

## A DEA approach to Microfinance Institutions efficiency



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## Motivation

- 2005 was declared by the United Nations the International Year of Microcredit, in order to acknowledge the contribution that microcredit makes towards poverty reduction.



- The Nobel Peace Prize for 2006 was awarded to Muhammad Yunus, microfinance pioneer and founder of Grameen Bank.

- Microfinance institutions (MFIs) are not a rarity any more, but are becoming first-class members of financial and banking systems in developing countries.
- Their growing parameters are outstanding, both in number of firms and in number of clients.



## Motivation

- MFIs focus on social matters: they give small loans, microcredits, to low income people excluded from conventional financial institutions.
- But they also perform financial tasks.
- MFIs have to submit themselves to performance assessments tacking into account their dual nature: financial and social.

- How can we measure the performance of MFIs?
- It is not enough to measure their financial performance in terms of profitability.
- How do we measure their social impact? Do we use social indicators?
- Both things should be done: there is a Double Bottom Line; Yaron (1994):
  - ▶ *First Bottom Line is financial*; Adams and Von Pischke (1992)
  - ▶ *Second Bottom Line is social*; Navajas et al. (2000), Dunford (2000)

## Financial efficiency

- Much has been studied in all kinds of institutions: banks, saving banks, cooperatives. Berger y Humphrey (1997) surveyed 130 papers from 21 countries.
- An institution is efficient if it generates a high level of output with few inputs. This is a standard definition.



- What inputs and outputs should be included? There are various views according to whether we look at financial institutions from the point of view of **intermediation** or from the point of view of **production**.

## Intermediation and production models

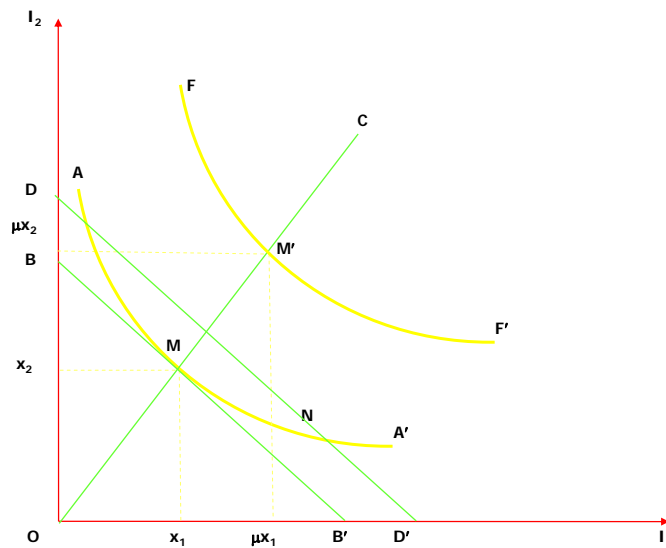
■ Under the **intermediation** model, financial institutions take deposits and place loans: Berger and Mester (1997), Athanassouopoulos (1997).

