

THE EFFICIENCY OF MICRO-DEVELOPMENT (EMD) – THEORETICAL MODELING AND EMPIRICAL STUDIES

Long-term economic development crucially depends on an efficient and most productive use of scarce resources on the micro level. With respect to low-income countries agricultural production processes are still at the center of all development efforts. However, as scarce natural resources are the base of rural livelihoods in such countries the linkages between agricultural or other rural located production and the quality and quantity of natural resources have to be considered in the assessment of the relative performance of such rural production activities.

The ‘**Efficiency of Micro-Development**’ (EMD) project focuses on the relative economic performance of micro level development. It consists of two components: (1) The quantification of the relative productivity and efficiency of production units, households, and economic sectors by mainly regressing on primary and secondary data by other ongoing projects; and (2) The theoretically consistent modeling of different efficiency measurement approaches. EMD can be therefore regarded as a research endeavour cross-cutting different projects in ZEF.

(1) **Empirical studies** to quantify the relative performance of micro-development processes and structures have been conducted in the following sectors and countries:

-The technical efficiency of **smallholder maize production in Ethiopia** was investigated by determining the most crucial policy factors for enhancing production performance (Sauer/Tsegaye, 2005). It could be shown that a high variance in technical efficiency on the farm level exists. A general need for technological improvement and change could be stated, several starting points for policy measures aiming at enhancing the farm efficiency in the short-run were discussed. It should be basically focused on improving the managerial skills of the farmers and fostering agricultural extension programs aimed at improving resource allocation. In contrast to most applications we adequately test for whether the estimated maize production frontiers have the required regularities of monotonicity and quasi-concavity, and hence run the risk of making improper policy recommendations. Only consistent relative scores of technical efficiency are used as an empirical basis for discussion and policy inferences. The consistency areas are determined and clearly stated to the reader.

-The level and determinants of relative technical efficiency of **smallholder farmers in Malawi** were assessed using a stochastic frontier analysis tested for economic regularity conditions (Sauer/Tchale/Wobst, 2005). The results indicate medium to high levels of technical efficiency, consistent with apriori expectations with the relatively higher yielding hybrid maize. Higher levels of relative technical efficiency are obtained when farmers use integrated soil fertility options compared to the use of inorganic fertilizer only. Of the policy variables included in the analysis, agricultural input and output market, credit and extension access strongly influence smallholder technical efficiency. Government needs to resuscitate these public policy issues in order to effectively address sustainability of Malawian agriculture and its impact on poverty.

-Empirical evidence on the links between production efficiency, biodiversity, and resource management was delivered by analysing a case study on **small-scale tobacco production** in the Miombo woodlands in Tanzania (Abdallah/Sauer, 2005). The subsistence nature of tobacco production in Tanzania suggests that most power driven equipments, fertilizers and sustainable crop processing technologies are beyond the reach of most small-scale tobacco growers. The

consequence is that in order to expand their production tobacco farmers heavily substitute such inputs by an increasing use of wood. Hence an increasing amount of forest land is cleared by the farmers resulting in forest degradation and a loss of biodiversity. This study determines in a first step the efficiency of tobacco production bordering the Miombo woodlands in Tanzania as well as investigates factors for the relative inefficiency on farm level. In a second step the relation between forest species diversity in the surrounding woodlands and tobacco production efficiency as well as between diversity and the type of institutional arrangement with respect to forest management are empirically analysed. The results indicate that the different efficiency measures vary widely over the sample, showing a significant positive effect of the curing technology – i.e. the design of the barn - and the source of the firewood. The majority of farmers produce with increasing returns to scale. A strong positive correlation between the tobacco production efficiency and forest diversity as well as between community based arrangements and forest diversity is revealed. This finally suggests that agricultural production efficiency is conducive for environmental sustainability with respect to tobacco in Tanzania as well as supports property rights based institutional arrangements for forest resource management.

(2) The more **theoretical and modeling component** of EMD focuses on the microeconomic and mathematical underpinnings of the quantitative models used in applied development and agricultural economics:

-The availability of efficiency estimation software – freely distributed via the internet and relatively easy to use – recently inflated the number of corresponding applications. The resulting efficiency estimates are used without a critical assessment with respect to the literature on theoretical consistency, flexibility and the choice of the appropriate functional form. The robustness of policy suggestions based on inferences from efficiency measures nevertheless crucially depends on theoretically well-founded estimates. The research so far has been addressed **stochastic efficiency measurement by critically reviewing the theoretical consistency** of recently published technical efficiency estimates (Sauer et al., 2005 and Sauer, 2005a,b). The results confirm the need for a posteriori checking the regularity of the estimated frontier by the researcher and, if necessary, the a priori imposition of the theoretical requirements.

-Modeling efforts are related to the **theoretically consistent modeling** of stochastic efficiency measurement by applying a non-radial input-specific cost model as well as the popular error components approach. An inclusion of monotonicity and curvature restrictions in the iterative maximisation algorithm is currently attempted. A **linkage to bootstrapping** techniques has been applied to test for the relative performance of different flexible functional forms (Sauer, 2005).

