 – Plant of Level -1

Figure 2 – Plant of Level 2

Figure 3 – Plant of Level 3

Sessions

For most parallel sessions, each paper has been allocated 20 minutes (4 papers in a 1.5-hour session). In some rare cases (sometimes due to last-minute changes to the programme), there will be only 3 papers in a session. In such cases, Chairs are recommended to allocate the same time to the presenters as in the other sessions and use the remaining time for discussion. Please time your presentations accordingly.

The PhD discussion session consists of three papers. We recommend that the 30-minute time for each presentation be distributed between the student and the discussant as follows: 15 minutes for the student's presentation, 10 minutes for the discussant's discussion, and 5 minutes for Q&A.

Parallel sessions will be held in rooms 3B, 3C, 3D, 3E, and SA on Level 3; in room CC on Level 2; and in the Auditorium and room -1A on Level -1. The locations of the rooms are indicated in Figures 1, 2, and 3 above. The Opening Session and Plenary 1 will take place in the Grande Auditório (see Map 2) and the remaining plenary sessions will take place in the Auditorium of the Faculty of Economics (Building 8).

The Chair of each parallel session is, usually, the last presenting author, as indicated in the detailed programme.

Parallel Sessions in this programme are identified using three parameters:
(i) day (Wed for Wednesday, Thu for Thursday and Fri for Friday);
(ii) time (09h00-10h30; 11h00-12h30;14h00-15h30;16h00-17h30), and
(iii) rooms where sessions will take place (Aud: Auditorium; -1A: Room -1A; CC: Room CC; SA: Sala de Atos; 3E: Room 3E; 3D: Room 3D; 3B: Room 3B and 3C: Room 3C).

• Presenting authors are identified by the underlined.

Important Information for Presenters

Each conference room is equipped with a computer and an interactive TV/board. Presenters are strongly advised to bring their presentations (PowerPoint or PDF format) on a USB drive and upload them to the room's computer during the break before their session begins. Please ensure your presentation is uploaded at least 5 minutes before the start of your session.

We do NOT recommend using personal computers for presentations, as we cannot guarantee software and hardware compatibility.

Lunches and coffee breaks

Lunches will be served every day between 12:00 and 14:00 in the Refectory. The location of the Refectory is indicated on Map 2. Coffee breaks will be served in Building 8 (level 2 and level 3), in the area near the stairs, except for the coffee break on the morning of June 19, which will be held in the Hall of the Grande Auditório.

There will be two daily coffee breaks: the first between 10:30 and 11:00, and the second between 15:30 and 16:00. The only exception is on Wednesday, June 19th, as the mid-afternoon coffee break will be replaced by a Welcome Reception on Deserta Island.

How to get to the University of Algarve, Gambelas Campus

There are regular bus services from Faro city centre to the University of Algarve (Gambelas Campus). If you are staying in the city centre you can catch bus number 18 to “Universidade – Gambelas” and also back to the city center (“Terminal Rodoviário”). This is a frequent circular route operated by the company Proximo. You can find the timetable here:

18 T. Rodoviário - Gambelas (via Penha)

IDA | DIAS ÚTEIS *OUTBOUND | BUSINESS DAYS*	A U	E U	A U	E U	A U	E U	E U	A U	E U	A U	E U	A U	E U	E U	A U	E U	E U	A U	E U	A U	E U	E U	E U	E U	A U	E U
Terminal Rodoviário	7:25	7:45	7:55	8:15	8:30	8:45	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:15	12:30	13:05	13:15	13:30	14:05	14:30	14:45	15:05	15:30	16:05	16:30	16:45
Universidade - Penha	7:38	7:58	8:08	8:28	8:43	8:58	9:13	9:43	10:13	10:43	11:13	11:43	12:13	12:28	12:43	13:18	13:28	13:43	14:18	14:43	14:58	15:18	15:43	16:18	16:43	16:58
Teatro Municipal / Fórum Algarve	7:45	8:05	8:15	8:35	8:50	9:05	9:20	9:50	10:20	10:50	11:20	11:50	12:20	12:35	12:50	13:25	13:35	13:50	14:25	14:50	15:05	15:25	15:50	16:25	16:50	17:05
Universidade - Gambelas Sul	7:55	8:15	8:25	8:45	9:00	9:15	9:30	10:00	10:30	11:00	11:30	12:00	12:30	12:45	13:00	13:35	13:45	14:00	14:35	15:00	15:15	15:35	16:00	16:35	17:00	17:15

IDA | DIAS ÚTEIS *OUTBOUND | BUSINESS DAYS*	A U	E U	A U	E U	E U	A U	E U	A U	E U	E U	E U	E U
Terminal Rodoviário	17:05	17:30	17:45	18:05	18:30	18:45	19:05	19:45	20:05	21:05	22:05	23:05
Universidade - Penha	17:18	17:43	17:58	18:18	18:43	18:58	19:18	19:58	20:18	21:18	22:18	23:18
Teatro Municipal / Fórum Algarve	17:25	17:50	18:05	18:25	18:50	19:05	19:25	20:05	20:25	21:25	22:25	23:25
Universidade - Gambelas Sul	17:35	18:00	18:15	18:35	19:00	19:15	19:35	20:15	20:35	21:35	22:35	23:35

VOLTA | DIAS ÚTEIS *INBOUND | BUSINESS DAYS*	A U	E U	A U	E U	A U	E U	E U	A U	E U	A U	E U	E U	E U	E U	A U	E U	E U	A U	E U	A U	E U	E U	E U	E U	A U	E U
Universidade - Gambelas Sul	7:55	8:15	8:30	8:40	9:00	9:15	9:30	10:00	10:30	11:00	11:30	12:00	12:35	12:45	13:00	13:20	13:45	14:00	14:35	15:00	15:15	15:35	16:00	16:35	17:00	17:15
Teatro Municipal / Fórum Algarve	8:05	8:25	8:40	8:50	9:10	9:25	9:40	10:10	10:40	11:10	11:40	12:10	12:45	12:55	13:10	13:30	13:55	14:10	14:45	15:10	15:25	15:45	16:10	16:45	17:10	17:25
Universidade - Penha	8:12	8:32	8:47	8:57	9:17	9:32	9:47	10:17	10:47	11:17	11:47	12:17	12:52	13:02	13:17	13:37	14:02	14:17	14:52	15:17	15:32	15:52	16:17	16:52	17:17	17:32
Terminal Rodoviário	8:24	8:44	8:54	9:09	9:29	9:44	9:59	10:29	10:59	11:29	11:59	12:29	13:04	13:14	13:29	13:49	14:14	14:29	15:04	15:29	15:44	16:04	16:29	17:04	17:29	17:44

VOLTA | DIAS ÚTEIS *INBOUND | BUSINESS DAYS*	A U	E U	A U	E U	E U	A U	E U	A U	E U	E U	E U	E U
Universidade - Gambelas Sul	17:35	18:00	18:15	18:35	19:00	19:15	19:35	20:15	20:35	21:35	22:35	23:40
Teatro Municipal / Fórum Algarve	17:45	18:10	18:25	18:45	19:10	19:25	19:45	20:25	20:45	21:45	22:45	23:50
Universidade - Penha	17:52	18:17	18:32	18:52	19:17	19:32	19:52	20:32	20:52	21:52	22:52	23:57
Terminal Rodoviário	18:04	18:29	18:44	19:04	19:29	19:44	20:04	20:44	21:04	22:04	22:59	0:09

A-U | Anual - Dias Úteis | *Business Days*
E-U | Escolar - Dias Úteis | *School Days - Business Days*
A-S | Anual - Sábados | *Saturdays*

Bus number 19 (T. Rodoviário to Gambelas via Aboim Ascenção) is also an alternative, but the trip takes longer.

19 T. Rodoviário - Gambelas (via Aboim Ascensão)

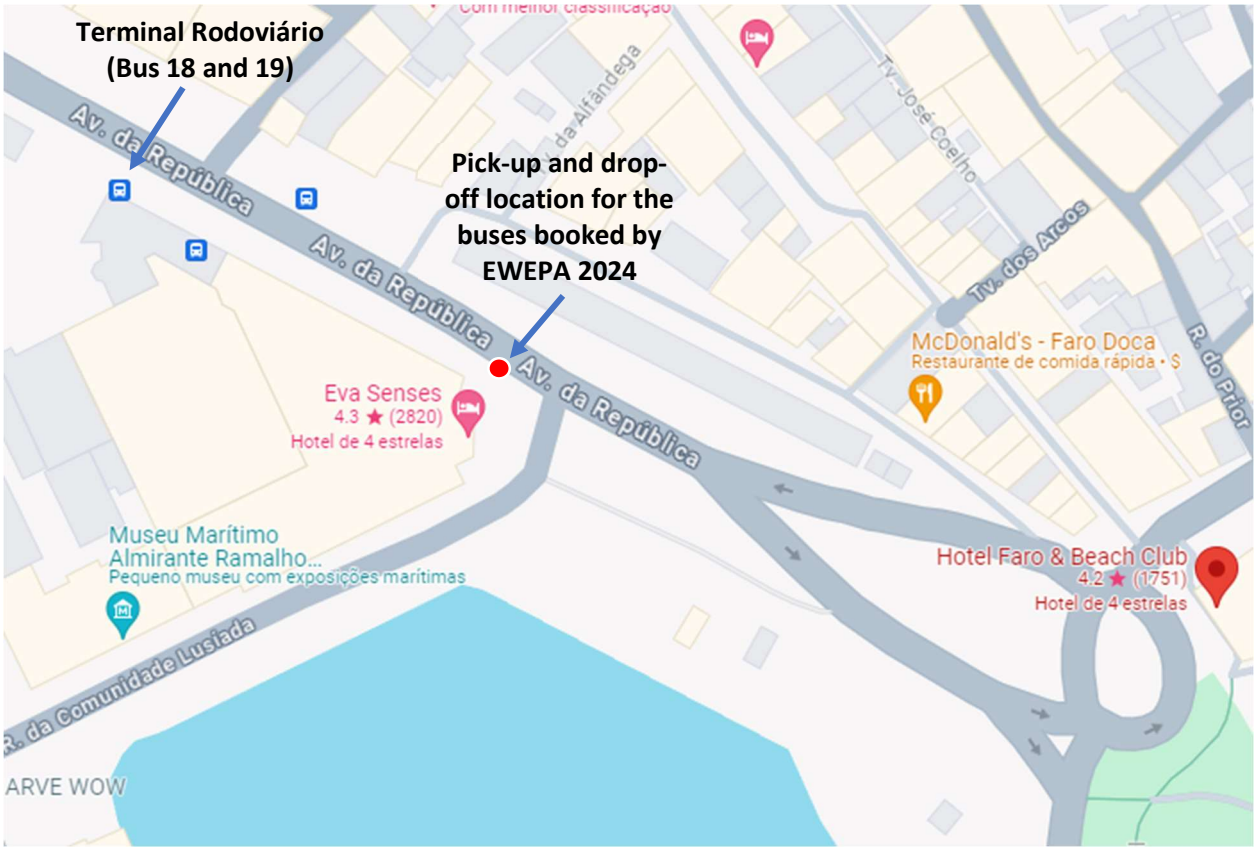
IDA | DIAS ÚTEIS *OUTBOUND | BUSINESS DAYS*	A U	A U	A U	A U	A U	A U	A U	A U	A U	E U	A U	A U	A U
Terminal Rodoviário	6:25	7:05	7:45	8:50	12:05	12:35	13:20	13:55	16:25	16:50	17:30	18:15	19:15
Teatro Municipal / Fórum Algarve	6:44	7:24	8:04	9:09	12:24	12:54	13:39	14:14	16:44	17:09	17:49	18:34	19:34
Junta de Freguesia	6:53	7:33	8:13	9:18	12:33	13:03	13:48	14:23	16:53	17:18	17:58	18:43	19:43
Universidade - Gambelas Sul	7:00	7:40	8:20	9:25	12:40	13:10	13:55	14:30	17:00	17:25	18:05	18:50	19:50

