



ulm university

universität
uulm



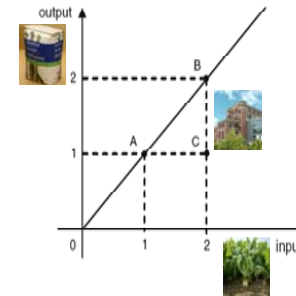
The Performance of Microinsurance Programs: A Frontier Efficiency Analysis

Christian Biener, Martin Eling
Institute of Insurance Science
Ulm University

5th International Microinsurance
Conference 2009
Session 11, Academic Track

Outline

1. Introduction
2. Microinsurance
3. Frontier Efficiency
4. Application to the Microinsurance Market
5. Policy Implications and Future Research



We are grateful to the *Microinsurance Network (Performance Indicators Working Group)* for providing us the data on microinsurance programs and for their valuable suggestions.

1. Introduction

- Objective:**
- Evaluate the performance of microinsurance programs
 - Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) as two main measurement techniques
- Motivation:**
- Microinsurance programs need to become viable
 - Monitoring and measurement of performance necessary
- Literature:**
- Rapidly growing number of contributions to frontier efficiency measurement in insurance during last 10 years
 - Research on microinsurance still in its early stages

1. Introduction

- Contribution:**
- First paper to analyze the efficiency of microinsurance; use of recent innovations in frontier efficiency
 - Extend performance indicators with a new benchmarking tool
 - Enhance the comparability of microinsurance programs
- Data and Methodology:**
- 21 microinsurance schemes from the *Microinsurance Network (Performance Indicators Working Group)*
 - Technical and cost efficiency analysis using both DEA and SFA
- Results:**
- Differences between the classical efficiency measurement and “social efficiency”
 - Significant diversity and improvement potential in the industry

2. Microinsurance: Key Performance Indicators

- Performance Indicators Handbook outlines current practice

(see Wipf/Garand, 2008)

- Ten key performance indicators:

(1) Net income ratio

(6) Claims rejection ratio

(2) Incurred expense ratio

(7) Growth ratio

(3) Incurred claims ratio

(8) Coverage ratio

(4) Renewal ratio

(9) Solvency ratio

(5) Promptness of claims settlements

(10) Liquidity ratio

- Four additional indicators to reflect the social function

3. Frontier Efficiency: Essentials

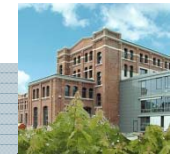
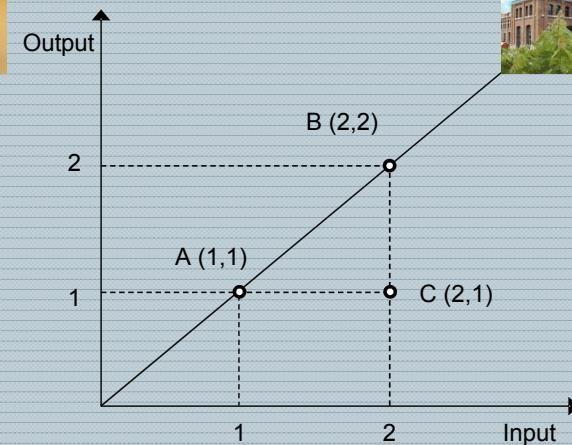
- **Basis:** Microeconomic production theory (one input, one output as an example)



- **Idea:** Performance of a company is measured relative to the efficient frontier, which is determined by the most efficient companies

3. Frontier Efficiency: Essentials

- Efficiency = Output/Input
 - Firm A: $1 / 1 = 1$
 - Firm B: $2 / 2 = 1$
 - Firm C: $1 / 2 = 0.5$
 - Efficiency scores range between 0 and 1



- Extension to multiple inputs / multiple outputs and variable returns to scale
- Application in a variety of fields, e.g., manufacturing companies, trading companies, banks, and insurance companies (see Eling/Luhnen, 2009a)

3. Frontier Efficiency: Advantages for Microinsurance

- (1) Applicability for benchmarking of profit and non-profit organizations
- (2) Performance summary in a single and easy to interpret statistic
- (3) Accommodation of dual function: financial and social
- (4) Identification of explicit performance targets (e.g., via shadow prices and slack variables)
- (5) Provision of managerial information (e.g., marginal rates of substitution/productivity/transformation)
- (6) Isolation of key performance determinants (e.g., age, size, profit-orientation)
- (7) Low data requirements

