

# 2016 African Centre for Development Finance Short course: Applied Data Envelopment Analysis in Performance Measurement

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

**Friday, 19 August – Sunday, 21 August 2016**  
Computer Lab, USB campus, Bellville, Cape Town, South Africa

## What is the programme about?

This three-day short course on postgraduate level focuses on Applied Data Envelopment Analysis (DEA) with a healthy balance between theory and hands-on application.

The course 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 by DEA will be carried out by course participants. Participants will be introduced to R, PIM, STATA and EMS software. Most of the second-stage analysis will be conducted in STATA.

The course is presented under the auspices of the African Centre for Development Finance at the University of Stellenbosch Business School (USB). The course is jointly offered by the University of Stellenbosch Business School in collaboration with the University of Ghana Business School. A certificate of attendance will be provided to those who have attended all the three days.

The presenters are Dr Kwaku Ohene-Asare, lecturer in Operations Research and Management at the University of Ghana Business School and visiting lecturer at the University of Warwick, UK, and Dr Nyankomo Marwa, senior lecturer in Development Finance and Applied Econometrics at the University of Stellenbosch Business School. (See more about the course lower down in this brochure.)

## What will you will gain from the course?

You will gain an appreciation of the principles underlying Applied Data Envelopment Analysis (DEA), issues arising from using DEA and some familiarity with the software for implementing DEA assessments.

## Who should attend?

- Those interested in assessing the performance of organisational units such as regional offices, bank branches, sales outlets, hospitals or schools
- Aspiring doctoral candidates, post-doctoral fellows, current doctoral fellows and other academics working in this domain will be given priority as well as those working with national institutes of productivity analysis.
- The course is compulsory for current PhD and Master's students working in the research area of performance evaluation at the University of Stellenbosch Business School.

## How to apply

Only 20 participants will be admitted due to logistical reasons. The admission will be on a rolling basis until all the positions have been filled or until the application deadline of Friday, 29 July 2016 has been reached.

**Apply online at:** <http://bit.ly/29xsuaa>

Once registered, you can cancel anytime up to two weeks before the start of the course. Please -email Norma Saayman at [Norma.Saayman@usb.ac.za](mailto:Norma.Saayman@usb.ac.za) if you have not received confirmation two weeks before the start of the course.





## More about the programme

**Dates and timeslots:** Friday, 19 August – Sunday, 21 August 2016 from 08:00 to 17:00 each day

**Application deadline:** Friday, 29 July 2016

**Course content:** See below

**Fees:** The course is fully sponsored by the University of Stellenbosch Business School. However, participants are responsible for their own accommodation and travel costs. The organisers will provide breakfast and lunch during the training.

**Group size:** maximum 20 participants (due to logistical reasons)

**Training method:** Lectures, small work groups, case studies, and hands-on use of software

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

**Language of tuition:** English

**On-campus accommodation:** Bellvista Lodge on the USB campus offers comfortable accommodation.

See [www.usb.ac.za/bellvista](http://www.usb.ac.za/bellvista), call +27 (0)21 918 4444 or send e-mail to [bvista@belpark.sun.ac.za](mailto:bvista@belpark.sun.ac.za).

## More about USB

The University of Stellenbosch Business School, located in northern Cape Town, South Africa, offers a range of postgraduate business management 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. USB also has the highest level of EQUIS accreditation in Africa. The school strives to develop responsible leaders through well-grounded business education and research.

## CONTACT US

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**Details about the course content:** Contact the course coordinator, **Dr Nyankomo Marwa**, at [✉ nyankomo@usb.ac.za](mailto:nyankomo@usb.ac.za).

**Details about study materials, logistics, etc.:** Contact Norma Saayman at [✉ Norma.Saayman@usb.ac.za](mailto:Norma.Saayman@usb.ac.za) or on

[☎ + 27 \(0\)21 918 4238](tel:+27219184238).



# Applied Data Envelopment Analysis in Performance Measurement

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, income 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 in which the first-order and second-order optimising conditions are satisfied. Nevertheless, inefficient production 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 three-day intensive introductory training 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 knowledge, and facilitate social networking in this domain across different sectors and sub-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 to be gained from the course are important, as put 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."

## Course activities

The first half of each day will be devoted to theoretical and methodological presentations and 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 will focus on the producer behaviour theory and a simple approach to productivity measurements. Day 2 will focus on data envelopment analysis and how to handle multiple inputs and multiple outputs cases and its application. Day 3 will focus on advanced application of DEA and extensions of these models with dynamic linkages in decision making.

## Course 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 productivity analysis and their interpretation and policy implications
- To develop the ability to critically review academic literature in this domain

## Learning outcomes

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

## Admission requirements

Participants are expected to have intermediate or advanced level microeconomic theory at undergraduate level, such as the treatment in Hal R. Varian's *Microeconomic Analysis* (third edition, 1992) or *Intermediate Microeconomics: A Modern Approach* (seventh edition, 2005). Basic knowledge of mathematical economics, econometrics, linear programming and applications is desirable but not compulsory. STATA, EMS, PIM, DEA Frontier and R will be employed. Prior knowledge of at least one of the software programs will be an added advantage.

## Credits and certification

The three-day introductory course on Efficiency and Production Analysis is jointly offered by the University of Stellenbosch Business School in collaboration with the University of Ghana Business School. The course is non-credit bearing but is pitched at postgraduate level. A certificate of attendance will be provided to those who have attend all three days.

