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Technical efficiency of Swiss nursing homes

Application of parametric frontiers

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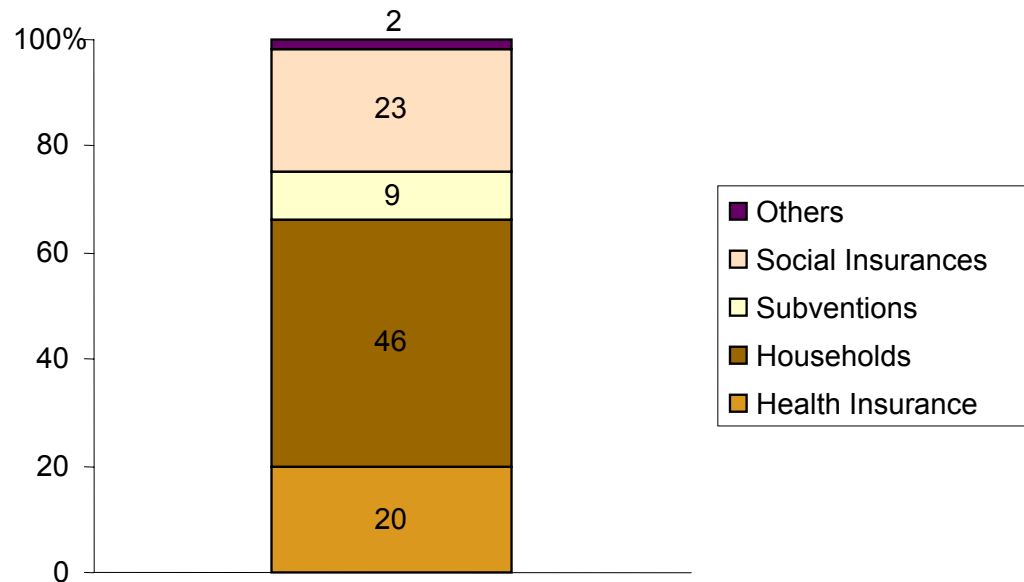


1. Long term care in Switzerland

- High level of health expenditure in Switzerland: **11.6% of GDP** (CHF 53 billions, 2005)
- Almost 15% is devoted to elderly people long term care
- Strong growth: 5,2% per year in real terms (1995-2002)
- The majority of these costs (86%) are linked to nursing home care

1. Long term care in Switzerland

How nursing homes get financed?



Family out-of-pocket payments cover a substantial part of nursing home costs



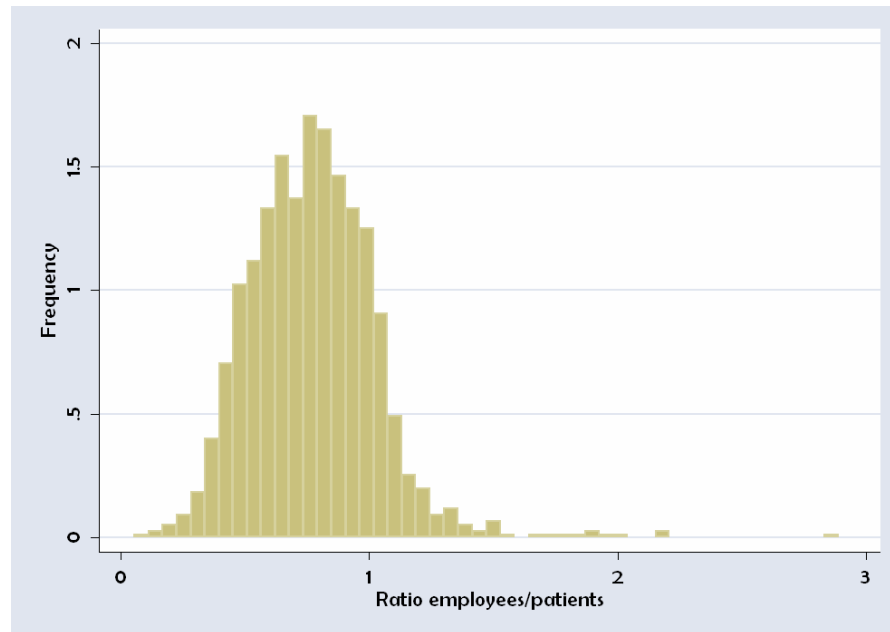
1. Long term care in Switzerland

■ Solutions

- Rationing (prevent the opening of new facilities)
- Increased out-of-pocket payments, creation of a special long term care insurance
- Reduction of the need for stay in facility (prevention, other type of infrastructure)
- *Increase in efficiency*