VOLTA | DIAS ÚTEIS *INBOUND | BUSINESS DAYS*	A U	A U	A U	A U	A U	A U	A U	A U	A U	A U	A U	A U	A U	A U
Universidade - Gambelas Sul	7:20	7:40	8:20	9:35	12:05	12:40	13:35	13:55	14:30	17:10	17:45	18:50	19:20	20:00
Junta de Freguesia	7:24	7:44	8:24	9:39	12:09	12:44	13:39	13:59	14:34	17:14	17:49	18:54	19:24	20:04
Montenegro - Terminal	-	7:50	8:30	-	-	-	-	-	-	-	-	-	-	-
Teatro Municipal / Fórum Algarve	7:35	8:04	8:44	9:50	12:20	12:55	13:50	14:10	14:45	17:25	18:00	19:05	19:35	20:15
Terminal Rodoviário	7:46	8:14	8:54	10:01	12:31	13:06	14:01	14:21	14:56	17:36	18:11	19:16	19:45	20:26

A-U | Anual - Dias Úteis | *Business Days*
E-U | Escolar - Dias Úteis | *School Days - Business Days*

Taxis and Uber services are also available in Faro.

To facilitate transportation to and from Gambelas Campus, free daily bus services will be available for EWEPA participants, subject to availability, from Faro Marina (in front of the AP EVA Senses Hotel) to the Gambelas University Campus and back. The buses will depart from this location at 8:30 am on June 19, 20 and 21 and at 11:00 am on June 18, and will return participants to Faro city center each day after the last scheduled sessions are finished. Map 3 below indicates the pick-up and drop-off location.



Map 3 – Location of the Terminal Rodoviário (Bus 18 and 19) and of the pick-up and drop-off points for buses booked by EWEPA 2024

Internet Access

If your institution is a member of the Eduroam network, you can connect to the internet using your Eduroam credentials. Alternatively, you can use the Conference Network using the following credentials:
Username: ewepa24
Password: 78569497

SOCIAL PROGRAMME

TUESDAY, JUNE 18TH 2024

18:30 | Welcome drink at the University of Algarve (Campus de Gambelas)

The University of Algarve (Photo 1) is a young state university, located in the southern part of Portugal, one of the most touristic regions of Portugal. The University has four faculties and four schools, offering a range of quality undergraduate and postgraduate courses in beautiful academic settings. The Gambelas Campus, where the welcome drinks and EWEPA 2024 will take place is close to Ria Formosa National Park, about 3 km away from the airport and 5 km away from the city centre of Faro.

Photo 1 – University of Algarve, Gambelas Campus

WEDNESDAY, JUNE 19TH 2024

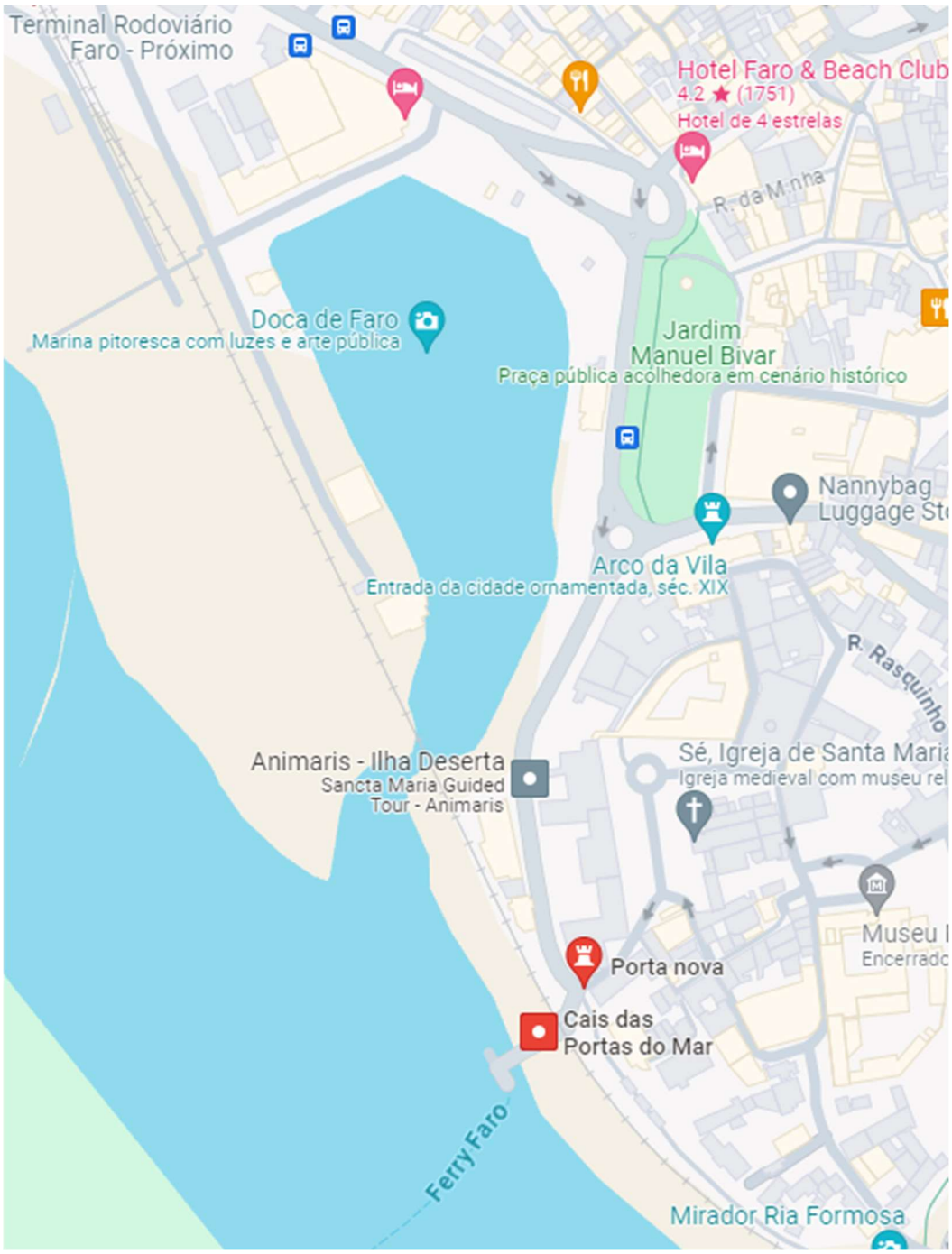
16:30 – 19:30 | Boat Trip in the Ria Formosa Lagoon and Welcome Reception on Deserta Island

Ria Formosa lagoon is a 19 km long system of barrier islands that communicate with the sea through six inlets. It has one of the richest and most interesting geologies, floras and faunas of Europe. It is also a protected area since 1987, with the status of Natural Park. The Welcome Reception will take place in Restaurant Estaminé (Photo 2), the only restaurant in Deserta Island.

Photo 2 – Estaminé Restaurant (Welcome Reception)

Access to Deserta Island has to be made by ferry. The ferry to go to Deserta Island will depart at 16:30 from “Cais Porta Nova” also known by “Cais das Portas do Mar”. Map 3 indicates its location (in red).

Conference Organizers are providing Bus Services from Gambelas Campus to Faro City for the participants to take the ferry to Deserta Island. The buses will depart from Gambelas Campus at 16:00.



Map 3 – Location of Cais das Portas do Mar

THURSDAY, JUNE 20TH 2024

19:30 | Conference Dinner at Hotel AP Eva Senses

AP Eva Senses Hotel (Photo 3) is nestled by the marina and the stunning landscape of Ria Formosa. It is one of the hotels with the finest location in Faro, boasting a privileged view of the Marina and Ria Formosa Natural Park. The hotel is also conveniently situated near Faro's entertainment venues and the city's most renowned restaurants.

Photo 3 – AP Eva Senses Hotel (Conference Dinner)

CONFERENCE PROGRAMME AT A GLANCE

TIME	TUESDAY 18TH JUNE PRE-CONFERENCE	WEDNESDAY 19TH JUNE	THURSDAY 20TH JUNE	FRIDAY 21ST JUNE
09h00 - 10h30		Opening Session Plenary 1 Kristof De Witte Discussant: Oleg Badunenko	Plenary 2 Barbara Casu Discussant: Ana Lozano-Vivas	Parallel Sessions
10h30 - 11h00		Coffee-break	Coffee-break	Coffee-break
11h00 - 12h30	Check-in	Parallel Sessions	Parallel Sessions	Parallel Sessions
12h30 - 14h00	Lunch	Lunch	Lunch	Lunch
14h00 - 15h30	Welcome & Plenary Pre-conference Antonio Peyrache Discussant: Chris Parmeter	Parallel Sessions	Parallel Sessions	Parallel Sessions
15h30 - 16h00	Coffee-break	Bus Service to Faro	Coffee-break	Coffee-break
16h00 - 17h30	PhD student Discussion Session	Boat Trip and Welcome Reception	Plenary 3 Lifetime achievement award Finn Førsund	Parallel Sessions
17h30 - 18h30				Closing session
18h30	Welcome drink			
19h30			EWEPA Dinner	

DETAILS OF SCIENTIFIC PROGRAMME

	Auditorium	Anf. -1A	Room CC	Sala de Atos	Room 3E	Room 3D	Room 3B	Room 3C
Tue (18th) 14h00-15h30	Welcome & Plenary Pre-Conference							
Tue (18th) 16h00-18h00	PhD Session							
Wed (19th) 09h00-10h30	* Opening Session & Plenary 1 - Kristof De Witte							
Wed (19th) 11h00-12h30	Special Session Office of the Audit Generals		RIEARN I	DEA Methods I	Productivity Analysis I	Electricity Regulation I	Country Analysis	
Wed (19th) 14h00-15h30	Justice	Agriculture I	RIEARN II	DEA Methods II	Productivity Analysis II	Regulation	Sustainability & Eco-efficiency I	Education I
Wed (19th) 16h00-17h30								
Thur (20th) 09h00-10h30	Plenary 2 Barbara Casu							
Thur (20th) 11h00-12h30	Agriculture II	Agriculture III	Sustainability & Eco-efficiency II	Banking & Finance I	Productivity Analysis III	Health I	Water and Sewage	Education II
Thur (20th) 14h00-15h30	Special Session in Honor of Gudbrand Lien	Agriculture IV		Banking & Finance II	Productivity Analysis IV	Health II		
Thur (20th) 16h00-17h30	Plenary 3 - Lifetime achievement award Finn Førsund							
Fri (21st) 09h00-10h30	SFA Methods I	Agriculture V	Gender (in)equality	DEA Methods III	Productivity Analysis V	Electricity Regulation II	Manufacturing I	Education III
Fri (21st) 11h00-12h30	SFA Methods II	Agriculture VI	Sustainability & Eco-efficiency III	Efficiency Methods	Multi-methods	Fishing	Manufacturing II	Education IV
Fri (21st) 14h00-15h30	Special Session in Honor of Mike Tsionas	Agriculture VII		Banking & Finance III	DEA Applications			
Fri (21st) 16h00-17h30	Special Session in Honor of Bob Russell	Agriculture VIII	Climate Impacts on Agricultural Productivity	Sports	SFA Applications			
Fri (21st) 17h30-18h30	Closing Session							

* The Opening Session and Plenary 1 will take place in the Grande Auditório (please, see Map 2 to check for the location).

