Analyzing Economic Performance Using DEA and the Bootstrap Approach

Chali Nondo, Central State University, Wilberforce, OH, USA

ABSTRACT

The objective of this study is twofold. First, the author uses the Data Envelopment Analysis (DEA) to determine the technical efficiency of 42 African countries for the period 1992 to 2007. Second, the author evaluates the determinants of the technical efficiency index using the bootstrapped bias-corrected efficiency scores. The DEA analysis indicates that lower income economies in Africa have very low levels of efficiency and have low levels of energy use. On the other hand, upper-middle African income economies appear to be more efficient in using their resources than all other income groups. Bootstrap and truncated regression results show that improvements in governance, promotion of FDI, and information communication technologies are major drivers of technical efficiency. Therefore, a major focus of policies must be directed towards improving governance and increasing capital investment, including the adoption and deployment of modern technologies.

Keywords: Bootstrapping, Data Envelopment Analysis (DEA), Economic Growth, Energy Consumption, Technical Efficiency

INTRODUCTION

In 2012, the African continent earned the recognition from the World Bank and other international organizations for being home to seven of the ten fastest growing economies in the world. Despite this stellar performance, African national governments still face significant challenges in terms of poverty, social and economic inequalities, unsustainable patterns of consumption and production, among other things. It is also a well-established fact that many African countries are endowed with many resources, including fossil and renewable energy resources. Stylized facts from the African Development Bank (ADB, 2011) and the United Nations Conference on Trade and Development (UNCTAD, 2012) indicate that African economies grossly underutilize their resources, thereby resulting in fewer goods and services being produced. Furthermore, many African countries are characterized by low energy use, labor-intensive activities, and low valued added extractive industries—which all reflects the low level of industrial development. The UNCTAD (2012) also report that compared to the rest of world, material productivity and overall productivity is low in Africa. For instance, in 2008, Africa had an average level of material productivity of $520 per ton of material, compared to the world average of $950.
With a view to stimulating more growth, many African countries are assuming responsibilities for managing their economies by restructuring their economies and by adopting better policies and institutions. Despite being party international agreements which promote sustainable development (such as the 1992 Rio Declaration on Environment, Kyoto Protocol, and a host of others), resource intensity remains high while productivity is low. Against this background, there is a need for an appraisal of the continent’s potential of reducing resource intensity and waste, to the extent that supportive economic environments are created which will support long run sustainable economic growth and development. Reducing resource intensity is about doing more with far fewer resources—such as energy, labor, and capital.

This study attempts to empirically shed light on the relationship between production inputs and national output, using the non-parametric Data Envelopment Analysis (hereinafter referred to as DEA). This study will offer insights and direction to policymakers on economic development, particularly with regard to efficient allocation and utilization of production resources, as well as identify the drivers of and barriers to economic efficiency in the African continent. Reducing resource intensity is about doing more with far fewer resources—such as energy, labor, and capital.

While there are a number of cross-countries DEA studies with a focus on Africa, there is a dearth of literature on DEA macroeconomic performance confined to a sample of African countries only. This study aims to fill that gap by analyzing the macroeconomic performance of a homogeneous sample of 42 African countries by combining DEA and regression analysis. Another feature of this study is that it takes into account production of undesirable outputs of CO₂ in the analysis. Further, this study contributes to the body of literature by taking into account the changes in efficiencies over a period of time (1992-2007), using the window analysis. Results from this present study will show the most efficient combinations of inputs and the potential resource savings that would result from making the inefficient countries efficient. By and large, this study will provide direction and opportunities for African countries to increase output by improving efficiency of resource utilization.

The rest of this paper is organized as follows: the next section provides a review of literature, the section after presents the conceptual framework and methodology employed in the analysis, while the next section introduces the data types and sources. Section five reports the results of the empirical analysis and finally, and the last section presents conclusions and policy recommendations of the study.

Literature Review

Building on the seminal work of Debreu (1951) and Koopmans (1951) on productive efficiency, Farrell (1957) assessed the production efficiency of agricultural production in the United States. Farrell decomposed production efficiency into two principal components: technical efficiency and allocative efficiency. Accordingly, technical efficiency measures the firm’s ability to produce maximum output based on a combination of inputs. It can also be measured in terms of the optimal combination of inputs to achieve a given level of output. On the other hand, allocative efficiency measures the ability of a firm to produce a given level of output using the cost-minimizing input ratios. These two measures are then combined to provide a measure of total economic performance. Farrell’s approach to productive efficiency is consistent with microeconomic production frontier in which maximum output can be achieved with any possible combination of inputs.

In response to the need for evaluating the effectiveness of U.S. educational programs, Charnes, Cooper, and Rhodes (1978), hereinafter referred to as CCR (1978), extended Farrell’s (1957) efficiency measurement of
Related Content

The Clinical Information System: A Case of Misleading Design Decisions
[www.irma-international.org/chapter/clinical-information-system/6297/](http://www.irma-international.org/chapter/clinical-information-system/6297/)

A Study of Green Marketing Practices in Indian Companies
[www.irma-international.org/article/a-study-of-green-marketing-practices-in-indian-companies/115829/](http://www.irma-international.org/article/a-study-of-green-marketing-practices-in-indian-companies/115829/)

Inter-Workflow Patterns in Logistic Processes
[www.irma-international.org/chapter/inter-workflow-patterns-logistic-processes/36575/](http://www.irma-international.org/chapter/inter-workflow-patterns-logistic-processes/36575/)

Dynamic Evaluation of Indian Commercial Banking Sector: A Bank-Level Growth Frontier Approach
[www.irma-international.org/chapter/dynamic-evaluation-of-indian-commercial-banking-sector/121508/](http://www.irma-international.org/chapter/dynamic-evaluation-of-indian-commercial-banking-sector/121508/)

Impact of Social Media Readiness on Social Media Usage and Competitive Advantage