2. Concepts

- **Production:** use of inputs (ressources) to create ouputs (products)
- **Productivity :** output to input ratio (employee per patient)





2. Concepts

- **Technical efficiency**, ability to :
 - to provide the greatest volume of services with a given set of inputs (output-oriented technical efficiency)
 - to use a minimum of ressources for a definite volume of services (input-oriented technical efficiency)



3. Method

- A frontier is defined
- Efficiency is measured in relation to this frontier
- We distinguish two main groups of methods to define the frontier :
 - Non-parametric
 - Parametric
- Non-parametric methods are data-driven approaches
- Parametric methods involve the use of econometric techniques
- In both cases, units that lie below the frontier are relatively inefficient.
Their efficiency scores are computed in relation to the frontier



3. Method

- In this study we focus on parametric frontiers
- Two classes of econometric techniques are then available:
 - Deterministic frontier (COLS)
 - Stochastic frontier (SFA)
- Both specify a model of the general form (Cobb-Douglas production function):

$$\ln y_i = \alpha_i + \beta \ln x_i + \varepsilon_i$$

Where:

- y is the output
- α is the unit-specific constant
- x is a vector of inputs
- ε is the residual (deviation between observed and fitted values)

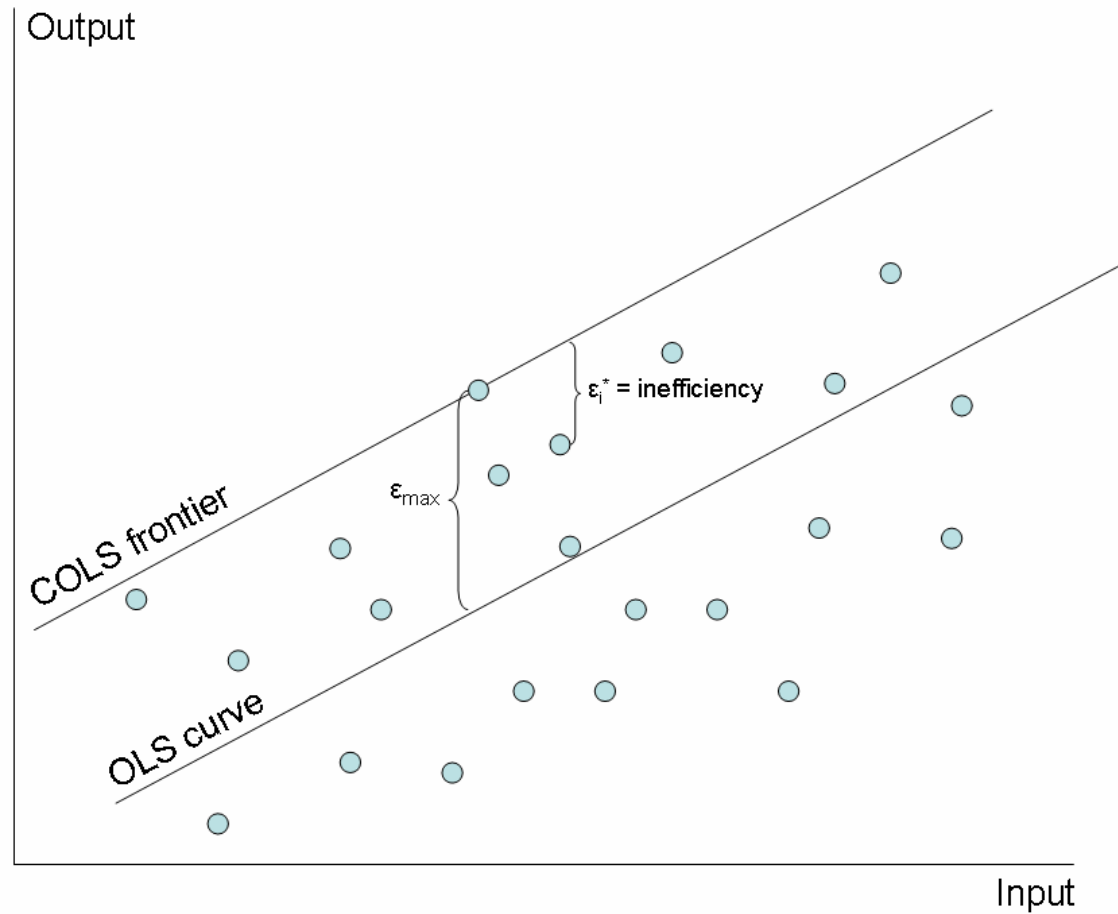


3. Method

- Efficiency analysis is based on a "distance to frontier" approach
- We focus on the residual
- The difference between COLS and SFA rests upon the interpretation accorded to the residual
 - ▶ In **COLS**, the entire residual is considered as arising from inefficiency
 - ▶ In **SFA**, the residual is a combination of inefficiency and statistical noise