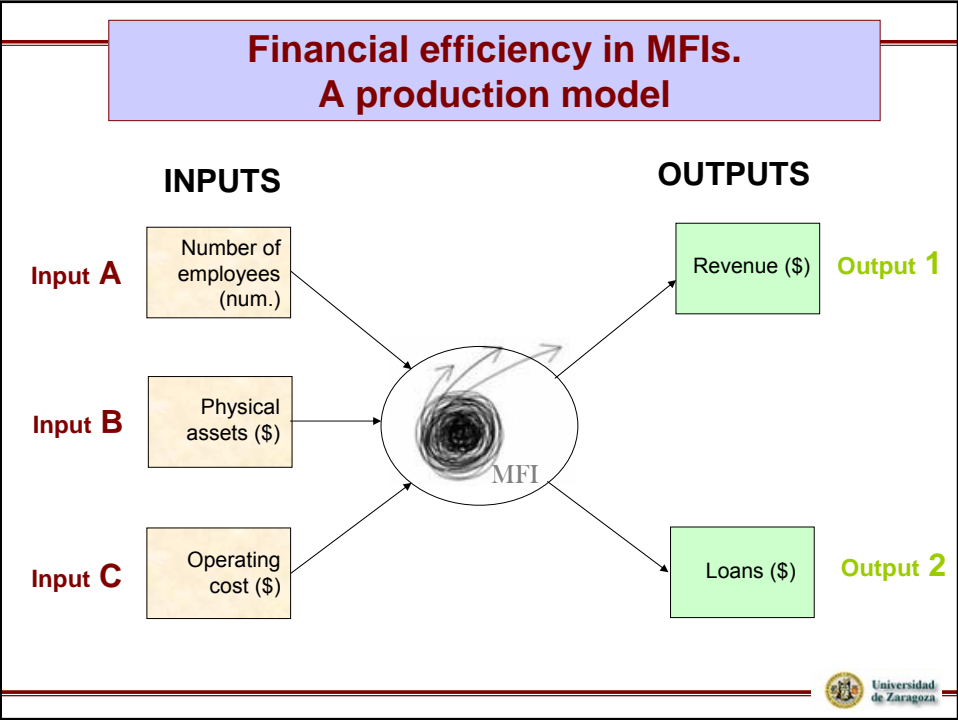
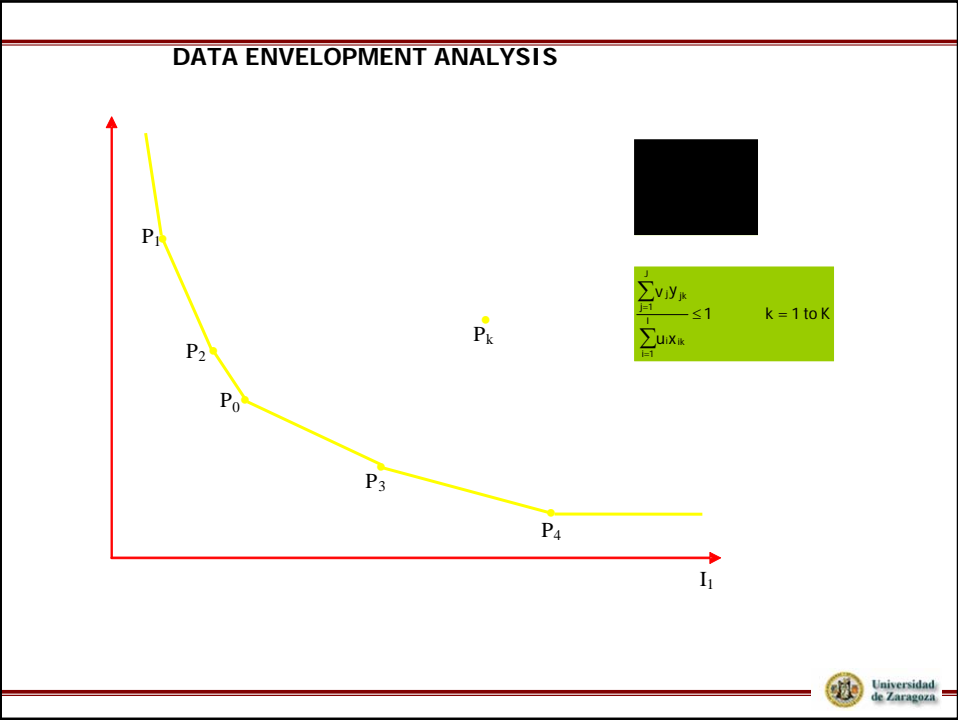


■ Under the **production** model, financial institutions use human and physical resources in order to process transactions such as grant loans or capture deposits: Vassiloglou and Giokas (1990), Soteriou and Zenios (1999).



### PRODUCTION FUNCTIONS





## Social efficiency

■ If an MFI is not financially efficient it will not survive long, but we soon realised that studying financial efficiency is not enough. These institutions have a social goal and this must also be assessed.

■ There are methodologies aimed at rating MFIs: CAMEL, GIRAFE, M-Cril, Microfinanza, Microrate, MICROS and MIRACLES. But most rating agencies use the Standard and Poor's approach and concentrate on financial aspects forgetting the social ones.

■ 6 rating approaches partially incorporate social indicators: IMP-ACT, AIMS, SROI, Accion PAF, CGAP (PAT) and SPI.



## Social efficiency modelling

■ We use as outputs the impact on women and on poverty.

■ The number of loans made to women is easy to obtain.

■ But poverty is a relative concept. Who is poor?



■ Given any two MFIs with identical inputs, the one that makes many small loans (small relative to the country's per capita GNI) will be more socially efficient than the one that makes larger loans.

