



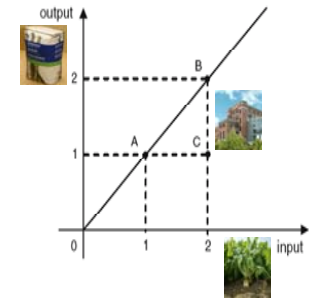
# The Performance of Microinsurance Programs: A Frontier Efficiency Analysis

AFIR / LIFE Colloquium 2009

Christian Biener, Martin Eling  
Institute of Insurance Science  
Ulm University

## Outline

1. Introduction
2. Microinsurance
3. Frontier Efficiency
4. Frontier Efficiency Analysis of Microinsurance Programs
5. Policy Implications and Future Research



We are grateful to the Microinsurance Network (Performance Indicator Working Group) for providing us the data on microinsurance programs.

# 1. Introduction

- Objectives:**
- 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, powerful benchmarking tool
  - Enhance the comparability of microinsurance programs
- Data and Methodology:**
- 21 microinsurance schemes from the *Microinsurance Network (Performance Indicator Working Group)*
  - Technical and cost efficiency analysis using both DEA and SFA
- Results:**
- Highlight differences between the market-based classical efficiency measurement and the social efficiency

## 2. Microinsurance: Definition

- **Definition of microinsurance:**

Insurance for low-income people and businesses in developing countries characterized by low premiums and low coverage limits

- **Various types of risks covered:**

Life, pension, health, disability, and property (especially agriculture)

- **Delivered through a variety of channels:**

Commercial insurers, non-governmental organizations (NGOs), mutuals, and small community-based schemes



## 2. Microinsurance: Key Performance Indicators

- Performance Indicators Handbook outlines current practice
- Ten key performance indicators:
  - 1) Net income ratio
  - 2) Incurred expense ratio
  - 3) Incurred claims ratio
  - 4) Renewal ratio
  - 5) Promptness of claims settlements
  - 6) Claims rejection ratio
  - 7) Growth ratio
  - 8) Coverage ratio
  - 9) Solvency ratio
  - 10) Liquidity ratio
- Four additional indicators to reflect the social function

### 3. Frontier Efficiency: What is this all about?

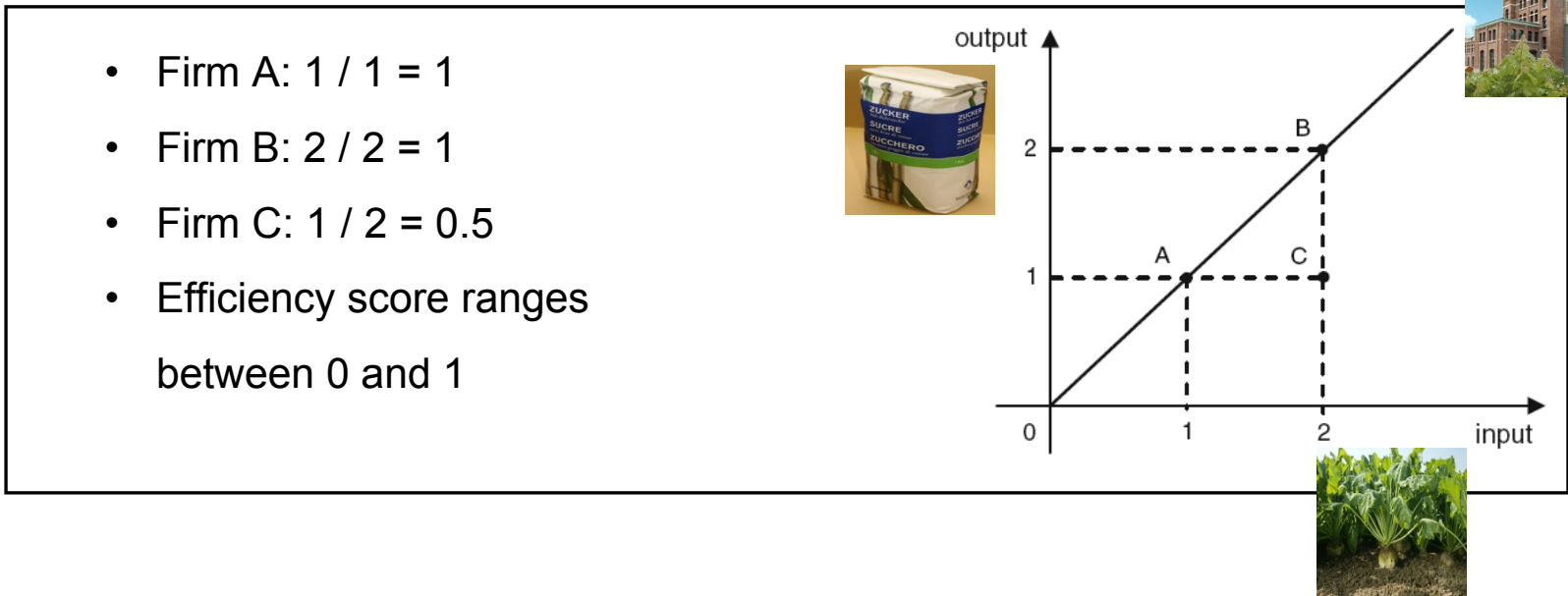
- **Basis:** Microeconomic production theory (one input, one output as an example)