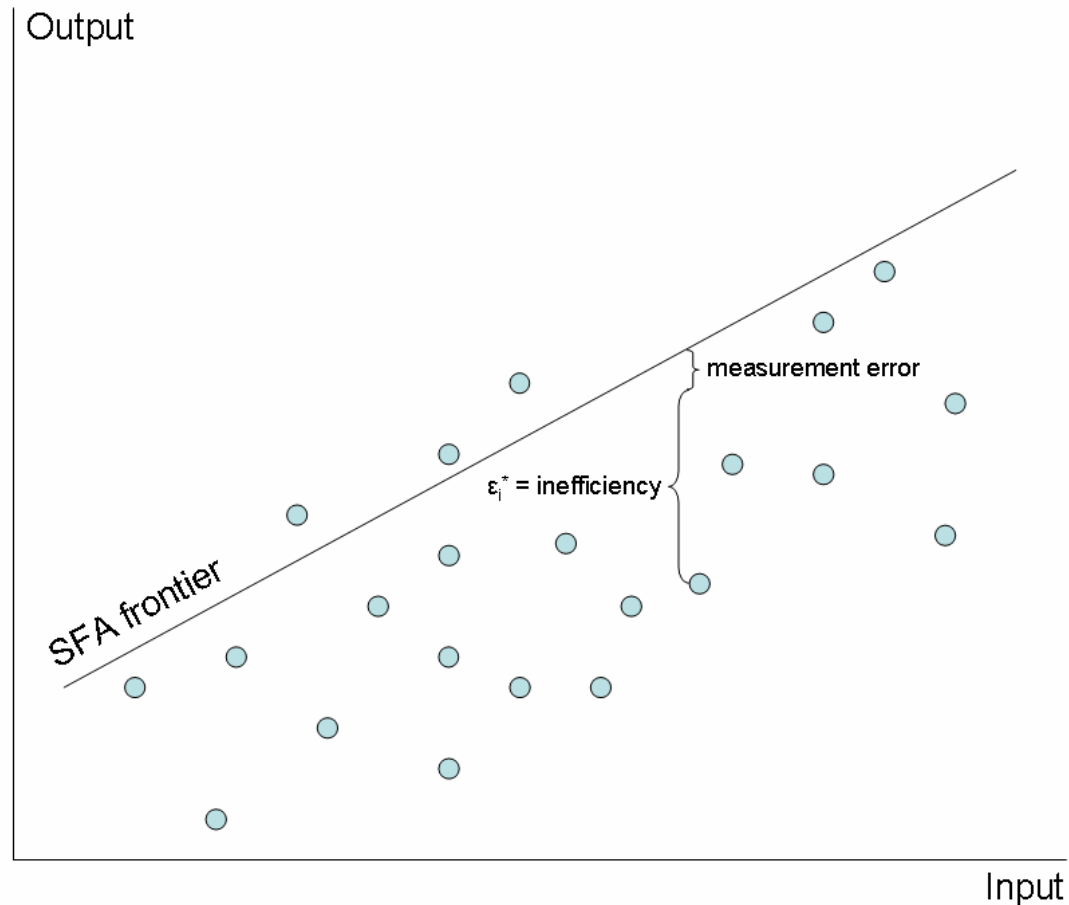
3. Method

Deterministic production frontier – COLS method



3. Method

Stochastic production frontier – SFA method





4. Application

■ Data

Official statistics of the non-hospital health services facilities

Contains **1431 facilities** (98% of Swiss facilities) of 3 types

- Public
- Private non-profit
- Private for profit

The database provides the following information:

- **characteristics** of the facility
- **accounting** (charges and income)
- type of **services** offered
- **patients**
- medical and non-medical **staff**



4. Application

■ Methodological choices

Focus on pure **technical efficiency** (ratio of observed output to maximum feasible output)

Estimation of **one COLS frontier** and **two stochastic frontiers**

Products (outputs): - ***patient-days***

Ressources (inputs) : - ***medical labour force (physical units)***
 - ***non medical labour force (physical units)***
 - ***other running costs (monetary units)***