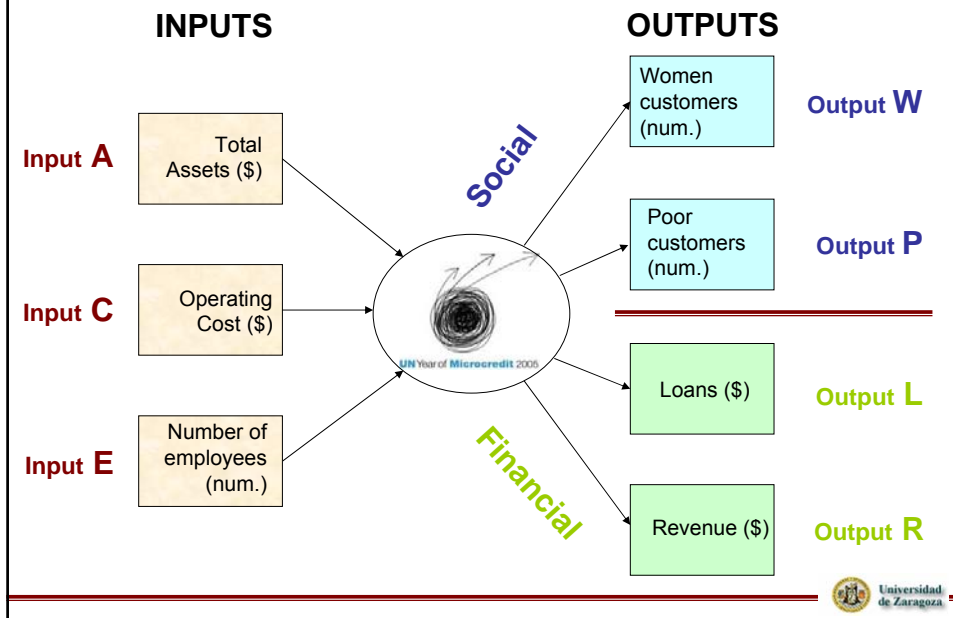
$$K = \frac{\text{Average loan}}{\text{GNIpc}}$$

$$p_i = 1 - \frac{K_i - \text{Min}(K)}{\text{Rank}(K)}$$

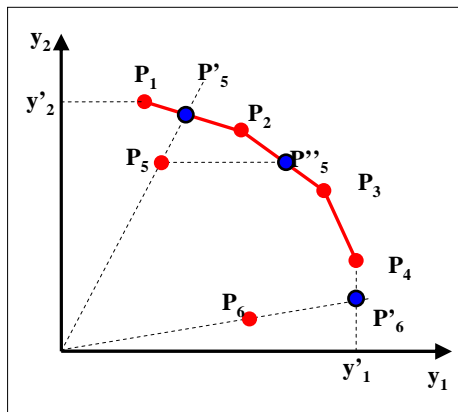
$$0 < p_i < 1$$

$$\text{Output } P = p_i * \text{Number of customers}$$

## Efficiency model (social and financial)



## Data Envelopment Analysis (DEA)



- DEA has not been used in MFIs.
- DEA can be used when the conventional cost and profit functions cannot be justified.

■ Berger and Humphrey (1997) classify 132 papers according to the approach used:

► **Parametric-** Stochastic Frontier Approach (SFA), Distribution Free Approach (DFA), Thick Frontier Approach (TFA).

► **Non- parametric-** Data Envelopment Analysis (DEA), Free Disposal Hull (FDH), Index Numbers (IN), Mixed Optimal Strategy (MOS).

■ **DEA**, used in 62 papers is the most popular approach.

## DEA Mathematical formulation

Min  $\Phi$

$$\sum_j \lambda_j x_{jm} \leq \Phi x_{j_o, m} \quad ; m = 1, 2, \dots, M$$

$$\sum_j \lambda_j y_{jn} \geq y_{j_o, n} \quad ; n = 1, 2, \dots, N$$

$$\lambda_j \geq 0 \quad ; j = 1, 2, \dots, J$$

Where:

- $\Phi$  DEA efficiency inverse
- $x_{jm}$  Value of input m from DMU j
- $j_o$  DMU whose efficiency is estimated
- $y_{jn}$  Value of output n for DMU j
- $\lambda_j$  Variable to be calculated from the data