Plenary Sessions

TUESDAY, JUNE 18
14H00-15H30 | Auditorium

Plenary Early Career Day

Antonio Peyrache, University of Queensland, Australia
Chair/Discussant: Chris Parmeter

Title: "Efficiency and Productivity Analysis from a System Perspective: Historical Overview and Possible Future Developments".

Abstract: The last decade has witnessed an exponential proliferation of studies on Network Data Envelopment Analysis (NDEA) as a tool to measure efficiency and productivity for production systems. Those systems are composed of various layers of decision making (hierarchically organized) and potentially interconnected production processes. The decision makers face the problem of allocating resources to the various production processes in an efficient manner. In this presentation I will present the main ideas behind this approach, its epistemological foundation, some simple models and examples, and prospective future avenues of research.

Short Biography: Antonio Peyrache is a Senior Lecturer at the School of Economics, University of Queensland, Australia; and the deputy director of the Centre for Efficiency and Productivity Analysis (CEPA). Antonio obtained an undergraduate and master's degree in Statistics and Economics from "La Sapienza" University of Rome. He obtained his PhD from the same university in 2008. He has co-authored and published about 18 papers in the field of Efficiency and Productivity analysis. Antonio has been involved in consultancy and research collaborations with several organizations, including, for example, the Asian Productivity Organization (APO) and the Vietnamese Ministry for Science and Technology. In recent years, Antonio has focused his research on activity analysis production models and their application to applied problems of optimal allocation of resources in production organizations. This spurred an interest in the trade-off that several public service providers seem to show between processing times of new cases (patients for hospitals, criminal and civil cases for courts, etc.) and the resources of those production units. Backloads, capacity constraints and rationing by waiting are the key elements of the modelling and applications that have attracted his attention in recent years.

Discussant: Christopher F. Parmeter is an associate professor in the Economics Department. He received his Ph.D. in Economics from the State University of New York at Binghamton. His research focuses on applied econometrics across a broad array of fields in economics including productivity and efficiency analysis, economic growth, microfinance, international trade, and environmental economics. He has published over 100 research articles in internationally recognized peer-reviewed journals including Journal of Economic Growth, Journal of Econometrics, Journal of Applied Econometrics, Economic Journal, and Journal of Environmental Economics and Management , and published the Cambridge University Press book "Applied Nonparametric Econometrics." He is currently vice-editor at Journal of Productivity Analysis and Co-Editor at Environmental and Resource Economics. In addition, he serves as an associate editor at Empirical Economics, Econometrics and Statistics, and Journal of Environmental Economics and Management, while also serving as a member

of the editorial councils of Advances in Econometrics and Journal of the Association of Environmental and Resource Economists. He was previously an associate editor at the American Journal of Agricultural Economics and the Journal of African Business.
Focuses on applied econometrics across a broad array of fields in economics including productivity and efficiency analysis, economic growth, microfinance, international trade, and environmental economics. He has published over 100 research articles in internationally recognized peer-reviewed journals including Journal of Economic Growth, Journal of Econometrics, Journal of Applied Econometrics, Economic Journal, and Journal of Environmental Economics and Management, and published the Cambridge University Press book "Applied Nonparametric Econometrics." He is currently vice-editor at Journal of Productivity Analysis and Co-Editor at Environmental and Resource Economics. In addition, he serves as an associate editor at Empirical Economics, Econometrics and Statistics, and Journal of Environmental Economics and Management, while also serving as a member of the editorial councils of Advances in Econometrics and Journal of the Association of Environmental and Resource Economists. He was previously an associate editor at the American Journal of Agricultural Economics and the Journal of African Business.

WEDNESDAY, JUNE 19
09H00-10H30 | Grande Auditório

Plenary 1

Kristof De Witte, Faculty of Economics and Business at KU Leuven, Belgium
Chair/Discussant: Oleg Badunenko

Title: Multidimensional policy evaluations and the efficiency-enhancing channel

Abstract: This presentation explores the nuances between efficiency and effectiveness in educational systems, starting with the educational production function and utilizing Stochastic Frontier Analysis (SFA) to estimate student under-achievement. We begin by examining how resource constraints can bridge the gap between efficiency and effectiveness. We then review non-parametric methods for evaluating the causal impact of policy changes within a multi-input, multi-output framework, highlighting the advantages of integrating econometric impact evaluation with efficiency analysis. In particular, we address endogeneity issues by introducing a quasi-experimental design within a conditional multi-input, multi-output efficiency framework. This allows for a decomposition of overall efficiency into 'group-specific' efficiency (reflecting internal managerial inefficiency) and 'program' efficiency (indicating the impact of policy interventions on performance). This decomposition facilitates the interpretation of efficiency scores in terms of causality. Finally, we extend this non-parametric framework to an SFA context. The practical application of these methodologies is demonstrated through case studies of secondary schools in Flanders, Belgium, showcasing their utility and effectiveness.

Short Biography: Kristof De Witte is a full professor in Education Economics and Political Economy at the Faculty of Economics and Business at KU Leuven, Belgium, and he holds the chair in 'Effectiveness and Efficiency of Educational Innovations' at United Nations University (UNU-MERIT) at Maastricht University, the Netherlands. Kristof De Witte has more than 100 indexed publications, most in the area of education economics, performance evaluation, and political economy and many in the leading journals from various academic fields, including 'American Sociological Review', 'The Economic Journal', 'Journal of Urban Economics', 'European Journal of Operational Research', 'Government Information Quarterly', 'Economics of Education Review', 'Labour Economics', 'Exceptional Children', 'World Development', and 'Educational Research Review'. Kristof De Witte serves as an expert in the

'European Commission Expert Group on quality investment in education and training' and is the recipient of numerous awards and honours, including the '2021 Pioneer Award' of KU Leuven, the '2020 Laureate of the Academy' award from the Royal Flemish Academy of Belgium for Science and the Arts, the '2021 CELSA Service to Society Award' (honorific), two international prizes for his doctoral dissertation, among others.

Discussant: Oleg Badunenko is an Associate Professor at Brunel University London. His research interests are in the economics and applied microeconometrics. Oleg's focus is on efficiency and productivity analysis in various areas of societal life, whereby he both develops and applies best-practice methods, and provides software for practitioners. As such, he investigates real-world phenomena in health, education but also in banking and manufacturing. His research investigates the socio-economic determinants of behavior and efficiency at the school and higher education levels, and determinants of productivity in health care sector. His recent work investigates choices that individuals make trading off security and privacy as well public and private sector employment. He is additionally working on issues related to competition in banking and effects of macroeconomic events on banks' behavior.

THURSDAY, JUNE 20
09H00-10H30| Auditorium

Plenary2

Barbara Casu, Faculty of Finance at Bayes Business School, City, University of London, UK
Chair/Discussant: Ana Lozano Vivas

Title: Innovating Efficiency: Emerging Themes Transforming Banking

Abstract: The talk will examine how technological advancements, regulatory changes, emerging business models, customer-centric innovations, and sustainability initiatives are transforming banking. We will explore the integration of AI, blockchain, and automation in streamlining operations, the shift towards personalized and multi-channel banking, and the adoption of green financing and ESG practices. By highlighting these emerging themes, we provide insights into new standards for assessing bank efficiency in a rapidly evolving financial landscape.

Short Biography: Professor Barbara Casu is the Head of the Faculty of Finance at Bayes Business School, City, University of London (UK), and the Director of the Centre for Banking Research (CBR). Previously she held the role of Director of the Bayes Executive PhD Programme. Her main research interests are in empirical banking, payment systems, financial regulation, financial innovation, and corporate governance. Barbara has published widely, with over 50 publications in peer reviewed Journals. She has also written the popular textbook "Introduction to Banking" (Pearson FT), which is widely adopted for banking courses across the world. She has recently co-edited the Palgrave Handbook of European Banking. Outside academia, Professor Casu has been a consultant/visiting researcher at several organizations, including the International Monetary Fund (IMF); the European Commission (EC); the South African Reserve Bank (SARB); Centre for European Policy Studies (CEPS); the Building Societies Association (BSA).

Discussant: Ana Lozano-Vivas is a Professor of Economic Analysis at the University of Malaga, Spain, specializing in Efficiency and Productivity, Banking Microeconomics, and Applied Microeconomics. Her research focuses on efficiency and productivity analysis within the banking sector, along with various

aspects of banking microeconomics such as regulation, competition, business models, and risk management, among others.
She has having held visiting researcher positions at Florida State University, Ohio University, and New York University's Stern School of Business. Additionally, she has been actively involved in consultancy roles for organizations like the OECD and the IMF, as well as serving as an external consultant for the Bank of Luxembourg on the PERFILUX Project.
Her contributions extend to policy discussions, including participation in conferences addressing finance for research and innovation. Ana has served as an expert for the Risk Finance Advisory Group of the European Commission. Currently, she acts as an independent advisor to the European Bank of Finance.

THURSDAY, JUNE 20
16H00-17H30 | Auditorium

Plenary 3 - Session in honour of Finn Førsund

Chair: Robin Sickles

Special Guest, "Words to Honor Colleague Lennart Hjalmarsson".
Sverre Kittelsen, "Scale economies and capacity utilization in somatic hospitals in Norway".
Kenneth Løvold Rødseth, "Estimating and decomposing environmental efficiency using a generalized materials balance model: Application to U.S. power plants".
Victor Podinovski, "Scale and marginal characteristics of nonparametric production frontiers".
Rolf Färe and Shawna Grosskopf, "Production under physical constraints" (online participation).

