The Africa Centre for Development Finance (ACDF)

USB University of Stellenbosch Business School

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WORKSHOP | Applied Efficiency and Productivity Analysis Using Data Envelopment Analysis

Monday, 30 April – Friday, 4 May 2018

University of Stellenbosch Business School, Cape Town, South Africa
Presented by Dr Kwaku Ohene-Asare, University of Ghana Business School, and Dr Nyankomo Marwa, University of Stellenbosch Business School

What is the workshop about?

This five-day workshop on postgraduate level will focus on applied Data Envelopment Analysis with a healthy balance between the theory and hands-on application.

The workshop will cover the economic theory of efficiency and productivity analysis and its measurement using non-parametric analysis. Both basic and advanced DEA models for measuring efficiency in multi-input, multi-output situations will be covered. An illustrative assessment using DEA will be carried out by participants. In addition, recent developments in DEA with slack-based models will be discussed. Participants will be introduced to R, STATA and EMS software.

The workshop is offered by the Africa Centre for Development Finance at the University of Stellenbosch Business School in collaboration with the University of Ghana Business School. Financial support is provided by Stellenbosch University.

Who should attend?

- Those interested in assessing the performance of organisational units such as regional offices, bank branches, sales outlets, hospitals and schools
- Aspiring doctoral candidates, post-doctoral fellows, current doctoral fellows and other academics working in this domain
- Those working with the national institutes of productivity analysis

The workshop is compulsory for current PhD and Master's students in Development Finance working on performance evaluation at the University of Stellenbosch Business School.

What you will gain from the workshop?

Participants will gain an appreciation of the principles underlying Data Envelopment Analysis (DEA) and issues arising in using it, and develop the skills to do empirical modelling for DEA using R and STATA.

Study material covered

- The economic theory of efficiency and productivity analysis and its measurement using non-parametric analysis

- Basic and advanced DEA models for measuring efficiency in multi-input, multi-output situations
- An illustrative assessment using DEA
- Recent developments in DEA with slack-based models and stochastic DEA
- An introduction to R, STATA and EMS software (most of the second-stage analysis will be conducted in STATA)

Admission requirements

Participants are expected to have the following:

- Intermediate or advanced level micro-economic theory at undergraduate level, such as the treatment in *Microeconomic Analysis* by H.R. Varian (1992; New York: W.W. Norton) or *Intermediate Microeconomics: A Modern Approach* (H.R. Varian (2005; New York: W.W. Norton).
- Basic knowledge of mathematical economics, econometrics, linear programming and applications is desirable but not compulsory.
- STATA, EMS and R will be employed. Prior knowledge of at least one of the software packages will be an added advantage.

WORKSHOP CONTENT

Overview

The performance measurement of different decision-making units (DMUs) is important for performance improvement and monitoring. Specifically, knowledge about production technologies and producer behaviour is important for the public sector, private sector and social sector of the economy. Such knowledge offers useful insights for those desiring to know how envisaged policies and market conditions can affect resource allocation, production, incomes and prices across different sectors of the economy.

Productivity analysis evaluates the scale, efficiency and technological dynamics of DMUs across countries and within sectors. While innovations are needed to push the competitive envelope to the next frontier, efficiency gains are necessary to ensure that the implemented technologies achieve their potential.

Economists and operational researchers suggest that such variations in performance could be explained by the heterogeneity in the level of productive efficiency among DMUs. However, in conventional economics inefficient behaviour is assumed away, satisfying first-order and second-order optimising conditions. Nevertheless, "inefficiency processes exist in the real world, as a perusal of almost any trade publication will verify, and as the hordes of consultants armed with their buzzwords will testify" (Fried, Lovell & Schmidt, 2013: 3-4). Thus, productive inefficiency exists, and it deserves to be included in our analytical toolkit because it can generate refutable hypotheses concerning the sources of variation in business performance.

The five-day intensive workshop in Efficiency and Productivity Analysis will be devoted to modelling sources of inefficiency in production processes and their impact on economic and financial performance. The training aims to build research capacity and facilitate social networking in this domain across different sectors of the economy. The focus will be on the application of the underlying production theory to the empirical evidence required to support decision making.