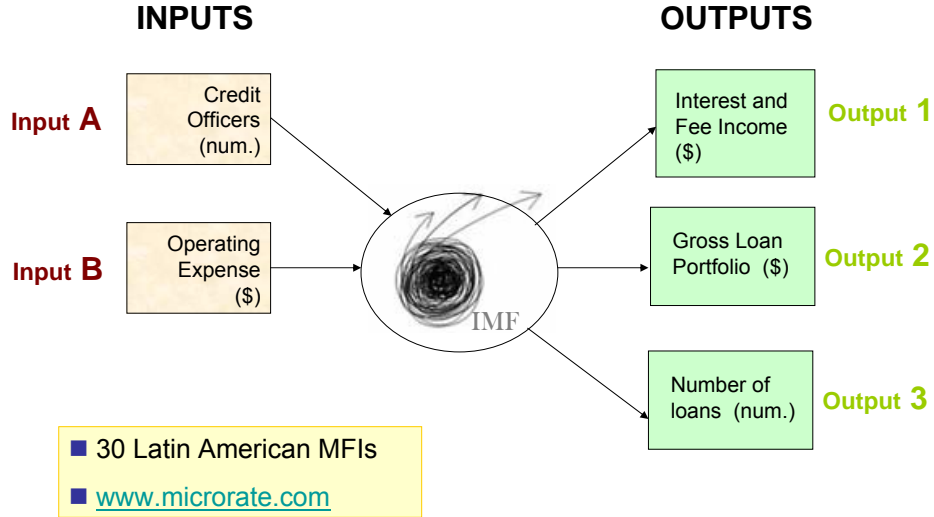


## Methodological contribution

- DEA is very sensitive to input/output selection. Adding or removing inputs and outputs can change a MFI from efficient to inefficient (or the other way round).
- DEA efficiency is just a number that provides very poor information. Two MFIs may have achieved the same level of efficiency but may have followed very different strategies.
- We estimate many specifications involving many combinations of inputs and outputs. We obtain a matrix of efficiencies by models that is later analysed by means of multivariate statistical techniques: Principal Components Analysis, Cluster Analysis, and Regression; Serrano and Mar Molinero (2004).
- Assessing DEA efficiency for each possible combination of inputs and outputs (21).
- Notation: Based on initials AE-W includes as inputs "Assets" and "Employees" and as output "Women".