Special Sessions

WEDNESDAY, JUNE 19
11H00-12H30 | Auditorium

Special session: Office of the Audit Generals and Efficiency Analysis

Chair: Jonas Månsson

José Carpinteiro, Tribunal de Contas, Portugal. Approaches to Performance Audit: Experience of the Portuguese Court of Auditors.
Jonas Månsson, Where do National Audit Offices and research meet? – some reflections from spending 15 years at both places?
Tonny Kawukit, Office of the Audit General, Uganda. Audit of Ugandan Custom Stations.
Kristoffer Grønsberg, Office of the Auditor General, Norway. Audit on Norwegian Hospitals.

THURSDAY, JUNE 20
14H00-15H30 | Auditorium

Agriculture session in honor of Gudbrand Lien

Chair: Subal Kumbhakar (online)

Luis Orea, "Who benefits most from knowledge spillovers and technology diffusion? An analysis of dairy farms using a heteroskedastic spatial stochastic frontier".
Saurav Raj Kunwar, "Shadow prices of agricultural carbon sequestration and greenhouse gas emissions".
Moritz Hartig, "Talking about the weather – Farm-level inefficiency and climate extremes".
Maroua Afi, "Integrated Crop-Livestock vs. Specialized Farming Systems in The Great Plains: What Scope for Sustainable Intensification of food production?"

FRIDAY, JUNE 21
14H00-15H30 | Auditorium

Session in honor of Mike Tsionas

Chair: Chris Parmeter

Alecos Papadopoulos, "Two-tier stochastic frontier analysis: heterogeneous error distributions and model selection".
Ioannis Bournakis, Marwan Izzeldin, Mike Tsionas, Olivier Cardi, "Corporate Social Responsibility (CSR) in the UK: Who Pays the Price?".
Arne Henningsen, "Bayesian estimation of CES-CET production technology parameters to improve CGE models".
Kristiaan Kerstens, Oleg Badunenko and Jafar Sadeghi, "Revenue functions are nonconcave in the inputs when the technology is nonconvex: the unbearable lightness of convexification".

FRIDAY, JUNE 21
16H00-17H30 | Auditorium

Special Memorial Tribute to R. Robert Russell

Chair: Dan Henderson

Dan Henderson, "A Micro Theorists Contribution to Macroeconomics".
Rolf Färe and Shawna Grosskopf, "R.R. Russell: Our Friend in Duality: Professional and Personal".
Robin Sickles, "From Karlsruhe and Newark to Porto: 40 Productive Years Learning from R. R. Russell".

Also with contributions from **Robert Chambers** and **Knox Lovell**.

Details per Day/ Session

TUESDAY, JUNE 18

11:00 – 14:00 - Arrival and Check-in

Tue|14:00-15:30 | Aud.
Plenary Early Career Day – Antonio Peyrache

Chair/Discussant: Chris Parmeter

15.30-16.00 Coffee break

Tue|16:00-18:00 | Aud.
PhD student's presentations

Chair: Antonio Peyrache

Anna Rita Dipierro, Pierluigi Toma. ***From terroir to quality: handling the run for efficiency across time and space for Italian agri-food***

Discussant: Mette Asmild

Andrea Rodriguez, Lourdes Trujillo, Ramon Nuñez. ***The Inclusion of CO2 Emissions in Spanish Port Productivity and Efficiency Analysis***

Discussant: Luis Orea

Alexander Ottl, Mette Asmild. ***Profitability Decomposition in Data Envelopment Analysis: Unraveling the 'A Dollar is not a Dollar' Phenomenon in Economic Resource Allocation***

Discussant: Victor Podinovski

WEDNESDAY, JUNE 19

8.00-9.00 - Arrival and Registration

Wed|09:00-10:30 | Grande Auditório
Plenary 1 - Kristof De Witte

Chair/Discussant: Oleg Badunenko

10.30-11.00 Coffee break

Wed|11:00-12:30 | Aud.
Special session office of the audit generals and efficiency analysis

Chair: Jonas Månsson

Parallel sessions

Wed|11:00-12:30|CC
Agricultural, Food and Natural Resource Productivity Analyses in Ibero-America: Session Organized by the Iberoamerican Network of Agrifood and Natural Resource Economics (RIEARN)
RIEARN I

Chair: Federico Garcia and Boris Bravo-Ureta

THE DETERMINANTS OF THE AGRICULTURAL TFP GROWTH IN THE BRAZILIAN SEMIARID REGION – AN ANALYSIS FOR THE PERIOD 2006-2017, Maria Josiell Nascimento da Silva; Humberto Francisco Silva Spolador

CLIMATE CHANGE, DROUGHT, AND AGRICULTURAL PRODUCTION IN BRAZIL, Steven Helfand; Francisco Cavalcanti; Ajax Moreira

ASSESSMENT OF DEFORESTATION AND CLIMATE CHANGE EFFECTS ON BRAZILIAN AGRICULTURAL PRODUCTIVITY AND EFFICIENCY LEVELS: AN EMPIRICAL APPROACH USING STOCHASTIC FRONTIER ANALYSIS, André Danelon; Silke Hüttel; Stefan Seifert; Humberto Spolador; Subal Kumbhakar

THE EFFECTS OF WEATHER VARIABILITY AND CLIMATE CHANGE ON FARM OUTPUT AND PRODUCTIVITY GROWTH IN LATIN AMERICAN

AND CARIBBEAN COUNTRIES: A STOCHASTIC METAFRONTIER ANALYSIS, Michée Arnold Lachaud; Boris Bravo-Ureta; Eric Njuki; Jason Beckman

Wed|11:00-12:30|SA
DEA Method I

Chair: Laurens Cherchye

RATIO-DATA CONVEXITY AND THE FREE DISPOSAL HULL MODEL, Giovanni Cesaroni

SOME PROBLEMS WITH BENEFIT OF THE DOUBT MODELS, Paul Rouse

A PAIRWISE-FRONTIER-BASED CLASSIFICATION METHOD FOR TWO-GROUP CLASSIFICATION, Qianying Jin; Kristiaan Kerstens; Ignace Van De Woestyne; Zhongbao Zhou

NONPARAMETRIC IDENTIFICATION OF FACTOR-BIASED AND HICKS-NEUTRAL TECHNICAL CHANGE, Laurens Cherchye; Bram De Rock

Wed|11:00-12:30|3E
Productivity Analysis I

Chair: Léopold Simar

A NEW BIENNIAL TOTAL FACTOR PRODUCTIVITY MALMQUIST INDEX, Jesús T. Pastor

PERMUTATION TESTS ON COMPARISONS OF PRODUCTION FRONTIERS OVER TIME AND BETWEEN GROUPS IN NONPARAMETRIC MODELS, Anders Rønn-Nielsen; Dorte Kronborg; Mette Asmild

CONICAL FDH ESTIMATORS OF DIRECTIONAL DISTANCES AND LUENBERGER PRODUCTIVITY INDICES FOR GENERAL TECHNOLOGIES, Simar Léopold; Di Leo Simone; Daraio Cinzia

STATISTICAL INFERENCE FOR HICKS–MOORSTEEN PRODUCTIVITY INDICES, Valentin Zelenyuk; Leopold Simar; Shirong Zhao

Wed|11:00-12:30|3D
Electricity Regulation I

Chair: Ørjan Mydland

HANDLING LARGE ELECTRICITY PRICE VARIATION IN REGULATION OF ELECTRICITY DSOs IN NORWAY, Hilde Marit Kvile; Eivind Skjærven; Peder Undeli

INCENTIVIZING THE OPTIMAL LEVEL OF SPARE CAPACITY, Eivind Skjærven; Hilde Marit Elverum Kvile

REGULATION OF ELECTRIC ENERGY DISTRIBUTION IN GERMANY: STATUS QUO AND CONSIDERED CHANGES, Carolin Ladda; Heinz Ahn; Ana Lopes-Ahn

EFFECTS ON ELECTRICITY DISTRIBUTION COMPANIES DUE TO THE INCREASE IN ELECTRIC VEHICLES IN NORWAY, Ørjan Mydland; Fikru Kefyalew Alemayehu; Subal C. Kumbhakar; Gudbran Lien

Wed|11:00-12:30|3B
Country Analysis

Chair: Mercedes Sánchez

INTANGIBLE CAPITAL AS DRIVER OF PRODUCTIVITY: A REGIONAL AND SECTORAL APPROACH, Mercedes Gumbau

EU WASTE RECYCLING TARGETS: WHERE ARE WE AT?. A PERFORMANCE EVOLUTION ASSESSMENT, Laura Carosi; Giovanna D'Inverno; Trinidad Gómez; Maria Molinos-Senante; Giulia Romano

ECONOMIC DEVELOPMENT AND FOOD WASTE: A CROSS-COUNTRY EXAMINATION USING STOCHASTIC FRONTIER ANALYSIS, Emiliano Lopez Barrera

GREEN SMES STRATEGIES: AN INTEGRATED APPROACH TO RESOURCE EFFICIENCY, GREEN MARKETS AND SUPPORTS IN SMES, Mercedes Sánchez; Consuelo Calafat; Rosa Puertas

12.30-14.00 Lunch

Parallel sessions

Wed|14:00-15:30|Aud.
Justice

Chair: Pablo Arocena

EVALUATING SPECIALIZATION AND DIVERSIFICATION ECONOMIES IN JUDICIAL COURTS, Pablo Arocena

THE EFFICIENCY OF DISTRICT COURTS IN NORWAY AFTER THE REFORM: A DEA ANALYSIS, Anatoliy Goncharuk

ECONOMIES OF SCALE IN DISTRICT COURTS, Jonas Månsson

UNDER(MINING) JUDICIAL EFFICIENCY: A DATA-DRIVEN EXPLORATION OF DYNAMICS IN PORTUGAL'S JUDICIAL SYSTEM, Mariana Simões Lopes; Maria Conceição Silva; Miguel Alves Pereira

Wed|14:00-15:30|-1A
Agriculture I

Chair: Yang Liu

AGRICULTURAL MECHANIZATION SERVICES, ADVERSE SELECTION AND BY-STAGE PRODUCTIVITY OF SMALL FARMS: EVIDENCE FROM WHEAT PRODUCTION IN NORTHERN CHINA, Yu Sheng; Hangyu Sheng; Jiping Ding

PRODUCTIVITY CHANGE OF ESTONIAN DAIRY FARMS FROM 2006-2022: COMPARISON OF TOTAL FACTOR PRODUCTIVITY AND AGRICULTURAL TERMS OF TRADE, Raul Omel

REGIONAL DEVELOPMENT AND INTELLECTUAL CAPITAL: UNVEILING THE INNOVATION-TRADITION DILEMMA, Pierluigi Toma

ASSESSING HOW PRODUCTION TECHNOLOGY DIVERSITY IMPACTS ENVIRONMENTAL TOTAL FACTOR PRODUCTIVITY IN CHINA'S AGRICULTURE AT THE PROVINCIAL SCALE, Yang Liu; Maria Vrachioli; Johannes Sauer