4. Application to the Microinsurance Market: Data

- Data: 21 microinsurance schemes; unbalanced panel (2004-2008); source: *Performance Indicators Working Group of the Microinsurance Network*

- Choice of in- and outputs:

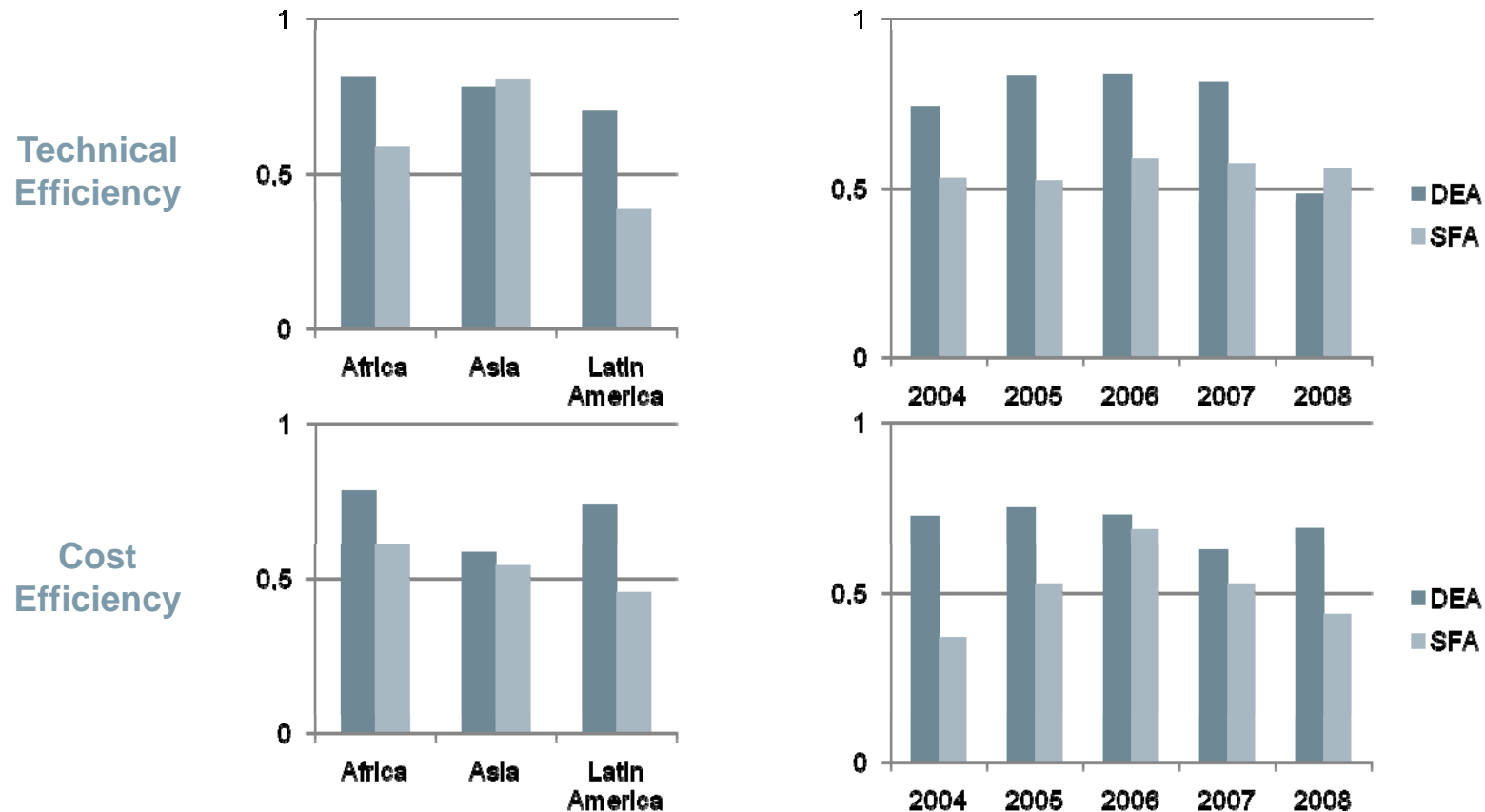
Inputs	Proxy
Labor and business service	Operating expenses / ILO Inquiry wage per year
Debt capital	Total liabilities
Equity capital	Capital & surplus
Outputs	Proxy
Benefits + additions to reserves	Net incurred benefits + additions to reserves
Investments	Total investments
Social Output Indicator (SOI)	Ratio of number of insured to target population