## Sample and data: financial efficiency model



## DEA efficiency results

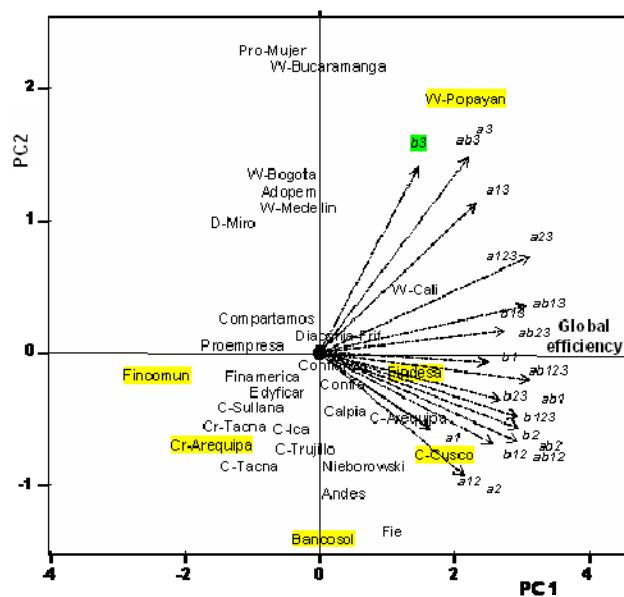
DMU	A1	A2	A123	A2	A3	A3	AB1	AB12	AB123	AB13	AB2	AB23	AB3	B1	B2	B123	B13	B2	B23	B3	
Adopem	16	16	60	60	15	60	60	62	66	66	54	66	66	62	62	66	66	54	66	66	
Andes	36	64	64	48	64	64	38	66	85	66	85	85	38	49	81	81	49	81	81	14	
Bancosol	45	86	86	47	86	86	33	67	90	67	90	90	33	46	81	81	46	81	81	9	
Calpia	40	72	73	60	72	73	50	55	75	78	60	75	78	50	36	60	60	36	60	13	
C-Arequipa	53	67	76	71	67	76	56	97	97	97	87	88	56	72	83	83	72	83	83	21	
Cr-Arequipa	13	13	18	18	13	18	15	49	49	49	46	46	15	49	49	49	49	46	46	15	
C-Cusco	65	95	95	80	95	95	60	100	100	100	100	100	60	71	94	94	71	94	94	18	
C-Ica	24	32	42	39	32	42	33	64	66	66	64	66	66	33	53	64	53	64	64	20	
Compartamos	33	33	52	52	16	45	44	78	78	78	78	30	45	44	62	62	62	29	29	23	
Confia	42	42	53	53	41	52	41	81	81	81	56	57	41	61	61	61	61	54	54	16	
Confianza	41	46	57	55	46	57	44	70	70	70	55	60	44	51	52	52	51	52	52	15	
C-Sullana	22	26	41	40	26	41	35	66	66	66	65	65	35	59	63	63	59	63	63	26	
C-Tacna	24	30	35	33	30	35	27	66	67	66	66	66	27	57	65	65	57	65	65	17	
Cr-Tacna	22	26	32	31	26	32	25	56	56	56	56	52	25	46	50	50	46	50	50	14	
C-Trujillo	21	30	41	37	30	41	32	62	75	75	62	75	32	55	74	74	55	74	74	24	
Diaconia-Fril	22	34	63	59	34	63	56	63	81	81	63	81	63	81	56	55	79	79	55	79	40
D-Miro	24	24	61	61	23	61	58	52	61	61	38	61	58	40	40	40	40	37	37	27	
Edyficar	41	47	52	50	47	52	38	65	65	65	65	51	56	38	47	49	47	49	49	12	
Fie	30	57	57	43	57	57	35	70	100	100	70	100	100	35	56	97	97	56	97	18	
Finamerica	27	38	50	45	38	50	39	55	56	55	56	56	39	41	53	53	41	53	53	16	
Fincomun	25	25	26	26	14	22	19	37	37	37	37	14	22	19	26	26	26	13	13	5	
Findesa	100	100	100	100	100	100	68	100	100	100	100	100	68	56	56	56	56	52	52	11	
Nieborowski	30	30	41	41	29	41	33	94	94	94	94	77	77	33	86	86	86	76	76	26	
Proempresa	50	50	59	59	46	58	44	71	71	72	72	48	60	44	48	48	48	48	41	12	
Pro-Mujer	12	13	74	74	13	74	33	33	74	74	30	74	74	29	29	51	51	29	51	51	
W-Bogota	23	28	72	70	28	72	69	53	72	70	49	72	69	42	47	47	42	47	47	35	
W-Bucaramanga	22	24	87	87	24	87	87	59	59	87	87	51	87	87	49	50	53	53	50	53	53
W-Call	30	41	82	78	41	82	74	84	95	95	84	95	95	74	73	93	93	73	93	50	
W-Medellin	20	23	65	65	23	65	64	60	60	65	65	65	64	54	57	57	54	57	57	48	
W-Popayan	28	30	100	100	30	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	