(3) **Ongoing and planned activities** include:

(i) the investigation of the effects of **intra-household bargaining power** on the productivity and efficiency of **rural Ethiopian households**. In the relevant literature it has remained unexplored, if and in which way bargaining power has an impact on household production. The aim of this work is to fill this gap by investigating the role of the distribution of productive resources among couples of rural Ethiopian households in determining the outcome of household production. We advance the hypothesis that the degree of equality of the intrahousehold resource allocation has an impact on productive efficiency and hence on total production and welfare. That is, the more equal the allocation of resources, the higher the household's productivity (work by Seebens/Sauer).

(ii) the analysis of the **relative efficiency of fisheries at Lake Victoria by Bayesian estimation tools** as well as the determination of the different factors for inefficiency on the

fleet level. It is expected that Bayesian tools will enhance the scope for a priori considerations and hence are suitable for incorporating consistency restrictions (work by Sauer/Lokina).

(ii) the performance measurement of **small scale farmers in the Eastern Amazon** on the base of farm profits. Here a shadow profit function will be applied to capture the informal price relations and their effects on the relative farm efficiency (work by Mendoza/Sauer).

(iv) the organisation of a **workshop** in 2006/2007: The current measurement of economic performance is dominated by stochastic frontier as well as data envelopment approaches. Numerous applications have been conducted for developing countries both on a micro as well as a macro level so far. This workshop aims to bring together researchers engaged in quantitatively oriented analysis of the economic performance of rural production activities in developing countries. Beside appealing empirical applications on a sectoral or national level we are interested in contributions concerned with theoretical and modelling aspects of efficiency and productivity measurement. Finally we are particularly interested in applications focusing on the efficiency and productivity of natural resources' use in a rural context (e.g. irrigation, water supply, fisheries, forest use, soil issues). The best papers will be published in a special volume 'efficiency and development – rural activities and natural resources' as well as the ZEF discussion paper series (organisation by Sauer/Seebens).

(v) the establishment of the '**Efficient Development Network (EDN)**': an international network of researcher and academics engaged in quantitative productivity and efficiency analysis and based in developing as well as developed countries (Sauer).

(4) **Output** (by 07/2005):

PAPERS/ARTICLES

- SAUER, J. (2005a); Efficiency Flooding - Black-Box Frontiers and Policy Implications, in: *International Journal of Applied Econometrics*, Vol. 2 (1).
- SAUER, J., K. FROHBERG, H. HOCKMANN (2005); Stochastic Efficiency Measurement: The Curse of Theoretical Consistency, in: *Journal of Applied Economics* (forthcoming).
- SAUER, J. (2005b); Economic Theory and Econometric Practice: Parametric Efficiency Analysis, in: *Empirical Economics* (accepted for second revision 5/2005).
- SAUER, J., T. YILMA (2005); Consistent Efficiency Scores for Small-Scale Maize Production in Ethiopia, in: *Journal of Productivity Analysis* (submitted 3/2005).
- ABDALLAH, J., J. SAUER (2005); Efficiency, Biodiversity and Resource Management – Tobacco and Forest in Tanzania, in: *Forest Policy and Economics* (submitted 4/2005).
- SAUER, J., H. TCHALE, P. WOBST (2005); Relative Technical Efficiency in Maize-Based Farming Systems in Malawi (work in progress).
- SAUER, J., FROHBERG, K., HOCKMANN, H. (2004); Black-Box Frontiers and Implications for Development Policy - Theoretical Considerations; *ZEF Discussion Paper Series*, No. 92, 2004.

CONFERENCE CONTRIBUTIONS

- BIOECON 2005, Economics and the Analysis of Ecology and Biodiversity, Kings College Cambridge, 9/2005 (Paper).
- DEUTSCHER TROPENTAG 2005, University of Hohenheim 10/2005 (3 Papers Submitted).
- EAERE 2005 - European Association of Environmental and Resource Economists, 14. Annual Conference 2005, Bremen 6/2005, Invited Session Chair 'Renewable Resources IV' (Paper).
- EAAE 2005 - European Association of Agricultural Economists, Annual Conference 2005, Copenhagen, 8/2005 (Paper).
- EWEP 2005 - European Workshop on Efficiency and Performance Analysis, Brussels 6/2005, Session 'Innovative Applications' (Paper).

OVERALL SUMMARY

Project Title	THE EFFICIENCY OF MICRO-DEVELOPMENT (EMD) – THEORETICAL MODELING AND EMPIRICAL STUDIES
Research Keywords	Efficiency and Productivity, Quantitative Measurement of Micro-Performance, Theoretical Modeling
Countries of Research	Ethiopia, Malawi, Tanzania, Brazil
Research Objectives	(1) the economic assessment of development processes on the micro level (2) the quantification of the relative performance of production units, households and sectors (3) the formulation of adequate policy measures to adress inefficient resource use (4) to make a contribution to consistent modeling
Main Results so far	See page attached.
ZEF Staff involved	Johannes Sauer (senior staff), Holger Seebens (doctoral student), Tsegaye Yilma (doctoral student), Jumanne Abdallah (doctoral student), Hardwick Tchale (doctoral student), Arisbe Mendoza (doctoral student)
Timetable	Project start: June 2004 Proposed end: June 2007
Main Cooperation Partners	different projects within ZEF: e.g. PASAD, Eastern Amazon, GLOWA
Main Funding Partners	staff funded by ZEF, doctoral students funded by respective projects
Contact:	project leader: jsauer@uni-bonn.de
Homepage / Project Link on ZEF Homepage	Link on homepage to be created. Project Leader: http://www.zef.de/module/register/staff_details.php?pk=329