- All numbers were deflated to 2004 using the consumer price indices published by the International Monetary Fund (IMF) and converted into USD

4. Application: Efficiency Estimates at Firm-Level (without SOI)

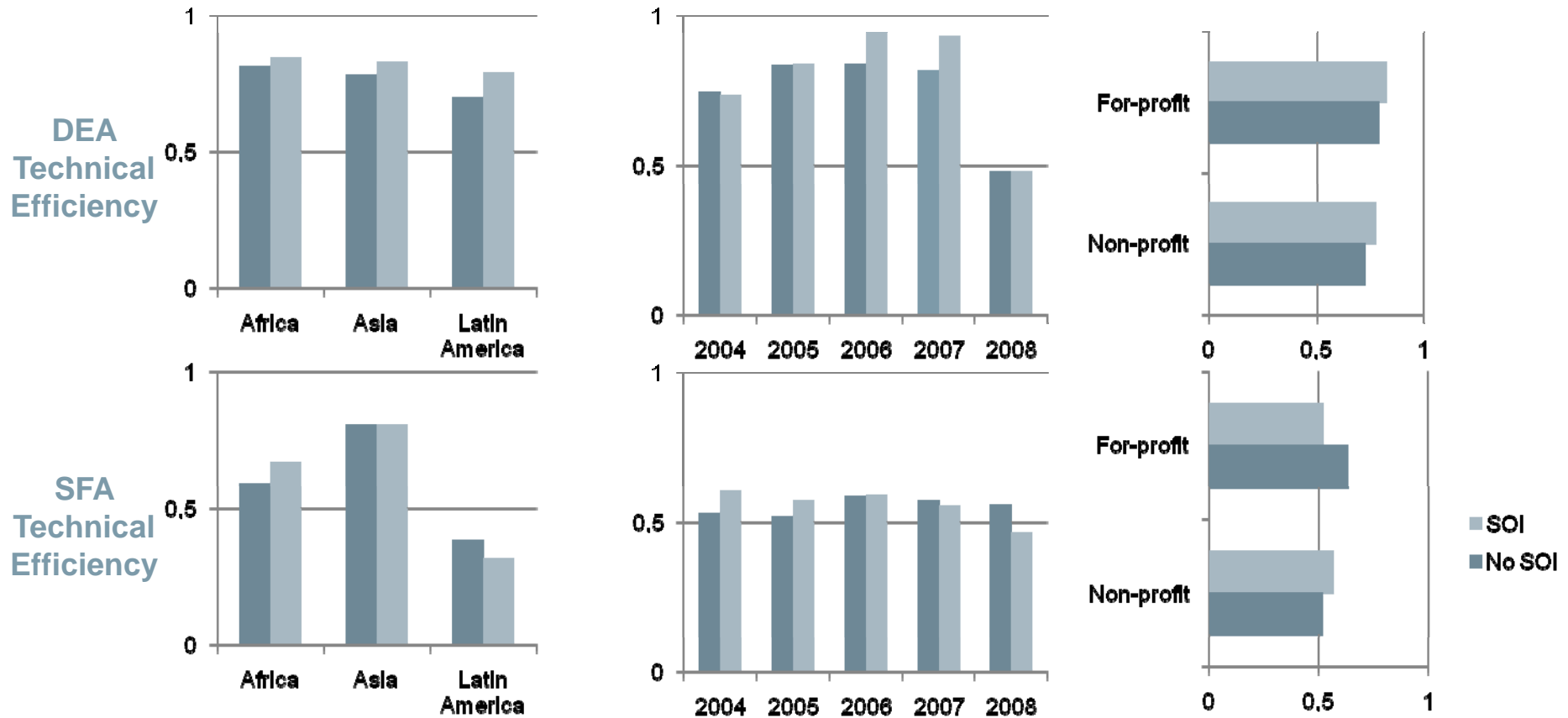
		Technical efficiency						Cost efficiency					
Microinsurer		2004	2005	2006	2007	2008	Mean	2004	2005	2006	2007	2008	Mean
Africa	1	n/a	n/a	0.89	0.86	0.53	0.76	n/a	n/a	1.00	1.00	1.00	1.00
	2	0.85	0.95	0.97	0.94	n/a	0.93	0.03	0.08	0.04	0.06	n/a	0.05
	3	n/a	n/a	0.88	0.86	n/a	0.87	n/a	n/a	1.00	1.00	n/a	1.00
	4	n/a	0.87	0.90	0.89	0.53	0.80	n/a	1.00	1.00	0.85	1.00	0.96
	5	0.77	0.87	0.90	0.88	0.53	0.79	1.00	1.00	0.90	0.90	1.00	0.96
	6	n/a	n/a	n/a	0.86	0.53	0.69	n/a	n/a	n/a	0.25	1.00	0.62
	7	0.81	0.91	0.94	0.77	n/a	0.86	1.00	0.98	0.87	0.74	n/a	0.90
	Mean	0.81	0.90	0.91	0.87	0.53	0.81	0.68	0.76	0.80	0.68	1.00	0.79
Asia	8	0.77	0.86	0.88	0.86	n/a	0.85	0.45	0.46	0.39	0.39	n/a	0.42
	9	0.77	0.77	0.76	0.90	n/a	0.80	1.00	0.45	0.47	0.64	n/a	0.64
	10	n/a	n/a	0.88	0.86	0.53	0.76	n/a	n/a	1.00	1.00	0.68	0.89
	11	n/a	n/a	0.89	0.87	0.53	0.76	n/a	n/a	1.00	0.63	0.75	0.79
	12	n/a	0.87	0.92	0.86	0.52	0.79	n/a	0.80	0.61	0.15	0.23	0.44
	13	0.78	0.86	0.88	0.91	0.53	0.79	1.00	1.00	0.42	0.30	0.35	0.61
	14	n/a	n/a	n/a	0.89	0.51	0.70	n/a	n/a	n/a	0.28	0.26	0.27
	Mean	0.77	0.84	0.87	0.88	0.52	0.78	0.82	0.68	0.65	0.48	0.45	0.58
Latin America	15	0.85	0.89	0.89	0.76	0.53	0.78	0.70	0.81	0.74	0.62	1.00	0.77
	16	n/a	n/a	0.94	0.88	n/a	0.91	n/a	n/a	0.85	1.00	n/a	0.93
	17	0.77	0.87	0.88	0.86	n/a	0.85	1.00	1.00	1.00	1.00	n/a	1.00
	18	0.82	0.88	0.63	0.53	0.53	0.68	0.64	0.72	0.47	0.45	1.00	0.66
	19	0.11	0.28	0.06	0.08	n/a	0.13	0.08	0.17	0.06	0.07	n/a	0.10
	20	0.83	0.88	0.91	0.88	0.00	0.70	0.81	0.98	0.98	0.87	0.00	0.73
	21	0.77	0.87	0.88	0.87	n/a	0.85	1.00	1.00	1.00	1.00	n/a	1.00
	Mean	0.69	0.78	0.74	0.69	0.35	0.70	0.70	0.78	0.73	0.71	0.67	0.74
Mean	0.74	0.83	0.84	0.81	0.48	0.76	0.73	0.75	0.73	0.63	0.69	0.70	