The knowledge and skills gained from this workshop are important as explained by Prof Joe Zhu: "Since business performance variation exists, it is incumbent on the profession to develop the analytical tools and the empirical techniques needed to study it. If we can quantify it, and if we can identify its sources, we have a chance of adopting private practices and public policies designed to improve it."

Structure

The first half of each day will be devoted to theoretical and methodological presentations, and it will jigsaw activities on empirical papers. The other half of the day will be used for hands-on demonstrations in the computer lab. The

practicum will include applications of the theory, computer analyses with actual data sets, and interpretations of results in practice. Applications to various economic sectors will be considered, such as banking and finance, insurance, oil, health, agriculture, tourism, electrical power generation, and education. Day 1 and Day 2 will focus on producer behaviour theory and a simple approach to productivity measurements. Day 3 will focus of Data Envelopment Analysis and how to handle multiple inputs and multiple outputs cases and its application. Day 4 and Day 5 will focus on the advanced application of DEA and extensions of these models with dynamic linkages to decision making.

Workshop objectives

- To introduce and discuss the conceptual and theoretical foundations of efficiency and productivity analysis
- To demonstrate how to use statistical software to empirically measure efficiency and do productivity analysis, and their interpretations and policy implications
- To develop the ability to critically review academic literature in this domain

Learning outcomes

- Develop an understanding of the theory of producer behaviour and its application in performance measurement
- Understand different methodological approaches for efficiency and productivity analysis
- Develop proficiency in selecting appropriate methodological approaches given the performance problem
- Develop proficiency in applying Data Envelopment Analysis and its extension in measuring performance and productivity analysis

Workshop outline

	Day	Lecture	Practicum	Facilitator
Day 1	1	The theory of producer behaviour	Productivity analysis using ratios Some applications of SFA and regression analysis	Dr Kwaku Ohene-Asare Dr Nyankomo Marwa
	2	Concept of efficiency and productivity analysis		
	3	Introduction to ratios, parametric and non-parametric approach		
Day 2 and 3	1	Standard DEA setting	Estimation and interpretation of basic DEA model Two-stage analysis (OLS, Panel, Tobit)	Dr Kwaku Ohene-Asare Dr Nyankomo Marwa
	2	Scale, technical and pure technical efficiency		
	3	Second-stage analysis and review of empirical papers		
Day 4 and 5	1	Bootstrap DEA, Multiplier Model	Bootstrap DEA Estimation Malmquist Cost-efficiency estimation Non-radial measures estimation	Dr Kwaku Ohene-Asare Dr Nyankomo Marwa
	2	Dynamic performance (Malmquist, Global Malmquist, Meta Frontier)		
	3	Cost-efficiency Non-radial measures		

More about the workshop

Dates:
Monday, 30 April to Friday, 4 May 2018 (from 08:00 – 17:00)

Venue:
Computer Lab, University of Stellenbosch Business School, Bellville, Cape Town, South Africa

40 **Number of participants**

Language of instruction:
English

Training methods:
Lectures, small workgroups, case studies, and hands-on use of software (R and STATA)

Costs:
ZAR4 000 ($330) per person. Participants are responsible for their own accommodation and transport to and from Cape Town.

Sponsorships:
A limited number of scholarships available for postgraduate students at Stellenbosch University.

Study material:
The workshop pack will be made available to participants during registration. The materials required for pre-course reading will be sent to the participants via email or via the workshop website.

Certification:
This workshop is presented at postgraduate level. It is non-credit bearing. A certificate of attendance will be provided to participants who have attended all five days.

Application deadline:
Friday, 16 March 2018

How to apply

Find the online application form **here**. Admission will be on rolling basis until the positions are filled or until the application deadline. Once registered, you can cancel up to four weeks before the start of the workshop. The application deadline is **Friday, 16 March 2018**.

Contact us

Details about the workshop content: Contact the coordinator, Dr Nyankomo Marwa, at nyankomo@sun.ac.za or on telephone + 27 (0)21 918 4292.

Details about study materials, logistics, etc.: Contact Norma Saayman at Norma.Saayman@usb.ac.za or on telephone + 27 (0)21 918 4238. Or contact Dr Sola Oduwole, coordinator of the Africa Centre for Development Finance, at olusola@usb.ac.za or on +27(0)21 918 4290.