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

### 3. Frontier Efficiency: What is this all about?

- Efficiency = Output/Input



- 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/Luhtinen, 2009a)



### 3. Frontier Efficiency: Advantages for Microinsurance

- 1) Frontier efficiency methods were originally developed for benchmarking of nonprofit organizations (production function unknown); this is the situation faced by microinsurance providers
- 2) Frontier efficiency methods are superior to traditional financial ratio analysis; they summarize performance in a single statistic that controls for differences among firms (multidimensional framework)
- 3) Inputs and outputs used in efficiency measurement include financial indicators, but the methods can also accommodate social indicators (and thus display the important social function of microinsurance)

(... list continued in the paper)

## 4. Frontier Efficiency Analysis of Microinsurance Programs

- Data: 21 microinsurance schemes from the *Performance Indicator Working Group* of the *Microinsurance Network* (2004 to 2008 balance sheet data)
- Choice of inputs and outputs:

Inputs	Proxy
Labor and business service	Operating expenses / ILO Inquiry wage per year
Debt capital	Total liabilities
Equity capital	Capital & surplus
Outputs	
Benefits + additions to reserves	Net incurred benefits + additions to reserves
Investments	Total investments
Social Output Indicator	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 US-\$

## 4. Frontier Efficiency: DEA (without social output indicator)

		Technical efficiency (TE)						Cost efficiency (CE)						
		Microinsurer	2004	2005	2006	2007	2008	Mean	2004	2005	2006	2007	2008	Mean
Africa	1	n/a	n/a	0.88	0.87	0.95	0.90	n/a	n/a	1.00	1.00	1.00	1.00	
	2	0.90	0.95	0.97	0.95	n/a	0.94	0.02	0.05	0.03	0.03	n/a	0.03	
	3	n/a	n/a	0.88	0.87	n/a	0.88	n/a	n/a	1.00	1.00	n/a	1.00	
	4	n/a	0.88	0.93	0.95	0.95	0.93	n/a	0.95	0.89	0.76	0.90	0.88	
	5	0.80	0.86	0.88	0.87	0.95	0.87	1.00	1.00	0.70	0.56	0.69	0.79	
	6	n/a	n/a	n/a	0.89	0.95	0.92	n/a	n/a	n/a	1.00	1.00	1.00	
	7	0.82	0.90	0.93	0.78	n/a	0.86	1.00	0.98	0.87	0.74	n/a	0.90	
	Mean	0.84	0.90	0.91	0.88	0.95	<b>0.90</b>	0.67	0.74	0.75	0.73	0.90	<b>0.80</b>	
Asia	8	0.79	0.86	0.88	0.87	n/a	0.85	0.45	0.44	0.39	0.39	n/a	0.42	
	9	0.79	0.77	0.76	0.91	n/a	0.81	0.99	0.46	0.47	0.63	n/a	0.64	
	10	n/a	n/a	0.88	0.87	0.95	0.90	n/a	n/a	1.00	1.00	0.74	0.91	
	11	n/a	n/a	0.95	0.87	0.95	0.92	n/a	n/a	0.75	0.61	1.00	0.78	
	12	n/a	0.86	0.90	0.86	0.95	0.89	n/a	0.47	0.53	0.15	1.00	0.54	
	13	0.79	0.87	0.88	0.93	0.95	0.88	1.00	1.00	1.00	1.00	1.00	1.00	
	14	n/a	n/a	n/a	0.90	0.95	0.93	n/a	n/a	n/a	0.17	0.24	0.21	
	Mean	0.79	0.84	0.87	0.89	0.95	<b>0.88</b>	0.81	0.59	0.69	0.56	0.80	<b>0.64</b>	
Latin America	15	0.80	0.87	0.88	0.88	0.95	0.88	1.00	1.00	1.00	1.00	1.00	1.00	
	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	0.78	0.87	0.88	0.87	n/a	0.85	1.00	1.00	1.00	1.00	n/a	1.00	
	18	0.83	0.88	0.63	0.53	0.95	0.76	0.64	0.72	0.47	0.44	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	0.85	0.91	0.91	0.72	0.68	0.81	0.86	0.99	0.83	0.68	0.19	0.71	
	21	0.79	0.86	0.87	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	0.86	<b>0.74</b>	0.76	0.81	0.75	0.74	0.73	<b>0.77</b>	
	Mean	0.75	0.83	0.84	0.82	0.93	<b>0.83</b>	0.75	0.73	0.73	0.68	0.81	<b>0.73</b>	