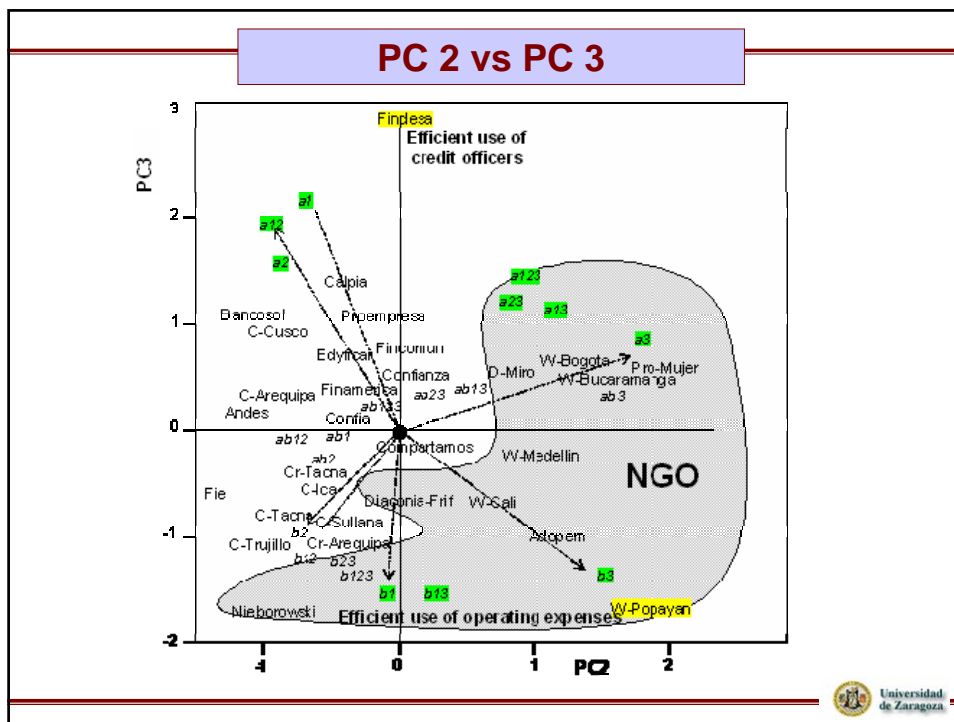


## Multivariate analysis

- The level of efficiency achieved by a particular MFI depends on the specification chosen. We will explore what is behind a DEA score.
- The methodology involves treating specifications as variables and MFIs as cases in a Principal Components Analysis (PCA).
- In order to interpret the meaning of the components we resort to the technique of Property Fitting (Pro-Fit), that draws lines in the figures pointing towards the value of the property increases.

## PC 1 vs PC 2



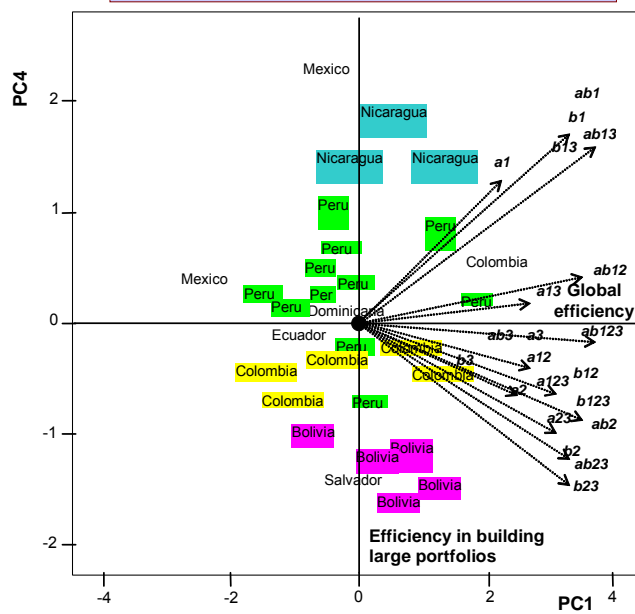


- ### DEA PC interpretation
- PC1: overall measure of efficiency that summarises all the models
  - PC2: NGO status
  - PC3: Inputs: Credit officers versus operating expenses
  - PC4: Outputs: The inclusion or exclusion of the gross loan portfolio affects efficiency values

## Non-Governmental Organizations

- NGOs: Pro-Fit line B3: they try to make a large number of loans and operate as cheaply as possible.
- Non-NGOs: Pro-Fit lines A1, A12, A2: they rely on their specialised staff to build a profitable portfolio of loans.

## Country effect



## Conclusions

- We have used DEA to assess MFIs efficiency.
- Our methodological contribution goes beyond DEA measures and tries to explain differences between scores obtained under different models and specifications.
- We have obtained 4 efficiency PCs, each one of them related to a different aspect: global efficiency, NGO status, input selection and output selection.
- This way we can understand why a given MFI reach an efficiency score under a given specification, or what is the path to efficiency followed by a group of MFIs.

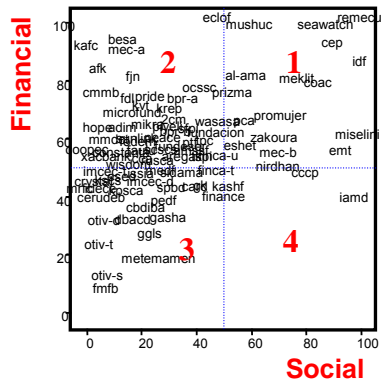
## Empirical study. Social and Financial efficiency

- The data comes from Microfinance Information eXchange ([www.mixmarket.org](http://www.mixmarket.org))
- 89 MFIs are included
- 2003 data from annual accounts and non-financial information.