More about the facilitators

Dr Kwaku Ohene-Asare, University of Ghana Business School

Dr Ohene-Asare is an associate professor in the Operations and Management Information Systems Department of the University of Ghana Business School. He is also a Senior Adjunct Lecturer at Lancaster University Ghana, Associate Fellow of Warwick University and Max International Associate. He is an operations researcher, management scientist and economist. Previously, he taught at the Warwick Business School, UK, and at the GIMPA Business School, Ghana. He specialises in operational research and econometric techniques (including Data Envelopment Analysis) and in stochastic frontier econometrics and their application in decision-making units (DMUs), including financial institutions, oil and gas, electricity, DMUs in education, sport, agriculture, fast food restaurants and government departments. His interests include corporate social responsibility, advanced microeconomics and industrial economics. He supervises master's and PhD students. He also supervises students whose research interest is in efficiency and productivity analysis. He a reviewer of the following journals: Omega, European Journal of Operational Research, Journal of Productivity Analysis, Energy, Economics and Business Letters, the International Transactions in Operational Research and African Journal of Business Management. He is a member of the Royal Economic Society (UK), the Operational Research Society (UK) and the Econometric Society (USA). He has received various awards including the Sixth North American Productivity Workshop Conference Grant.

Dr Nyankomo Marwa, University of Stellenbosch Business School

Dr Marwa is a senior lecturer in Development Finance and Econometrics at the University of Stellenbosch Business School, South Africa. He holds visiting lecturer positions at the School of Management Sciences of the University of Quebec in Montreal, and the J Herbert Smith Centre for Technology Management and Entrepreneurship at the University of New Brunswick, Canada. Previously, he taught at the School of Economics and Business Studies of Sokoine University of Agriculture, Tanzania, and worked as forensic scientist at the Tanzania Forensic Bureau. Marwa has published more than 12 articles in international peer-reviewed journals focusing on development finance, efficiency analysis, applied econometrics and agricultural economics. He has more than 10 years of international teaching and research experience. He holds a PhD in Development Finance from the University of Stellenbosch Business School, an MSc in Agricultural Economics from the University of Nebraska, Lincoln, USA, an MSc in Applied Statistics and Biostatistics from Hasselt University, Belgium, and a BSc in Agricultural Economics and Agribusiness from Sokoine University of Agriculture, Tanzania. He has been awarded several international awards, including the American Fulbright Fellowship, MITACS Fellowship, Belgian Technical Cooperation Fellowship, Canadian Nixen Fellowship, and Saskatchewan University Doctoral Scholar Fellowship. He is currently supervising various doctoral and master's students on performance evaluation and development finance.

Suggested reading

Allen A., & Thanassoulis E. (2004.) Improving envelopment in data envelopment analysis. *European Journal of Operational Research*, 154, 363-379.

Banker, R., Charnes, A., & Cooper, W.W. (1984.) Some models for estimating technical and scale inefficiencies in Data Envelopment Analysis. *Management Science*, 30, 1078-1092.

Barrow, M., & Wagstaff, A. (1989.) Efficiency measurement in the public sector: An appraisal. *Fiscal Studies*, 10(1), 72-97.

Boussofiane, A., Dyson, R. G., & Thanassoulis, E. (1991.) Applied Data Envelopment Analysis. *European Journal or Operational Research*, 52(1), 1-15.

Charnes, A., Cooper, W.W., & Rhodes, E. (1978.) Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2, 429-444.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005.) *An Introduction to Efficiency and Productivity Analysis*. 2nd edition. Springer.

Cook, W. D., & Seiford, L. M. (2009). Data envelopment analysis (DEA): Thirty years on. *European Journal of Operational Research*, 192(1), 1-17.

Cooper, W.W., Seiford, L.M., & Tone, K. (2007.) Data Envelopment Analysis. Kluwer: Dordrecht.

Cooper, W. W., Seiford, L. M., & Zhu, J. (2011.) Handbook on Data Envelopment Analysis. Springer.

Daraio, C., & Simar, L. (2007.) *Advanced Robust and Nonparametric Methods in Efficiency Analysis: Methodology and Applications*. Springer.

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S., & Shale, E. A. (2001.) Pitfalls and protocols in DEA. *European Journal of Operational Research*, 132(2), 3-17.

Emrouznejad, A., & Yang, G. L. (2018). A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016. *Socio-Economic Planning Sciences*, 61, 4-8.