•Outputs:  
Top 50%

•Inputs:  
Top 20%

•Good financial ratios

•Outputs:  
Top 35%

•Inputs:  
Lower 20%

•Poor financial ratios

## 4. Frontier Efficiency: SFA (without social output indicator)

		Technical efficiency (TE)						Cost efficiency (CE)						
		Microinsurer	2004	2005	2006	2007	2008	Mean	2004	2005	2006	2007	2008	Mean
Africa	1	n/a	n/a	1.00	0.45	0.36	0.60	n/a	n/a	0.45	0.66	0.65	0.58	
	2	0.57	0.06	0.57	0.05	n/a	0.31	0.00	0.00	0.00	0.00	n/a	0.00	
	3	n/a	n/a	0.59	0.51	n/a	0.55	n/a	n/a	0.85	0.97	n/a	0.91	
	4	n/a	0.86	1.00	0.81	0.95	0.91	n/a	0.40	0.22	0.16	0.13	0.23	
	5	1.00	0.76	0.55	0.54	0.72	0.71	0.23	0.70	0.15	0.12	0.05	0.25	
	6	n/a	n/a	n/a	0.78	1.00	0.89	n/a	n/a	n/a	n/a	0.11	0.72	0.41
	7	0.15	0.22	0.13	0.10	n/a	0.15	0.45	0.98	0.16	0.85	n/a	0.61	
	Mean	0.57	0.48	0.64	0.46	0.76	<b>0.59</b>	0.23	0.52	0.30	0.41	0.39	<b>0.43</b>	
Asia	8	1.00	0.84	0.99	1.00	n/a	0.96	0.01	0.17	0.06	0.03	n/a	0.07	
	9	1.00	0.73	0.99	0.75	n/a	0.87	0.08	0.08	0.13	0.14	n/a	0.11	
	10	n/a	n/a	0.92	1.00	1.00	0.97	n/a	n/a	0.07	0.25	0.98	0.43	
	11	n/a	n/a	0.76	1.00	0.86	0.87	n/a	n/a	0.06	0.31	0.15	0.17	
	12	n/a	0.49	1.00	0.20	0.31	0.50	n/a	0.05	1.00	0.07	0.08	0.30	
	13	1.00	1.00	0.98	0.96	1.00	0.99	0.51	0.34	0.96	0.71	0.32	0.57	
	14	n/a	n/a	n/a	0.97	0.74	0.86	n/a	n/a	n/a	0.02	0.04	0.03	
	Mean	1.00	0.76	0.94	0.84	0.78	<b>0.86</b>	0.20	0.16	0.38	0.22	0.32	<b>0.24</b>	
merica	15	1.00	0.99	0.98	0.96	0.96	0.98	0.88	0.66	0.91	0.92	0.83	0.84	
	16	n/a	n/a	0.36	0.46	n/a	0.41	n/a	n/a	0.13	0.23	n/a	0.18	
	17	0.66	0.54	0.35	0.35	n/a	0.47	0.92	0.93	0.35	0.43	n/a	0.66	
	18	0.14	0.15	0.13	0.17	0.23	0.16	0.12	0.14	0.05	0.08	0.09	0.10	

- Lower level of efficiency (effect of noise)