Wed|14:00-15:30|CC
Agricultural, Food and Natural Resource Productivity Analyses in Ibero-America: Session Organized by the Iberoamerican Network of Agrifood and Natural Resource Economics (RIEARN)
RIEARN II

Chair: Federico Garcia and Boris Bravo-Ureta

EXPLORING AGRICULTURAL PRODUCTIVITY DYNAMICS IN THE BRAZILIAN CERRADO: INSIGHTS FROM VARIED LAND INPUT MEASURES, Pablo Guimarães; Humberto Spolador

DIGITAL FARMING TECHNOLOGY ADOPTION AND TECHNICAL EFFICIENCY OF BRAZILIAN BEEF CATTLE FARMS, Marcelo José Carrer; Marcela de Mello Brandão Vinholis; Hildo Meirelles de Souza Filho; Gabriela dos Santos Eusebio; Letícia Caroline da Silva David

TECHNICAL EFFICIENCY OF COW-CALF SYSTEMS IN PASTURE BASED RANCHES, Federico García-Suárez

TECHNOLOGY ADOPTION AND IMPACTS IN AGRICULTURE PRODUCTION: A SYSTEMATIC REVIEW FROM THE STOCHASTIC FRONTIER APPROACH, Larissa Pagliuca; Marcelo Jose Carrer

Wed|14:00-15:30|SA
DEA Methods II

Chair: Lars Skage Engebretsen

GROUP DECISION MAKING WITH IMPRECISE DATA ENVELOPMENT ANALYSIS FOR RISK ASSESSMENT, Adel Hatamimarbini; Pegah Khoshnevis; Aliasghar Arabmaldar

DATA ENVELOPMENT ANALYSIS IN MANAGEMENT ACCOUNTING: NEW FRONTIERS EXPLORING INDUSTRY CHARACTERISTICS, Claire Cui; Julie Harrison; Frederick Ng; Paul Rouse

DATA ENVELOPMENT ANALYSIS (DEA) FOR STOCHASTIC DYNAMIC COST-EFFICIENCY ANALYSIS OF INVENTORY CONTROL SYSTEMS: A WINDOW ANALYSIS, CHANCE-CONSTRAINED, AND PRINCIPLES OF OPTIMAL CONTROL THEORY APPROACH, Paulo Nocera Alves Junior; Ali Emrouznejad; Wilfredo Yushimito; Carlos Monardes Concha; Isotilia Costa Melo

PIONEER – MAKING EFFICIENCY ANALYSES EASIER, Lars Skage Engebretsen; Ove Haugland Jakobsen; Aleksander Valberg Eilertsen; Kristoffer Grønsberg

Wed|14:00-15:30|3E
Productivity Analysis II

Chair: Thomas Triebs

THE KOREAN ECONOMY: PRODUCTIVITY, TECHNOLOGICAL CHANGE, AND RD INVESTMENT, Seogwon Hwang; Minji Kang

ANALYZING COMPETITIVENESS IN SMALL OPEN ADVANCED ECONOMIES THROUGH TOTAL FACTOR PRODUCTIVITY: INSIGHTS AND IMPLICATION FOR SWEDEN, Anupama Unnikrishnan; Jonas Månsson

INNOVATION OUTPUT POSSIBILITIES AND PERFORMANCE CHANGE FOR EUROPE AND ITS INTERNATIONAL COMPETITORS, Michela Bello; Panagiotis Ravanos; Oscar Smallenbroeck

FIRM SUBSIDIES AND INPUT USE, Thomas Triebs

Wed|14:00-15:30|3D
Regulation

Chair: David Saal

THE ROLE OF POLITICAL FACTORS AND DEMAND UNCERTAINTY IN THE EXCESS OF CAPACITY FOR LANDLORD PORT AUTHORITIES: AN APPLICATION TO THE SPANISH CASE, Ramon Nunez-Sanchez; Soraya Hidalgo-Gallego; David Miranda

A REGULATORY PERSPECTIVE FOR ROBUST BENCHMARKING OF UTILITIES, Emil Heesche; Mads Frandsen

ECONOMIC ANALYSIS OF WATER MANAGEMENT IN THE EUROPEAN UNION, Juan Pablo Henao Henao; Maria Vrachioli; Roberto Villalba; Johannes Sauer

ASSESSING THE PERFORMANCE OF COMPLEX NETWORK SYSTEMS UNDER THE LASSO+DEA FRAMEWORK, Fionn Cliffe; David Saal

Wed|14:00-15:30|3B
Sustainability & Eco-efficiency I

Chair: Marijn Verschelde

DETERMINANTS OF ECO-EFFICIENCY OF LISTED FOOD AND BEVERAGE FIRMS: THE ROLE OF ENVIRONMENTAL MANAGEMENT, THE BOARD OF DIRECTOS AND SOCIAL PERFORMANCE, Alan Wall; Alfons Oude Lansink; José Antonio Pérez-Méndez

WHEN ONE TONNE IS NOT ONE TONNE: SUSTAINABLE EFFICIENCY OF FIRMS WHEN DECARBONIZATION IS IMPERFECTLY OBSERVED, Bram De Rock; Laurens Cherchye; Marijn Verschelde

MEASURING AND MANAGING (UN)SUSTAINABLE WORKLOAD UNDER DIGITIZATION: A FRONTIER-BASED JOB DEMANDS-RESOURCES MODEL, Ahmed-Youssef Oukassou; Raluca Parvulescu; Marijn Verschelde

FROM OUTLIER TO SUSTAINABILITY IDENTIFICATION IN NONPARAMETRIC FRONTIER ANALYSIS, Ahmed-Youssef Oukassou; Raluca Parvulescu; Nicky Rogge; Marijn Verschelde

Wed|14:00-15:30|3C
Education I

Chair: Lori Taylor

POLICY RESPONSES TO COVID-19 AND THE EFFICIENCY OF ITALIAN UNIVERSITIES, Gaetano Francesco Coppeta; Tommaso Agasisti; Alice Bertoletti

MEASURING TECHNOLOGICAL CHANGE IN THE SPANISH UNIVERSITY SYSTEM (2013-2020), Gemma Perez-Lopez; Victor Gimenez; Diego Prior; Jose Luis Zafra-Gomez

TO FEED OR NOT TO FEED: TEXAS SCHOOLS' PARTICIPATION IN CEP, Kathy Hayes; Shawna Grosskopf; Laura Razzolini; Lori Taylor

15.30-16.00 Bus Service to Faro – Boat Trip

THURSDAY, JUNE 20

Thu|09:00-10:30 | Aud.
Plenary 2 – Barbara Casu

Chair/Discussant: Ana Lozano Vivas

10.30-11.00 Coffee break

Parallel sessions

Thu|11:00-12:30|Aud.
Agriculture II

Chair: Hervé Dakpo

THE ROLE OF AND EXTENSION PROGRAM FOR DIFFERENT CROPS: A STOCHASTIC METAFRONTIER PERSPECTIVE, Roberto Jara-Rojas; Miss Monica Maldonado

THE ROLE OF TECHNOLOGY AND TECHNICAL EFFICIENCY IN ITALIAN DAIRY FARMING ACROSS ALTITUDES: A STOCHASTIC META-FRONTIER ANALYSIS, Claudia Stefania Gondos; Elena Castellari; Alan Wall; Boris E. Bravo-Ureta

TECHNICAL AND ENVIRONMENTAL PRODUCTIVITY OF SWISS DAIRY FARMS: A BY-PRODUCTION STOCHASTIC FRONTIER ANALYSIS, Iordanis Parikoglou

EXAMINING THE COMPETITIVENESS PRESSURE OF WINE PRODUCTION IN EU NATIONS: A LATENT CLASS BOUNDED INEFFICIENCY MODEL, Hervé Dakpo; Laure Latruffe; Yann Desjeux

Thu|11:00-12:30|-1A
Agriculture III

Chair: Miguel Alves Pereira

EFFICIENCY ANALYSIS IN THE AGRICULTURAL SECTOR: HETEROGENEITY MATTERS IN THE LAND OF MILK AND HONEY, Ludwig Lauwers; Elizabeth Ahikiriza; Guido Van Huylenbroeck; Jef Van Meensel; Wim Verbeke

ANALYSING WEATHER'S IMPACT ON TECHNICAL EFFICIENCY: A STUDY OF CROP FARMS IN NORWAY, Habtamu Alem

FRONTIER ANALYSIS TECHNIQUES TO DERIVE ELIGIBLE CONTACT FARMS FOR TARGETED EXTENSION: EMPIRICAL EVIDENCE FROM UGANDAN DAIRY FARMING, Elizabeth Ahikiriza; Guido Van Huylenbroeck; Ludwig Lauwers

FROM GRAPES TO THE GLASS: A NETWORK DEA SIMULATION APPROACH FOR UNVEILING WINE SUPPLY CHAIN EFFICIENCY, Miguel Alves Pereira; António Vieira; Rui Fragoso; José Rui Figueira

Thu|11:00-12:30|CC
Sustainability & Eco-efficiency II

Chair: Barnabe Walheer

UNDESIRABLE FACTORS IN THE RAW MATERIAL FLOW PROCESS: A COMPARISON BETWEEN INVERSE TRANSFORMATION APPROACHES, Ali Emrouznejad; Maria Michali; Gholam Reza Amin

PERFORMANCE-BASED CARBON EMISSION ABATEMENT ALLOCATION, Li-Hsueh Chen; Li-Ching Chen

ASSESSING SOCIOECONOMIC IMPACTS OF RENEWABLE ENERGY EXPANSION: A REGIONAL ANALYSIS IN BRAZIL, Aline Veronese da Silva; Cleiton José Carneiro Júnior

A SEQUENTIAL BENEFIT-OF-THE-DOUBT COMPOSITE INDICATOR, Barnabe Walheer

Thu|11:00-12:30|SA
Banking & Finance I

Chair: David Sherman

SENSITIVITY OF PORTFOLIO PERFORMANCES TO THE RANDOM NATURE OF THE DATA, Anne Vanhems; Leopold Simar; Ariane Szafarz; Marie Briere

RISK-AVERSION VERSUS RISK-LOVING PREFERENCES IN NONPARAMETRIC FRONTIER-BASED FUND RATINGS: A BUY-AND-HOLD BACKTESTING STRATEGY, Tiantian Ren; Kristiaan Kerstens; Saurav Kumar

SUSTAINABLE PERFORMANCE OF BANK BUSINESS MODELS IN ARGENTINA: A COST FRONTIER APPROACH, Ana Lozano-Vivas; Claudia Peretto; Alan Wall

DEA AS AN AUDIT TOOL TO IDENTIFY ABNORMAL FINANCIAL TRANSACTIONS FOR REVIEW AND VALIDATION, H. David Sherman; Joe Paradi

Thu|11:00-12:30|3E
Productivity Analysis III

Chair: Christopher O'Donnell

UNDERSTANDING THE IMPACT OF ENVIRONMENTAL FACTORS ON PRODUCTIVITY: INTRODUCING THE CONDITIONAL ORDER-M MALMQUIST INDEX, Marc Aliana-Cervera; Diego Prior; Emili Tortosa-Ausina