4. Application

■ Intermediate remarks

- measuring the production of a nursing home is not obvious
- patient-days is an imperfect indicator of service
- intensity of care needs vary among patients
- quality of care is not constant
- efficiency measurement is biased



4. Application

■ Corrected technical efficiency

A facility that treats the heaviest cases, or that offers services of higher quality, isn't equitably evaluated

In order to reduce this bias, **efficiency scores are adjusted**

The variables used to adjust efficiency are :

- **Case-mix variables**
 - patients over 85 years old (%)
 - patients who need more than 3 hours of care a day (%)
- The range of services as a proxy of **quality of care**



4. Application

■ How to take these influences into account ?

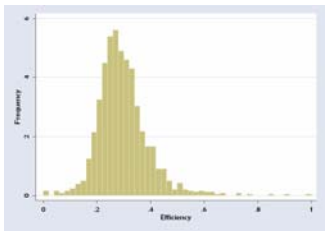
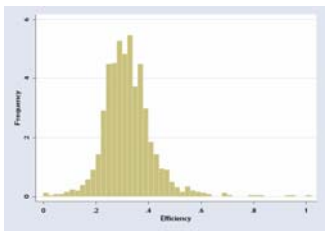
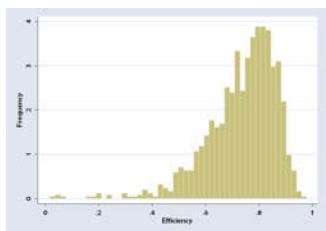
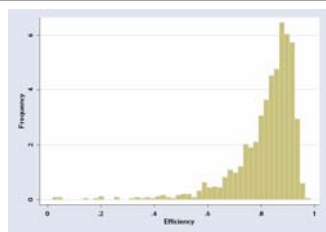
COLS