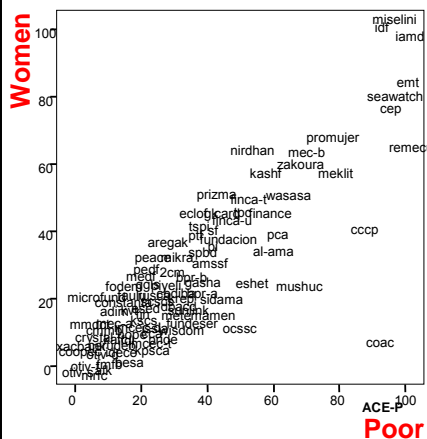
MFI	Social efficiency			Financial efficiency			
	ACE-WP	ACE-W	ACE-P	ACE-LR	ACE-L	ACE-R	C-R
2cm	29.87	24.75	28.38	84.70	84.70	8.00	3.10
adm	15.59	13.25	15.59	84.48	83.29	10.14	6.44
afk	4.14	1.00	4.14	87.65	83.94	85.35	9.41
akama	82.85	33.49	52.43	79.84	79.76	20.71	8.16
amozaf	34.11	30.09	33.06	53.75	52.44	12.67	7.02
aregak	38.33	36.33	33.20	54.83	52.57	21.70	10.22
beas	10.44	3.28	10.41	92.15	100.00	84.32	6.90
bjn-a	32.01	18.19	32.01	77.28	78.85	12.28	12.29
bjn-b	28.97	23.28	28.97	80.59	89.87	7.19	7.19
card	42.14	42.14	40.51	44.22	42.79	6.64	6.33
cbdlba	22.98	21.23	22.98	97.25	97.19	1.61	1.48
cca	10.34	9.12	18.77	56.51	57.22	20.25	6.87
coop	82.00	40.30	82.00	48.39	50.20	12.07	3.75
cepo	62.82	76.14	60.87	91.40	90.99	14.19	14.19
ceruleb	6.02	6.02	2.60	40.28	41.79	28.62	6.28
ommb	13.19	7.47	13.19	73.71	73.27	8.28	5.17
coac	88.73	8.57	88.73	77.40	79.04	14.38	4.80
constanta	21.03	15.93	21.03	53.48	52.07	10.44	5.34
coopec	1.39	1.39	0.11	54.83			4.13
crystal	9.85	8.01	9.85				
dbaco	24.27	14.29					

## Social and financial efficiency



- Financial efficiency is needed for survival. Financially efficient MFIs are in a better position to perform their social tasks.
- The correlation between social efficiency (ACE-WP) and financial efficiency (ACE-LR) is significant but low at 0.346.
- The IV quadrant: socially efficient but financially inefficient is almost empty.
- Only in 13 out of 89 MFIs social efficiency is higher than financial efficiency.
- Then, socially efficient MFIs are also financially efficient.

## MFIs efficiency in fighting poverty and supporting women



- We would expect that those institutions that are efficient at supporting the poor are also efficient at supporting women.
- Some MFIs aim solely at supporting poor women.
- The correlation coefficient between ACE-W (women efficiency) and ACE-P (poor efficiency) is 0.865
- To sum up, socially efficient MFIs are efficient in fighting poverty and supporting women.

## Type of MFI and efficiency

- MFIs can be banks, non-banking financial institutions, cooperatives, credit unions, and NGOs. NGOs emphasise the social aspects.
- 37 out of the 89 MFIs are NGOs.
- NGO have higher efficiencies in the 3 models associated with social efficiency: ACE-W, ACE-P y ACE-WP.

- Statistical testing based on differences of means (ANOVA and non-parametric).
- The only significant differences were associated with Women as an output.

	ANOVA			Non parametric			
	Wilks's Lambda	F	Sig.	Mann-Whitney U	Wilcoxon, W	Z	Sig.
ACE-WP	.978	1.925	0.169	742.000	2120.000	-1.832	0.067
ACE-W	.909	8.732	0.004	577.000	1955.000	-3.205	0.001
ACE-P	.982	1.596	0.210	746.000	2124.000	-1.798	0.072
ACE-LR	.999	.046	0.830	958.500	2336.500	-0.029	0.977
ACE-L	.999	.110	0.741	956.000	2334.000	-0.050	0.960
ACE-R	.995	.441	0.508	886.500	2264.500	-0.629	0.530
C-R	.986	1.263	0.264	874.500	1577.500	-0.728	0.466

## Profitability and social efficiency

- The argument is that a MFI needs to be profitable in order to survive, and that profitable MFIs are so because they are good at supporting viable projects.
- But it can also be argued that MFIs are not profit maximising institutions.
- Profitability has been measured through two financial ratios: (ROA) economic profitability and (ROE) financial profitability.

- The correlation between social efficiency measures and profitability, although positive, is low and never significantly different from zero.
- We have not found any significant relationship between profitability and social efficiency.