4. Application: Aggregated Estimates (Models without SOI)



- Efficiency scores high compared to other studies (see, e.g., Eling/Luhnen, 2009b)
 - Increasing efficiency estimates from 2004 on with a peak in 2006
 - SFA estimates lower than DEA (SFA allows for a random error term)
- ➔ SFA less sensitive to statistical noise, might be more appropriate here

4. Application: Models with Social Output Indicator



- Efficiency increases with additional social output indicator (SOI)
- Results consistent for model including and not including the SOI
- Non-profit insurers show significant upward shift in efficiency after implementation of SOI

➔ Non-profit show high social performance and catch up when considering the SOI

4. Application: Conditional Mean Approach

	Technical efficiency (without SOI)		Technical efficiency (with SOI)	
	coefficient	t-statistic	coefficient	t-statistic
Non-Profit-orient.	2.82	3.54 ***	0.83	0.92
Solvency	-0.58	-0.79	-0.48	-0.75
Small	-1.44	-1.73 **	-1.26	-1.46 *
Medium	-0.27	-0.28	0.37	0.50
Age	1.56	2.14 **	0.88	1.41 *
Life	0.31	0.33	-0.96	-1.07
Health	-1.30	-1.61 *	-0.76	-0.90
Credit-Life	-1.63	-1.60 *	-3.02	-3.35 ***
Group	-1.36	-1.67 **	0.54	0.81
Africa	-1.47	-1.86 **	-1.59	-1.73 **
Asia	-4.32	-4.63 ***	-4.10	-5.96 ***
2005	0.36	0.38	0.36	0.45
2006	0.08	0.08	0.60	0.70
2007	-0.51	-0.58	0.79	1.12
2008	1.32	1.40 *	2.42	2.40 ***

Note: * (**, ***) indicates significance level of 10% (5%, 1%).