- Two-step procedure

SFA frontiers

- Directly included in the frontier estimation

5. Results

Model	Distribution	Mean efficiency score
<p>COLS</p> <p>Gross efficiency</p>	 <p>A histogram showing the frequency distribution of Gross efficiency scores. The x-axis is labeled 'Efficiency' and ranges from 0 to 10. The y-axis is labeled 'Frequency' and ranges from 0 to 6. The distribution is unimodal and centered around 3, with a peak frequency of approximately 5.</p>	<p>29.7%</p>
<p>COLS</p> <p>Net Efficiency</p>	 <p>A histogram showing the frequency distribution of Net Efficiency scores. The x-axis is labeled 'Efficiency' and ranges from 0 to 10. The y-axis is labeled 'Frequency' and ranges from 0 to 6. The distribution is unimodal and centered around 3, with a peak frequency of approximately 5.</p>	<p>32.2%</p>
<p>SFA</p> <p>Normal/half-normal</p>	 <p>A histogram showing the frequency distribution of Normal/half-normal SFA efficiency scores. The x-axis is labeled 'Efficiency' and ranges from 0 to 10. The y-axis is labeled 'Frequency' and ranges from 0 to 6. The distribution is unimodal and centered around 8, with a peak frequency of approximately 5.</p>	<p>73.7%</p>
<p>SFA</p> <p>Exponential</p>	 <p>A histogram showing the frequency distribution of Exponential SFA efficiency scores. The x-axis is labeled 'Efficiency' and ranges from 0 to 10. The y-axis is labeled 'Frequency' and ranges from 0 to 6. The distribution is unimodal and centered around 9, with a peak frequency of approximately 5.</p>	<p>81.9%</p>



5. Results

- Do the different methods rank the units in the same order?

Rank	DMU n° SFA half-normal	DMU n° SFA exponential	DMU n° COLS
1	1276	1276	864
2	864	1118	1045
3	1118	864	1276
4	1045	445	1186
5	1186	473	1118
...
...
1326	1	1	1
1327	2	2	2
1328	3	140	140
1329	140	3	3
1330	1222	1222	1222

5. Results

Pearson correlation

	SFA half-normal	SFA exponential	COLS
SFA half-normal	1		
SFA exponential	0.9755	1	
COLS	0.8027	0.7117	1

Spearman rank correlation

	SFA half-normal	SFA exponential	COLS
SFA half-normal	1		
SFA exponential	0.9918	1	
COLS	0.8714	0.8104	1



5. Results

■ Explaining differences in technical efficiencies

The aim is to identify the **explanatory factors** of good and bad performances

Dependant variable

- Efficiency score

Potentially explanatory variables :

- Size of the facility (and square of the size)
- Status (for profit or not)
- State subsidies (for running costs)
- Occupancy rate

Use of **Tobit regression**

5. Results

Explaining net efficiency scores variations

Explanatory variables	Dependant variable– 3 models					
	COLS efficiency		SFA (half-normal) efficiency		SFA (exponential) efficiency	
	Coef.	t-value	Coef.	t-value	Coef.	t-value
Constant	0.269***	6.96	0.549***	13.11	0.621***	15.62
Beds	0.0012***	6.96	0.0025***	11.52	0.0022***	10.85
Beds ²	-3.40E⁻⁶***	-3.89	-8.6 E⁻⁶***	-7.84	-7.95 E⁻⁶***	-7.77
Subventions	-0.019**	-3.54	-0.034***	-4.10	-0.02**	-3.22
Occupancy	0.017	0.48	0.112**	2.56	0.14***	3.42
Profit	-0.039***	-5.55	-0.079	-10.22	-0.078***	-9.54
pseudo R ²	<u>6.55%</u>		<u>22.86%</u>		<u>17.9%</u>	

level of significance ***0.01;**0.05 ; *0.1

More than 75% of the inefficiency remains unexplained



6. Discussion

- Results are very sensitive to methodological choices:
 - COLS: mean efficiency of about 30%
 - SFA: mean efficiency around 80%
- Invariably, COLS will yield lower levels of average efficiency because the entire residual is attributed to inefficiency
- SFA take non-observed random noises into account
- SFA efficiency scores depend directly on the distributional assumption made for the inefficiency term of the error
 - ▶ **which method with which assumptions do we have to use?**
 - ▶ **which are the "correct" efficiency scores?**



6. Discussion

- Without uniform quality control, it's hard to know which part of what is perceived as inefficiency corresponds in fact to a difference in service quality
- These approaches are useful to improve the management of such facilities under certain conditions:
 - To have a precise Case-Mix indicator
 - Each facility should be subject to identical quality standards
- Size, subventions and regulation have a significant impact on efficiency



7. References

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