	ACE-WP	ACE-W	ACE-P	ROA	ROE	Age	Transparency
ACE-WP	1.000	0.891** (0.000)	0.994** (0.000)	0.116 (0.279)	0.206 (0.053)	0.068 (0.526)	0.060 (0.574)
ACE-W		1.000	0.886** (0.000)	0.093 (0.386)	0.151 (0.159)	0.167 (0.118)	0.062 (0.565)
ACE-P			1.000	0.112 (0.296)	0.206 (0.050)	0.037 (0.729)	0.052 (0.627)
ROA				1.000	0.768** (0.000)	0.127 (0.234)	0.214* (0.044)
ROE					1.000	0.132 (0.217)	0.123 (0.262)
Age						1.000	0.119 (0.268)
Transparency							1.000

## Age and social efficiency

- Any human activity has a learning process. MFIs should be getting more socially efficient as time goes on.
- But it could be that age means taking things for granted and that organisations become less productive.

No significant relationship was found between age and efficiency. This was found between age and size (0.382).

- MFIs do not become wiser with age, they just get fatter.

	ACE-WP	ACE-W	ACE-P	ROA	ROE	Age	Transparency
ACE-WP	1.000	0.891** (0.000)	0.994** (0.000)	0.116 (0.279)	0.206 (0.053)	0.068 (0.526)	0.060 (0.574)
ACE-W		1.000	0.866** (0.000)	0.093 (0.386)	0.151 (0.159)	0.167 (0.118)	0.062 (0.565)
ACE-P			1.000	0.112 (0.296)	0.208 (0.050)	0.037 (0.729)	0.052 (0.627)
ROA				1.000	0.768** (0.000)	0.127 (0.234)	0.214* (0.044)
ROE					1.000	0.132 (0.217)	0.123 (0.252)
Age						1.000	0.119 (0.266)
Transparency							1.000

## Transparency and social efficiency

- The issue has been extensively studied in accounting.
- The best organisations are presumed not to be afraid of disclosing information. Efficient MFIs should be eager to give a full account of their activities to donors. The most efficient should be the most transparent.
- Mix scores transparency by means of a diamond system.



- Association is low and not significant.
- There is significant correlation between profitability and transparency (0.264)

	ACE-WP	ACE-W	ACE-P	ROA	ROE	Age	Transparency
ACE-WP	1.000	0.891** (0.000)	0.994** (0.000)	0.116 (0.279)	0.206 (0.053)	0.068 (0.526)	0.060 (0.574)
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Age						1.000	0.119 (0.266)
Transparency							1.000

## Social efficiency and geographic location

- We identify four groups: Asia, Africa, Latin America and East Europe.

		Significant
Asia	ANOVA	ACE-W** ACE-WP*
	Mann-Whitney U	ACE-W** ACE-WP**
Africa	ANOVA	
	Mann-Whitney U	(ACE-L*) (ACE-R*)
Latin America	ANOVA	ACE-LR*
	Mann-Whitney U	ACE-L* ACE-R** ACE-LR*
East Europe	ANOVA	ROA* ACE-L* ACE-R** (ACE-P*)
	Mann-Whitney U	ROA** ROE* C-R* ACE-L* ACE-R** (ACE-P*) (ACE-WP*)

- Asian MFIs have high social efficiency. African MFIs have low financial efficiency. Latin American MFIs have high financial efficiency. East European MFIs have low social efficiency and high financial efficiency.

## Conclusions

- The performance of MFIs needs to be assessed both from the financial and from the social point of view (double bottom line).
- A DEA model has been developed to measure performance in both aspects. We have worked with financial and social outputs.
- We found a low but positive relationship between social efficiency and financial efficiency. MFIs clearly form 4 groups from this point of view.
- We found positive and significant correlation between two definitions of social efficiency (fight against poverty, supporting women).
- NGO MFIs appear to be more socially efficient than MFIs operating under other organisational structures.
- No relationship was found between social efficiency and other variables such as profitability, age, or transparency in accounting information.
- Geographical location is important, as known by the first study.



Gutiérrez Nieto, B.; Serrano Cinca, C.; Mar Molinero, C. (2007): Microfinance institutions and efficiency. *Omega: International Journal of Management Science* 35(2):131-142



Gutiérrez Nieto, B.; Serrano Cinca, C.; Mar Molinero, C. (2008): Social efficiency in Microfinance Institutions. *Journal of the Operational Research Society*, forthcoming

Work is continuing....