TECHNICAL EFFICIENCY AND PRODUCTIVITY GAINS IN 38 OECD COUNTRIES 1995-2019. A STOCHASTIC PRODUCTION FRONTIER ANALYSIS, Mateusz Wojniak; Marta Zieba

SUSTAINABLE PRODUCTIVITY INDICATORS: PRIVATE OR SOCIETAL PERSPECTIVE?, Arne Henningsen; Frederick Ang; Herve Dakpo; Moriah Bostian; Maria Vrachioli

GHG EMISSIONS AND PRODUCTIVITY CHANGE IN SELECTED SECTORS OF THE AUSTRALIAN ECONOMY, Christopher O'Donnell

Thu|11:00-12:30|3D
Health I

Chair: Minyan Zhu

EFFICIENCY OF ADDRESSING COVID-19 PANDEMIC BY THE STATES OF INDIA IN THE PRE-AS WELL AS POST VACCINATION PERIODS AND DIFFERENTIAL IMPACT ON EFFICIENCY OF UNION'S AND STATES' POLITICAL PARTY ALLIGNMENT, Trishit Bandyopadhyay

ASSESSMENT OF CONTAINMENT PERFORMANCE POLICIES AGAINST COVID-19 USING A BENEFIT-OF-THE-DOUBT APPROACH, Roxani Karagiannis; Giannis Karagiannis

QUANTIFYING THE TRADE-OFF BETWEEN CAPACITY UTILISATION AND PATIENT WAITING TIME: THE CASE OF AMBULANCE SERVICES IN THE UK, Minyan Zhu; Antonio Peyrache

Thu|11:00-12:30|3B
Water and Sewage

Chair: Ana camanho

WATER WASTE: A PRODUCTIVITY ANALYSIS OF THE WATER SUPPLY IN PORTUGAL, Isotilia Costa Melo; Francisco Silva Pinto; Paola Ravelojaona

HOW DOES THE PLANT LEVEL FRAGMENTATION IN SEWAGE TREATMENT INFLUENCE MUNICIPAL LEVEL ECONOMIES OF SCALE?, Tomohiro Kitamura; David Saal; Takuya Urakami; Pablo Arocena

BENCHMARKING ANALYSIS IN THE BRAZILIAN WATER AND SEWAGE SECTOR: A DIRECTIONAL BENEFIT-OF-THE-DOUBT APPROACH, Andréia May; Carlos Ernani Fries; Hermílio Vilarinho; Ana S. Camanho

EVOLUTION OF PERFORMANCE IN THE WATER AND SEWAGE SECTOR IN BRAZIL: A ROBUST DIRECTIONAL BENEFIT-OF-THE-DOUBT ASSESSMENT OF MUNICIPALITIES FROM SANTA CATARINA STATE, Andréia May; Hermilio Vilarinho; Carlos Ernani Fries; Ana Camanho

Thu|11:00-12:30|3C
Education II

Chair: Oleg Badunenko

MEASURING OPTIMAL TUITION IN TAIWAN USING A STOCHASTIC FRONTIER HEDONIC FUNCTION APPROACH, Ya-Yun Fu; Wei-Hsin Kong

PERFORMANCE TRENDS IN EDUCATIONAL EQUITY IN THE OECD: AN INTERNATIONAL ASSESSMENT USING MALMQUIST INDICES, Giovanna D'Inverno; Cristina Polo; Gabriela Sicilia; Rosa Simancas

EXAMINING LABOR PRODUCTIVITY GAPS IN DIFFERENT EDUCATIONAL SYSTEMS: A COMPARATIVE ANALYSIS OF SPANISH REGIONS, Jose M. Cordero; Oleg Badunenko

12.30 - 14.00 Lunch

Thu|14:00-15:30 | Aud.
Special session in honour of Gudbrand Lien

Chair: Subal Kumbhakar

Parallel sessions

Thu|14:00-15:30|-1A
Agriculture IV

Chair: Raluca Parvulescu

MEASURING THE SUSTAINABILITY EFFICIENCY OF DAIRY FARMS IN MEXICO: A PRODUCTIVE EFFCIENCY APPROACH, Bouali Guesmi; José Luis jaramillo Villanueva; Benigna Gonzalez Ortiz; Amer Ait Sidhoum; José María

HOW CAN AGRICULTURAL PRODUCTION BE RECONCILED WITH ENVIRONMENTAL PRESERVATION: 'LAND SPARING' VERSUS 'LAND SHARING'?, Salomé Kahindo

ENVIRONMENTALLY ADJUSTED EFFICIENCY OF RAIN-FED AND IRRIGATED ENTERPRISES IN THE SAN SALVADOR BASIN, URUGUAY, Tiho Ancev; Francisco Rosas; Moriah Bostian

BALANCING PROFITABILITY, PROTEIN PRODUCTION, AND PESTICIDE REDUCTION: WHAT ARE THE LEVERS FOR ACTION FOR FRENCH ARABLE FARMS?, Raluca Parvulescu; Jean-Philippe Boussemart; Salomé Kahindo; Maé Guinet; Nicolas Munier-Jolain

Thu|14:00-15:30|SA
Banking & Finance II

Chair: Robin Sickles

ISLAMIC BANKS, SQUARE PEG IN A ROUND HOLE? EVIDENCE FROM MENA REGION USING METAFRONTIER DIRECTIONAL DISTANCE FUNCTIONS, Ben Jemaa Mekki

A MULTIDIMENSIONAL ASSESSMENT OF FINTECH COMPANIES: FINANCIAL INDICATORS, ACHIEVEMENT OF SUSTAINABILITY GOALS AND THE USE OF NEW

TECHNOLOGIES, Victor Giménez; Isabel Narbón Perpiñá; Diego Prior; Josep Rialp

REVISITING THE IMPACT OF BANKING COMPETITION WITH NONCOVEX TECHNOLOGY, Oleg Badunenko; Jérémie Bertrand; Kristiaan Kerstens; Paul-Olivier Klein

DIRECT AND INDIRECT IMPACTS OF NATURAL DISASTERS ON BANKS: A SPATIAL FRAMEWORK, Robin Sickles

Thu|14:00-15:30|3E
Productivity Analysis IV

Chair: Emili Grifell-Tatjé

U.S. FIELD CROP FARM PRODUCTIVITY: CLIMATIC EFFECTS, TECHNOLOGY, AND FARM PRACTICES, Sun Ling Wang; Ryan Olver; Daniel Bonin; Ryan William

ENVIRONMENTAL REGULATION AND LABOR EFFICIENCY, Moriah Bostian; Hanna Lindstrom; Tommy Lundgren; Mattias Vesterberg;

ARTIFICIAL INTELLIGENCE AND FIRM PRODUCTIVITY, Iulia Siedschlag; Juan Duran Vanegas

WHAT POLICY LEVER TO PULL?: ANALYSIS OF DIRECTED TECHNICAL CHANGE FOR IDENTIFYING EFFICIENT CONFIGURATIONS OF ENTREPRENEURIAL ECOSYSTEMS, Emili Grifell-Tatjé; Esteban Lafuente

Thu|14:00-15:30|3D
Health II

Chair: Camilla Mastromarco

EFFICIENCY AND FINANCIAL SOLIDITY OF HEALTHCARE SERVICE PROVIDER INSTITUTIONS (IPS) IN COLOMBIA, Ligia Melo

PURCHASE PRODUCTIVITY IN DUTCH YOUTH CARE: LOCALLY LEAST SQUARES FRONTIER METHOD APPLIED TO MUNICIPALITY DATA, Blank Jos; Van Heezik Alex

PERFORMANCE OF ITALIAN HOSPITALS, 2015–2019, Camilla Mastromarco

15.30-16.00 Coffee break

Thu|16:00-17:30 | Aud.
Plenary 3 – Session in honour of Finn Førsund

Chair/Discussant: Robin Sickles

FRIDAY, JUNE 21

Parallel sessions

Fri|09:00-10:30|Aud.
SFA Methods I

Chair: Alex Stead

THE DOUBLE HURDLE STOCHASTIC FRONTIER MODEL WITH ORDERED MULTIPLE CHOICES, Yi-Wun Chen

A BAYESIAN, SEMI-PARAMETRIC APPROACH TO INEFFICIENCY HETEROGENEITY IN SFA, Michael Wiper; Helena Veiga; Yaguo Deng

ESTABLISHING A LINK BETWEEN QUANTILE REGRESSION AND THE MAXIMUM LIKELIHOOD ESTIMATION IN STOCHASTIC FRONTIER ANALYSIS, Zangin Zeebari

A ROBUST ESTIMATION APPROACH TO SOLVING THE 'WRONG SKEW' PROBLEM, Alexander Stead; Phill Wheat; William H. Greene

Fri|09:00-10:30|-1A
Agriculture V

Chair: Stefen Seifert

INVESTIGATING PESTICIDE-SPECIFIC USE INEFFICIENCY IN THE PRESENCE OF

ENVIRONMENTAL SPILLOVERS, Emmanuel Ahovi; Jaap Sok; Alfons Oude Lansink

CAN WE OBSERVE RELATION BETWEEN ENVIRONMENTAL SUBSIDIES, BIODIVERSITY AND ECONOMIES OF SCOPE IN CZECH AGRICULTURE?, Lukas Cechura

LAND FRAGMENTATION AND FARM PERFORMANCE: THE CASE OF AUSTRIAN CROP FARMS, Eder Andreas

ALGORITHMS KILLED THE TRIAL CONDUCTOR: A PROPOSAL FOR A FRONTIER APPROACH TO DIGITALIZE THE SEED VARIETY ADMISSION, Stefan Seifert; Maria Gerullis; Andreas Beel

Fri|09:00-10:30|CC
Gender (in)equality

Chair: Antonio Alvarez

MEASURING TOTAL GENDER PAY GAP WITH HICKS-MOORSTEEN INDEX, Dumas Audrey; Vega Poleth

LOOKING FOR UNITY IN EQUALITY: EVALUATING FEMALE DISADVANTAGE AND ACHIEVEMENT IN EU REGIONS, Nicky Rogge

GENDER DIFFERENCES IN PRODUCTIVITY IN THE BANKING SECTOR, Maria J. Perez Villadoniga; Ana Rodriguez-Alvarez; David Roibas; Raul Garcia de Vega

MEASURING THE GENDER WAGE GAP USING STOCHASTIC FRONTIERS: SOME MODELLING ISSUES, Antonio Alvarez; Graziella Bonanno

Fri|09:00-10:30|SA
DEA Methods III

Chair: Antonio Peyrache

A SINGLE-STAGE SOLUTION PROCEDURE WITHOUT A SMALL EPSILON, Grammatoula Papaioannou; Victor Podinovski