Epstein, M.K., & Henderson, J.C. (1989.) Data envelopment analysis for managerial control. *Decision Sciences*, 20, 90-119.

Fried, H., Lovell, C., & Schmidt, S. (2008). The Measurement of *Productive Efficiency and Productivity Change*. Oxford: Oxford University Press.

Golany, B., & Roll, Y. (1989.) An application procedure for DEA. *Omega*, 17(3), 237-250.

Marwa, N., & Aziakpono, M. (2016). Technical and scale efficiency of Tanzanian saving and credit cooperatives. *The Journal of Developing Areas*, 50(1), 29-46.

Liu, J. S., Lu, L. Y., & Lu, W. M. (2016). Research fronts in data envelopment analysis. *Omega*, 58, 33-45.

Liu, J. S., Lu, L. Y., Lu, W. M., & Lin, B. J. (2013). A survey of DEA applications. *Omega*, 41(5), 893-902.

Liu, J. S., Lu, L. Y., Lu, W. M., & Lin, B. J. (2013). Data envelopment analysis 1978-2010: A citation-based literature survey. *Omega*, 41(1), 3-15.

Podinovski, V. V. (2004.) Production trade-offs and weight restrictions in data envelopment analysis. *Journal of the Operational Research Society*, 55, 1311-1322.

Seiford, L. M. (1996). Data envelopment analysis: the evolution of the state of the art (1978–1995). *Journal of Productivity Analysis*, 7(2-3), 99-137.

Thanassoulis, E. (2001). *Introduction to the Theory and Application of Data Envelopment Analysis*. Kluwer.

Thanassoulis, E., Dyson, R.G., & Foster, M.J. (1987.) Relative efficiency assessments using data envelopment analysis: an application to data on rates departments. *Journal of the Operational Research Society*, 38,(5), 397-411.

Webster, J. J. (2003.) Managerial Economics: Theory and Practice. Academic Press.

Zhu, J. (2003). *Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets and DEA Excel Solver*, ISBN 978-1-4020-7082-2, Springer.

Other journals

- European Journal of Operational Research
- Omega
- Journal of Productivity Analysis
- DEA papers at **http://www.deazone.com**

Malmquist Indices and Global Malmquist

Coelli, T., Rao, D. S. P., & Battese, G. E. (1998.) *An Introduction to Efficiency and Productivity Analysis*. Kluwer.

Thanassoulis, E. (2001.) *Introduction to the Theory and Application of Data Envelopment Analysis*. Kluwer.

Tradeoff analysis

Asmild, M., Paradi, J. C., & Reese, D. N. (2006. Theoretical Perspectives of Tradeoff Analysis using DEA. *Omega: International Journal of Management Science*, 34, 337-343.

Podinovski, V. (2007.) Computation of efficient targets in DEA models with production trade-offs and weight restrictions. *European Journal of Operational Research*, 181, 586-591.

Podinovski, V. (2007.) Improving data envelopment analysis by the use of production trade-offs. *Journal of the Operational Research Society*, 58, 1261-1270.

Multi-directional efficiency analysis

Asmild, M, Hougaard, J. L., Kronborg, D., & Kvist, H.K. (2003.) Measuring inefficiency via potential improvements. *Journal of Productivity Analysis*, 19, 59-76.

Bogetoft, P., & J. L. Hougaard. (1999.) Efficiency Evaluations Based on Potential (Non-Proportional) Improvements. *Journal of Productivity Analysis*, 12, 231-245.

Bad outputs

Fare, R., Grosskopf, S., Lovell, C. A. K., & Pasurka, C. (1989.) Multilateral productivity comparisons when some outputs are undesirable: a nonparametric approach. *The Review of Economics and Statistics*, 71, 90-98.

Scheel, H. (2001.) Undesirable outputs in efficiency valuations. *European Journal of Operational Research*, 132, 400-410.

Seiford, L. M., & Zhu, J. (2002.) Modelling undesirable factors in efficiency evaluation. *European Journal of Operational Research*, 142, 16-20.

More about the University of Stellenbosch Business School

The University of Stellenbosch Business School, located in northern Cape Town, South Africa, offers a range of postgraduate business programmes which include an MBA and programmes in Development Finance and Futures Studies.

USB was the first school from an African university to receive all three international accreditations – AACSB, EQUIS and AMBA. The school strives to develop responsible leaders through well-grounded business education and research.