- Values consistent with DEA

## 4. Frontier Efficiency: Technical Eff. (with social output indicator)

		DEA technical efficiency						SFA technical efficiency						
		Microinsurer	2004	2005	2006	2007	2008	Mean	2004	2005	2006	2007	2008	Mean
Africa	1		n/a	n/a	0.91	0.89	0.95	0.92	n/a	n/a	0.99	0.59	0.57	0.71
	2		0.89	0.90	0.97	0.95	n/a	0.93	0.58	0.10	0.94	0.22	n/a	0.46
	3		n/a	n/a	0.91	0.88	n/a	0.90	n/a	n/a	0.60	0.92	n/a	0.76
	4		n/a	0.90	0.94	0.96	0.95	0.94	n/a	0.78	0.91	1.00	1.00	0.92
	5		0.79	0.90	0.88	0.88	0.96	0.88	0.89	0.65	0.95	0.98	0.75	0.84
	6		n/a	n/a	n/a	0.91	0.96	0.93	n/a	n/a	n/a	0.99	0.67	0.83
	7		0.82	0.93	0.95	0.79	n/a	0.87	0.18	0.29	0.24	0.13	n/a	0.21
	Mean		0.84	0.91	0.93	0.89	0.96	<b>0.91</b>	0.55	0.45	0.77	0.69	0.75	<b>0.68</b>
Asia	8		0.79	0.90	0.91	0.88	n/a	0.87	1.00	0.80	0.93	0.98	n/a	0.93
	9		0.79	0.90	0.91	0.92	n/a	0.88	0.99	0.65	0.92	0.97	n/a	0.88
	10		n/a	n/a	0.91	0.88	0.96	0.91	n/a	n/a	0.45	0.98	0.97	0.80
	11		n/a	n/a	0.96	0.89	0.95	0.93	n/a	n/a	1.00	0.57	0.93	0.83
	12		n/a	0.90	0.92	0.88	0.96	0.92	n/a	0.45	1.00	0.13	0.15	0.43
	13		0.79	0.90	0.91	0.88	0.95	0.89	0.61	0.60	0.78	0.90	0.97	0.77
	14		n/a	n/a	n/a	0.88	0.95	0.92	n/a	n/a	n/a	0.98	0.97	0.98
	Mean		0.79	0.90	0.92	0.89	0.95	<b>0.90</b>	0.87	0.63	0.85	0.79	0.80	<b>0.80</b>
America	15		0.80	0.91	0.91	0.88	0.96	0.89	0.99	0.96	0.98	0.92	0.98	0.97
	16		n/a	n/a	0.92	0.89	n/a	0.90	n/a	n/a	0.54	0.76	n/a	0.65
	17		0.80	0.90	0.91	0.88	n/a	0.87	0.67	0.70	0.74	1.00	n/a	0.78
	18		0.82	0.91	0.92	0.54	0.95	0.83	0.27	0.29	0.25	0.29	0.65	0.35

- High values for the social output indicator lead to improved efficiency
- Non-profit microinsurers improve efficiency but lag behind for-profit microinsurers

## 4. Frontier Efficiency: Conditional mean approach – Explaining inefficiency with various factors

	Technical efficiency		Technical efficiency incorporating social performance		Cost efficiency	
	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic
Intercept	-1.11	-1.42 *	-1.08	-1.61 **	-2.08	-2.46 ***
Organization	3.35	5.99 ***	4.57	6.63 ***	4.21	4.14 ***
Solvency	0.48	1.10	-0.24	-0.49	-1.96	-2.26 **
Small	-4.39	-9.75 ***	-3.56	-4.59 ***	-3.06	-3.51 ***
Medium	-2.28	-5.16 ***	-3.95	-5.99 ***	2.75	3.44 ***
Africa	-0.61	-1.47 *	-1.58	-3.01 ***	0.33	0.35
Asia	-2.11	-3.38 ***	-1.56	-2.54 ***	-1.49	-1.62 *
2005	0.50	0.86	0.85	1.04	-2.33	-2.24 **
2006	0.31	0.51	-0.94	-1.13	-1.89	-1.86 **
2007	0.51	0.87	-0.99	-1.34 *	-1.60	-1.63 *
2008	0.11	0.15	0.49	0.61	0.39	0.42

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

## 4. Frontier Efficiency: Possible Applications

- Descriptive efficiency comparison
- Peer-group analysis: different markets, companies and business units
- Regression analysis (Tobit analysis, conditional mean analysis)
- Shadow prices and slack variables

## 5. Policy Implications and Future Research

- **Policy Implications:**

- (1) First empirical application of frontier efficiency in microinsurance
- (2) Significant improvement potential in the industry
- (3) Derive implications for the management of microinsurance schemes

- **Future Research:**

- (1) Extend dataset
- (2) Sample matching and comparison (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., 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: Frontier Efficiency Literature

- Clustering of 82 insurance studies within ten categories of research questions (Eling/Luhnen, 2009a):

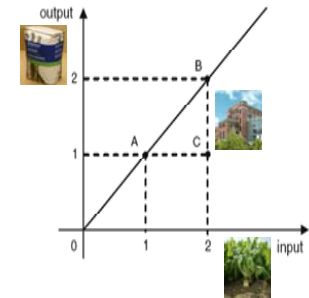
<b>Category</b>	<b>Countries</b>	<b># Studies</b>
1. Distribution systems	Germany, UK, US	6
2. Financial and risk management	US	3
3. General level of efficiency	Various countries	22
4. Cross-country comparisons	Various countries	7
5. Market structure	US, 14 European countries	3
6. Mergers	US, 7 European countries	4
7. Methodological issues	Canada, Japan, Spain, Taiwan, US	6
8. Organizational form	Belgium, Germany, Japan, Spain, UK, US	11
9. Regulatory change	Austria, Germany, Spain, Ukraine, UK, US	10
10. Scale and scope economies	Finland, France, Germany, Ireland, Japan Spain, US	10

## 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):

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

with  $\varepsilon_i$  as error component and  $\mu_i$  as technical inefficiency component