DECOMPOSITION WEIGHTS AND STAGE EFFICIENCIES IN THE ADDITIVE NETWORK DEA MODEL WITH SHARED RESOURCES, Giannis Karagiannis; Stavros Kourtzidis; Nickolaos G. Tzeremes

THE PARALLEL MULTI-COMPONENT NETWORK DEA WITH VARIABLE RETURNS TO SCALE, Giannis Karagiannis; Stavros Kourtzidis

HOMOTHETIC DATA GENERATED PRODUCTION METATECHNOLOGIES, Antonio Peyrache

Fri|09:00-10:30|3E
Productivity Analysis V

Chair: Hideyuki Mizobuchi

LEVERAGING INNOVATION FOR IMPROVED SERVICE PRODUCTIVITY: INSIGHTS FROM STOCHASTIC FRONTIER MODELS WITH ENDOGENEITY, Fikru Alemayehu; Kai Sun; Subal Kumbhakar

HOW DOES RURAL GENTRIFICATION AFFECT FARMING EFFICIENCY? APPLYING RENT GAP THEORY TO AGRICULTURE, Bazyli Czyzewski; Jakub Staniszewski; Lukasz Kryszak; Aleksander Grzelak; Michal Borychowski

A THEORETICAL MODEL OF EFFICIENCY DISTRIBUTIONS, Jaap Bos; Stefan Weiland

LASPEYRES-PAASCHE BOUNDS FOR PRODUCTIVITY INDEX, Hideyuki Mizobuchi; Valentin Zelenyuk

Fri|09:00-10:30|3D
Electricity Regulation II

Chair: Kjartan Rasmussen

HOW DOES THE CEO'S GENDER AFFECT PUBLIC UTILITIES' ECONOMIC DECISIONS?, Kristofer Månsson

A COMPARISON OF DATA ENVELOPMENT ANALYSIS, STOCHASTIC FRONTIER MODELS AND MODEL COMBINATION APPROACHES USING PANEL DATA, Toni Duras; Scott Hacker; Kristofer Månsson; Pär Sjölander; Magnus Söderberg

CROSSING NON-PARAMETRIC AND PARAMETRIC TECHNIQUES FOR MEASURING THE EFFICIENCY: EVIDENCE FROM THE IBERIAN GAS DISTRIBUTION SYSTEM OPERATORS, Vítor Marques; Diogo Bárbara, Rui Rita, Patrícia Raínha; Victor Moutinho

TIME-VARYING AND TIME-INVARIANT EFFICIENCY AMONG THE ELECTRICITY DISTRIBUTION COMPANIES IN SCANDINAVIAN COUNTRIES – A PANEL DATA STOCHASTIC FRONTIER APPROACH, Kjartan Rasmussen; Jonas Månsson

Fri|09:00-10:30|3B
Manufacturing I

Chair: Mohsen Afsharian

TECHNICAL AND STRUCTURAL EFFICIENCY IN ENERGY USE IN INDIAN MANUFACTURING: AN INTER-STATE ANALYSIS, Subhash Ray; Kankana Mukherjee

DIGITALIZATION AND FIRMS MARKUPS: EVIDENCE FROM SPANISH MANUFACTURING FIRMS, Juan A. Sanchis

LEVERAGING BENCHMARKING FOR DEMAND PREDICTION AND PRODUCT EVALUATION IN SUPPLY CHAIN MANAGEMENT, Mohsen Afsharian; Peter Bogetoft

Fri|09:00-10:30|3C
Education III

Chair: Dimitrios Sotiros

INCORPORATING PERCENTAGES IN THE ASSESSMENT OF SCHOOL EFFICIENCY: AN EMPIRICAL STUDY, Junlin Wu; Nikolaos Argyris; Victor Podinovski

THE EFFECTS OF HIGHER EDUCATION SYSTEMS' EFFICIENCY IN REGIONAL ECONOMIC GROWTH AND INEQUALITY REDUCTION: THE CASE OF THE MEXICAN STATES, Herberto Rodríguez; Emili Tortosa-Ausina; Victor Gimenez; Javier Ordóñez

A GENERALIZED COMPOSITION APPROACH IN NETWORK DATA ENVELOPMENT ANALYSIS FOR COMPLEX STRUCTURES: AN APPLICATION TO HIGHER EDUCATION INSTITUTIONS IN POLAND, Dimitrios Sotiros; Julia Zoladkiewicz; Gregory Koronakos; Dimitrios Despotis

10.30-11.00 Coffee break

Parallel sessions

Fri|11:00-12:30|Aud.
SFA Methods II

Chair: Christopher Parmeter

THE MOTIVATION FOR APPLICATION OF ROBUST STOCHASTIC FRONTIER ANALYSIS IN REGULATORY BENCHMARKING, Phill Wheat

THREE-WAY RANDOM EFFECTS STOCHASTIC FRONTIER MODEL, Levent Kutlu; Robin C. Sickles

LASSO+SFA AND XISTENCE OF INEFFICIENCY, Christopher Parmeter, Artem Prokhorov, Valentin Zelenyuk

INFERENCE IN THE NONPARAMETRIC STOCHASTIC FRONTIER MODEL, Christopher Parmeter, Leopold Simar, Ingrid Vankeilegom, Valentin Zelenyuk

Fri|11:00-12:30|-1A
Agriculture VI

Chair: Orlando Rodriguez

IMPACTS OF DEFORESTATION ON BRAZILIAN AGRICULTURAL PRODUCTIVITY, Adauto Rocha Junior

TOWARDS FOSSIL-INDEPENDENT AGRICULTURE? USE EFFICIENCY OF FOSSIL-BASED INPUTS IN SWEDISH AGRICULTURE, Vivian Wei Huang

EXPLANATION OF PERSISTENT AND TRANSIENT EFFICIENCY IN THE PRESENCE OF

ENDOGENEITY – A ONE STEP APPROACH WITHOUT DISTRIBUTIONAL ASSUMPTION, Lajos Baráth; Lukáš Cechura Cechura

EFFICIENCY WITHIN HETEROGENOUS TECHNOLOGIES FOR SUSTAINABLE COFFEE PRODUCTION: A LATENT CLASS FRONTIER MODEL IN COLOMBIA, Orlando Rodriguez; Maria Vrachioli; Johannes Sauer

Fri|11:00-12:30|CC
Sustainability & Eco-efficiency III

Chair: Magdalena Kapelko

ESTIMATING ECO-EFFICIENCIES OF FOOD RETAILERS – A BILEVEL OPTIMIZATION PROBLEM, Andreas Dellnitz

AN ANALYSIS OF SUSTAINABLE WASTE EFFICIENCY AT EUROPEAN LEVEL, Simone Di Leo; Idiano D'Adamo; Cinzia Daraio; Léopold Simar

MEASURING ENVIRONMENTAL INEFFICIENCY THROUGH MACHINE LEARNING TECHNIQUES, Magdalena Kapelko; Maria Guillen; Juan Aparicio; Miriam Esteve

Fri|11:00-12:30|SA
Efficiency Methods

Chair: Daniel J. Henderson

A FAST METHOD FOR IMPLEMENTING HYPOTHESIS TESTS WITH MULTIPLE SAMPLE SPLITS IN NONPARAMETRIC MODELS OF PRODUCTION, Paul W. Wilson; Léopold Simar

REGULATING MULTIPLE RELATED EXTERNALITIES, Mette Asmild; Trine Krogh Boomsma; Frank Jensen; Rasmus Nielsen

COMBINING BI-LEVEL OPTIMIZATION WITH DEA TO HANDLE PROFIT MAXIMIZATION AND EFFICIENCY EVALUATION UNDER A STOCHASTIC FRAMEWORK, Andreas C. Georgiou; Eleni-Maria Vretta; Konstantinos Kaparis; Kyriakos Bitsis; George Paltayian; Fenia Mavrodi; Emmanuel Thanassoulis

LABOR INCOME TAX SHOCKS AND LARGE FIRMS' RD, Daniel Henderson; Soroush Ghazi; Alexandra Soberon; Taining Wang

Fri|11:00-12:30|3E
Multi-methods

Chair: Thyago Nepomuceno

COMBINING MARKOVIAN AND DATA ENVELOPMENT ANALYSIS MODELLING IN MANAGING THE EVOLUTION OF POPULATION COHORTS, Andreas Georgiou; Emmanuel Thanassoulis; George Tsaples; Konstantinos Kaparis

CAUSAL EFFECTS OF POLICY INTERVENTIONS ON PRODUCTIVE PERFORMANCE: INTEGRATING SYNTHETIC CONTROL METHODS INTO THE NONPARAMETRIC APPROACH, Xun Zhou

EVALUATING PONDS AS NATURE-BASED SOLUTIONS: EFFECTIVENESS VS EFFICIENCY, Pietro Sala; Maria Vrachioli; Fabian Frick; Johannes Sauer

MULTICRITERIA METHODS AND DIRECTIONAL DISTANCES IN PUBLIC ADMINISTRATIONS: STATE OF THE ART WITH A NEW APPROACH, Thyago Nepomuceno; Cinzia Daraio

Fri|11:00-12:30|3D
Fishing

Chair: Kenneth Løvold Rødseth

DISENTANGLING TWO DECADES OF INEFFICIENCY TRENDS AND DYNAMICS IN THE GERMAN BROWN SHRIMP FISHERY BY PANEL STOCHASTIC FRONTIER ANALYSIS, Tim Knöpfel

IMPACT OF PRODUCTION ENVIRONMENT ON THE PRODUCTIVITY GROWTH OF NORWEGIAN TRAWLERS, Thanh Viet Nguyen

GREEN SCENARIOS FOR THE FISHING INDUSTRY: USING NON-PARAMETRIC PRODUCTION ANALYSIS TO MODEL

STRATEGIC RENEWAL OF THE NORWEGIAN FISHING FLEET, Kenneth Løvold Rødseth

Fri|11:00-12:30|3B
Manufacturing II

Chair: Alfons Oude Lansink

FIRMS' DIGITALIZATION AND TFP PERFORMANCE FOR SPANISH MANUFACTURING, Dolores Añon Higon; Juan A. Máñez; Amparo Sanchis; Juan Sanchis

EFFICIENCY ANALYSIS UNDER CYBER THREAT: THE CASE OF EUROPEAN FOOD MANUFACTURERS, Frederic Ang

RISK AND RETURN EFFICIENCY OF MANUFACTURING FIRMS: INTEGRATING CORPORATE SOCIAL RESPONSIBILITY PERFORMANCE, Alfons Oude Lansink

Fri|11:00-12:30|3C
Education IV

Chair: Audrone Jakaitiene

A BENEFIT-OF-THE-DOUBT MODEL FOR COUNTRY PERFORMANCE ASSESSMENT AND TARGET SETTING ALIGNED WITH THE EUROPEAN UNION 2030 EDUCATION AND TRAINING STRATEGY, Fernando Osório; Flávia Barbosa; Giovanna D´Inverno; Ana Camanho