## Course material

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

# COURSE CONTENT

## Course outline

	DAY	LECTURE	PRACTICUM	FACILITATOR
DAY ONE	1	The theory of producer behaviour	Productivity analysis using ratios	Dr Kwaku Ohene-Asare Dr Nyankomo Marwa
	2	Concept of efficiency and productivity analysis	Some application of SFA and regression analysis	
	3	Introduction to ratios, parametric and non-parametric approach		
DAY TWO	1	Standard DEA setting	Estimation and interpretation of basic DEA model	Dr Kwaku Ohene-Asare Dr Nyankomo Marwa
	2	Scale, technical and pure technical efficiency		
	3	Second-stage analysis and review of empirical papers	Two-stage analysis (OLS, Panel, Tobit)	
DAY THREE	1	Bootstrap DEA, Multiplier Model	Bootstrap DEA estimation Malmquist	Dr Kwaku Ohene-Asare Dr Nyankomo Marwa
	2	Dynamic Performance (Malmquist, Global Malmquist, Meta Frontier)		
	3	Cost-efficiency	Non-radial measures Estimation	
		Non-radial measures		

## Presenters

### Dr Kwaku Ohene-Asare, University of Ghana Business School

Dr Ohene-Asare lectures 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 at Warwick University and Max International Associate. He is an operations researcher/management scientist and economist. Previously, he taught at the Warwick Business School in the UK and GIMPA Business School in Ghana. He specialises in operational research and econometrics techniques (including Data Envelopment Analysis) and stochastic frontier econometrics and their applications to decision-making units (DMUs), including financial institutions, oil and gas, electricity, DMUs in education, sport, agriculture, fast food restaurants and government departments. His interest also expands to corporate social responsibility, advanced microeconomics and industrial eco-

nomics. He supervises master's and PhD students in the fields of efficiency and productivity analysis. He is 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 awards including DFID and Sixth North American Productivity Workshop Conference Grant, USA.

### Dr Nyankomo Marwa, University of Stellenbosch Business School

Dr Marwa is senior lecturer in Development Finance and Econometrics at the University of Stellenbosch Business School, South Africa. He holds visiting research positions



at the School of Management Sciences of the University of Quebec Montreal, Canada, and the University of Saskatchewan, 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. Dr Marwa has published more than 12 articles in international peer-reviewed journals in the areas of development finance, efficiency analysis, applied econometrics and agricultural economics. He has more than 10 years of international experience in teaching and research. He holds a PhD in Development Finance from

the University of Stellenbosch Business School; an MSc Agricultural Economics from the University of Nebraska, Lincoln, USA; an MSc Applied Statistics and Biostatistics from Hasselt University, Belgium; and a BSc Agricultural Economics and Agribusiness from Sokoine University of Agriculture, Tanzania. He has received several international awards, including an American Fulbright Fellowship, a Belgian Technical Cooperation Fellowship, a Canadian Nixen Fellowship, and a Saskatchewan University Doctoral Scholar Fellowship. He is currently supervising two doctoral students on Performance Evaluation and a number of masters' students in Development Finance.

## Suggested reading

### Data envelopment analysis

- 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 of 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., Rao, D.S.P. & Battese, G.E. 1998. *An Introduction to Efficiency and Productivity Analysis*. Berlin: Kluwer Academic Publishers.
- Coelli et al. 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 et al. 2011. *Handbook on Data Envelopment Analysis*. Springer
- Cooper, W.W., Seiford, L.M. & Tone, K. 2007. *Data Envelopment Analysis*. Dordrecht: Kluwer.
- Daraio, C. & Simar, L.. 2007 *Advanced Robust and Nonparametric Methods in Efficiency Analysis: Methodology and Applications*. Springer.
- Dyson, R.G., Allen, R., Santos, Sarrico, C.S., Read, Podinovski, V.V. & Shale, E.A. 2001. Pitfalls and protocols in DEA. *European Journal of Operational Research*, 132(2), 3-17.

- 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*. New York: Oxford University Press.
- Golany, B. & Roll, Y. 1989. An application procedure for DEA. *OMEGA*, 17(3), 237-250.
- 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. 2003. *Managerial Economics Theory and Practice*.
- 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.
- ### Stochastic frontier analysis
- Lovell, C.A.K. 1993. Production Frontiers and Productive Efficiency. In Fried, H., Lovell, C. & Schmidt, S. (Eds.). *The Measurement of Productive Efficiency: Techniques and Applications*, 3-67. New York: Oxford University Press.

Coelli, T., Rao, D.S.P. & Battese, G.E. 1998. *An Introduction to Efficiency and Productivity Analysis*. Berlin: Kluwer Academic Publishers.

### **Malmquist indices and Global Malmquist**

Coelli, T., Rao, D.S.P. & Battese, G.E. 1998. *An Introduction to Efficiency and Productivity Analysis*. Berlin: Kluwer Academic Publishers.

Thanassoulis, E. 2001. *Introduction to the Theory and Application of Data Envelopment Analysis*. Berlin: Kluwer Academic Publishers.

### **Tradeoff analysis**

Asmild, M., Paradi, J.C. & Reese, D.N. 2006. Theoretical Perspectives of Trade-off 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. & Hougaard, J.L. 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.

### **General**

*The European Journal of Operational Research, OMEGA and Journal of Productivity Analysis* publish many DEA papers. See <http://www.deazone.com>.