- Lower efficiency for non-profit microinsurers (but not significant in model with SOI)
- Negative impact of age on efficiency (donors? government subsidies?)

➔ Managerial information at the industry level (macro-level)

4. Application: Shadow Prices / Slack Variables

Selected results for shadow prices

DEA Techn. Effi.	<i>Input 1 (labor)</i>	<i>Input 2 (debt)</i>	<i>Input 3 (equity)</i>	<i>Output 1 (benefits)</i>	<i>Output 2 (investm.)</i>
0.11	0.0E+00	5.6E-07	1.2E-07	3.5E-06	2.3E-06

- Shadow prices: Efficiency increase when decreasing (increasing) input (output) by one unit
 - Management of cross-effects using marginal rates of substitution/productivity/transformation
- ➔ Managerial information at the level of the individual microinsurer (micro-level)

5. Policy Implications and Future Research

- **Policy Implications:**
 - (1) Significant diversity and improvement potential in the industry
 - (2) With social output indicator non-profit microinsurers look better
 - (3) Frontier efficiency is a valuable extension of current practices and provides managerial information at micro- and macro-level

- **Future Research:**
 - (1) Extend dataset
 - (2) Sample matching and comparison (see Eling/Luhnen, 2009b)
 - (3) Refine methodology

References

- Eling, M., and Luhnen, M., 2009a.** Frontier Efficiency Methodologies to Measure Performance in the Insurance Industry, forthcoming in: *Geneva Papers on Risk and Insurance*.
- Eling, M., and Luhnen, M., 2009b.** Efficiency in the International Insurance Industry: A Cross-country Comparison, forthcoming in: *Journal of Banking and Finance*.
- Wipf, J., and Garand, D., 2008.** Performance Indicators for Microinsurance – A Handbook for Microinsurance Practitioners, ADA: Luxembourg.

Appendix: Comparison Performance Indicators and Efficiency

Rank correlation statistics for performance indicators

	NIR	IER	ICR	RR	CRR	GR	CR	SR	LR	DEA	SFA
NIR	1.00	-0.02	0.36	-0.20	-0.26	0.05	0.11	0.08	-0.06	-0.20	0.03
IER		1.00	0.24	-0.32	0.05	0.25	0.13	-0.27	-0.14	0.19	-0.10
ICR			1.00	-0.18	-0.05	0.37	-0.03	0.05	-0.30	0.04	0.36
RR				1.00	-0.38	-0.05	0.12	-0.28	-0.95	-0.10	0.38
CRR					1.00	-0.05	-0.43	-0.33	0.39	0.01	0.14
GR						1.00	0.40	-0.16	-0.37	-0.08	-0.04
CR							1.00	-0.23	-0.04	-0.15	-0.10
SR								1.00	-0.01	0.10	0.23
LR									1.00	-0.30	-0.11
DEA										1.00	0.14
SFA											1.00

Note: NIR= net income ratio, IER=incurred expense ratio, ICR=incurred claims ratio, RR=renewal ratio, CRR=claims rejection ratio, GR=growth ratio, CR=coverage ratio, SR=solvency ratio, LR=liquidity ratio, DEA=DEA technical efficiency score, SFA=SFA technical efficiency score

- No clear pattern among key performance indicators, indicates high level of heterogeneity
- Frontier efficiency techniques can be a valuable addition (objective summary measure of different financial and social indicators)

Appendix: Formal Description

- **Data Envelopment Analysis** – Optimization Approach:

$$\text{Maximize}_{u_r, v_j} e_i = \frac{\sum_{r=1}^R u_r y_{ri}}{\sum_{j=1}^J v_j x_{ji}},$$

subject to $e_i \leq 1, u_r \geq 0, v_j \geq 0,$

with y_{ri} as amount of output r produced by i with $r = 1, \dots, R$, x_{ji} as amount of input j produced by i with $j = 1, \dots, J$, u_r as output-weighting factor, v_j as input-weighting factor, and e_i as efficiency

- **Stochastic Frontier Analysis** – Regression Approach

(Cobb Douglas production function as illustrative example):

$$\ln(y_i) = \alpha_0 + \sum_{j=1}^J \alpha_{ji} \ln(x_{ji}) + \varepsilon_i - \mu_i,$$

with ε_i as error component and μ_i as technical inefficiency component