BENCHMARKING IN EDUCATION: IMPROVING PERFORMANCE TOWARD THE DEFINED GOALS INSTEAD OF (RE)PRODUCING SOCIAL CATEGORIES OF WINNERS AND LOSERS, Dovile Stumbriene; Jose L. Ruiz; Inmaculada Sirvent

DOES ACHIEVEMENT GAP CORRELATE WITH AVERAGE PERFORMANCE? CASE OF PIRLS, Audrone Jakaitiene; Laura Ringiene; Gabriele Stupuriene; Rita Dukynaite; Rimantas Zelvys

12.30-14.00 Lunch

Fri|14:00-15:30 | Aud.
Special session in honour of Mike Tsionas
Chair: Chris Parmeter

Parallel sessions

Fri|14:00-15:30|-1A
Agriculture VII

Chair: Simone Russo

LAND RENTAL AND ARABLE FARMERS' ECO-EFFICIENCY IN CHINA, Jiajun Zhou

DOES COMPENSATION FOR REDUCED NITROGEN LEAKAGE AFFECT ECO-EFFICIENCY: EVIDENCE FROM SWEDISH CROP FARMS, Zhen Chen; Vivian Wei Huang

SOCIAL CAPITAL AND SMALLHOLDERS´ OIL PALM PRODUCTION IN COSTA RICA, Gabriela Enma Carbajo Alvarez; Bernhard Brümmer

DOES INSURANCE INCREASE THE PERSISTENT AND TRANSIENT TECHNICAL EFFICIENCY OF FARMS? EVIDENCE FROM ITALY, Simone Russo; Lukáš Cechura; Cristina Salvioni; Subal Kumbhakar

Fri|14:00-15:30|SA
Banking & Finance III

Chair: Takayoshi Nakaoka

PERFORMANCE MEASUREMENT OF EUROPEAN MUTUAL FUNDS UNDER THE SUSTAINABLE FINANCE DISCLOSURE REGULATION, Albane Tarnaud; Alfons Oude Lansink

DYNAMICS OF OPERATIONAL EFFICIENCY IN CREDIT LENDING AND RECOVERY OF STRESSED ASSETS: AN ALTERNATIVE APPROACH WITH UNDESIRABLE BY-PRODUCTS, Gargi Sanati; Anup Kumar Bhandari

OPERATIONAL EFFICIENCY IN THE PRESENCE OF UNDESIRABLE BYPRODUCTS: AN ANALYSIS OF INDIAN BANKING SECTOR UNDER TRADITIONAL AND MARKET-BASED BANKING FRAMEWORK, Anup Kumar Bhandari; Gargi Sanati

ANALYZING THE EFFECTS OF QUANTITATIVE EASING POLICY ON PRODUCTIVITY CHANGE UNDER CAPITAL ADEQUACY CONSTRAINT: EVIDENCE FROM JAPANESE BANKING INDUSTRY, Takayoshi Nakaoka; David Saal; Pablo Arocena

Fri|14:00-15:30|3E
DEA Applications

Chair: Charles-Henri Dimaria

OPTIMIZING BUILDING DESIGN USING FRONTIER ESTIMATION, Dag Fjeld Edvardsen

SETTING GOALS FOR CASE RESOLUTION TIMES OF POLICE FORCES IN BRAZIL: A STUDY OF THE EFFICIENCY OF PERNAMBUCO STATE POLICE, Lucio Silva; Josenildo Ferreira da Silva Junior; Ednael Francisco Vieira da Silva; Thyago Celso Cavalcanti Nepomuceno; Flavia Barbosa; Ana Maria Camanho

GROUP- AND METATECHNOLOGY EFFICIENCIES AND TECHNOLOGY GAP OF AIRLINES: A UNION METAFRONTIER DYNAMICS NETWORK DEA FRAMEWORK, Ming-Miin Yu

LET'S ALL GET PESSIMISTIC WITH ILL-BEING, DiMaria, Charles-Henri

15.30-16.00 Coffee break

Fri|16:00-17:30 | Aud.
Special session in honour of Bob Russell
Chair: Dan Henderson

Parallel sessions

Fri|16:00-17:30|-1A
Agriculture VIII

Chair: Gaofei Yang

ASSESSING THE COST-EFFECTIVENESS OF PROMOTING MIXED AGRICULTURAL REGIONS IN EUROPE, Murilo de Almeida Furtado; Miranda P. M. Meuwissen; Frederic Ang

ECO-EFFICIENCY AND ENVIRONMENTAL EFFICIENCY IN FARMING: QUANTITATIVE SYSTEMATIC SYNTHESIS AND META-REGRESSION ANALYSIS, Olha Halytsia; Maria Vrachioli; Johannes Sauer

SUSTAINABLE POLICY IMPACT ON AGRICULTURAL PRODUCTIVITY AND GREENHOUSE GAS EMISSIONS IN CHINA?, Gaofei Yang; Maria Vrachioli; Johannes Sauer

Fri|16:00-17:30|CC
Climate Impacts on Agricultural Productivity

Chair: Eric Njuki

CLIMATE CHANGE COULD BRING DOWN GLOBAL AGRICULTURAL YIELDS AND RESHAPE FOOD MARKETS IN THE NEAR TERM, Simone Pieralli; Ignacio Pérez-Domínguez; Christian Elleby

RD NEEDS TO OFFSET CLIMATE CHANGE IMPACTS ON US AGRICULTURAL PRODUCTIVITY, Ariel Ortiz-Bobea

CLIMATE, AND WEATHER IMPACTS ON AGRICULTURAL TOTAL FACTOR PRODUCTIVITY, Eric Njuki; Noé Nava; Boris Bravo-Ureta

Fri|16:00-17:30|SA
Sports

Chair: Gabriel Villa

DO FOOTBALL TEAMS INVEST INEFFICIENTLY IN PLAYERS WHEN COMPETITIVE BALANCE IS LOWER?, Dejan Trifunovic; Željko Jovic; Đorde Mitrovic

EVALUATING THE RELATIONSHIP BETWEEN ON-COURT PERFORMANCE AND SALARY CREATION OF NBA PLAYERS USING A TWO-STAGE NETWORK DEA MODEL, Pin-Hsuan Sung; Tsu-Tan Fu

A STONEZD ANALYSIS OF FOOTBALL TEAMS WAGES, Gabriel Villa; Sebastian Lozano

Fri|16:00-17:30|3E
SFA Applications

Chair: Araceli Ortega

EXPLORING THE ROLE OF GOVERNANCE AND AGRICULTURAL INTENSIFICATION IN LAND USE CHANGE, Gabriel Rosero; Jessie Lin

ARE SMART TOURIST DESTINATIONS MORE PRODUCTIVE EFFICIENT?, David Boto Garcia; Jose Francisco Baños Pino; Ines Sustacha; Eduardo Del Valle

GROWTH, CO2 EMISSIONS AND CONVERGENCE: AN ENHANCED HYPERBOLIC DISTANCE FUNCTION APPROACH, Roberto Balado-Naves; Jose Baños-Pino; Ana Rodriguez-Alvarez

EVALUATION OF THE PROGRAM "PRODUCCIÓN PARA EL BIENESTAR" USING A STOCHASTIC PRODUCTION META-FRONTIER, Araceli Ortega-Diaz

17.30–18.30 Closing Session

PARTICIPANTS (Alphabetically ordered by surname)

First Name	Last (Family) Name	Organisation/Institution	Country
Abdul-Baaki	Adedokun	Universidade do Algarve, FEUAlg	Portugal
Maroua	Afi	University of Nebraska Agricultural Economics	USA
Mohsen	Afsharian	Leibniz FH, University of Applied Sciences	Germany
Elizabeth	Ahikiriza	Makerere University	Uganda
Heinz	Ahn	Technische Universität Braunschweig	Germany
Emmanuel	Ahovi	Wageningen University and Research	Netherlands
Habtamu	Alem	Norwegian Institute of Bioeconomy Research (NIBIO)	Norway
Fikru	Alemayehu	Inland Norway University of Applied Sciences	Norway
Antonio	Alvarez	Univ. of Oviedo	Spain
Inmaculada	Álvarez	Universidad Autónoma de Madrid	Spain
Carla	Amado	Universidade do Algarve, FEUAlg	Portugal
Christine	Amsler	Michigan State University	USA
Tiho	Ancev	University of Sydney	Australia
Jasmine	Anceva	University of Sydney	Australia
Frederic	Ang	Wageningen University	Netherlands
Dolores	Añón Higón	Universitat de València	Spain
Pablo	Arocena	Public University of Navarre	Spain
Mette	Asmild	University of Copenhagen	Denmark
Oleg	Badunenko	Brunel University London	United Kingdom
Roberto	Balado-Naves	University of Oviedo	Spain
Trishit	Bandyopadhyay	TST Training and Research Service	India
Lajos	Baráth	HUN-REN KRTK	Hungary
Diogo	Bárbara	ERSE	Portugal

Mohamed	Ben Jemaa	University of Carthage	Tunisia
Bárbara	Bender	Universidade do Porto	Portugal
Anup	Bhandari	Indian Institute of Technology Madras	India
Kyriakos	Bitsis	University of Macedonia	Greece
Jos	Blank	IPSE Studies	Netherlands
Peter	Bogetoft	Copenhagen Business School CBS	Denmark
Jaap	Bos	Maastricht University	Netherlands
Moriah	Bostian	Lewis & Clark College, Centre for Environmental and Resource Economics (CERE), Umeå University	USA
A.J.	Bostian		USA
David	Boto Garcia	University Of Oviedo	Spain
Ioannis	Bournakis	SKEMA Business School	France
Boris	Bravo-Ureta	UCONN	USA
Margarita	Brugarolas	Asociación Española de Economía Agroalimentaria	Spain
Ana	Camanho	University of Porto	Portugal
Gabriela E.	Carbajo Alvarez	University of Göttingen	Germany
Laura	Carosi	University of Pisa	Italy
Marcelo	Carrer	Federal University of São Carlos - Brazil	Brazil
Lourdes	Castellano	Universidad de Las Palmas de Gran Canaria	Spain
Barbara	Casu	City, University of London	United Kingdom
Lukas	Cechura	Czech University of Life Sciences Prague	Czech Republic
Marc	Cervera	Universitat Autònoma de Barcelona	Spain
Giovanni	Cesaroni	Universitas Mercatorum	Italy
Bob	Chambers	University of Maryland	USA
Li-Hsueh	Chen	Fo Guang University	Taiwan
Zhen	Chen	Swedish University of Agricultural Sciences	Sweden
Yi-Wun	Chen	National Chung Cheng University	Taiwan

Laurens	Cherchye	KU Leuven	Belgium
Luís	Coelho	Universidade do Algarve	Portugal
Gaetano Francesco	Coppeta	Politecnico Di Milano	Italy
Isotilia	Costa Melo	CEREFIGE, University of Lorraine	France
Claire	Cui	the University of Auckland	New Zealand
Aline	da Silva	UNICAMP	Brazil
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