Efficiency of Hospitals in the Czech Republic

Jana Votápková (Procházková) & Lenka Šťastná

Jana Votápková (Procházková)
procj7as@fsv.cuni.cz
Charles University in Prague

EWEPA 2011
June 21 - 24, 2011

Motivation

Research Questions:

1. How efficient are Czech hospitals with and without determinants?
2. Which exogenous environmental factors influence efficiency and what effect do they have?
3. How much do individual efficiencies differ in terms of rankings with and without determinants.

Outline

1. Motivation and Background
2. Theoretical Model – Stochastic Frontier Analysis
3. Data
   - cost function variables
   - determinants of inefficiency
4. Empirical Results
   - Baseline Model
   - Model with Determinants
5. Discussion
6. Conclusions
7. Further Research

Stochastic Frontier Analysis

Cobb-Douglas Cost Function:

$$\ln c_{it} = \beta_0 + \sum_{s=1}^{S} \beta_s \ln y_{it}^s + \sum_{m=1}^{M} \beta_m \ln w_{it}^m, \tag{1}$$

SFA Model:

$$c_{it} = f(\mathbf{y}_{it}, \mathbf{w}_{it}, \beta) + v_{it} + u_{it} \tag{2}$$

Basic Model inefficiency effect u_{it} (Battese & Coelli, 1992):

$$u_{it} = u_i \exp(-\eta(t - T)), \tag{3}$$

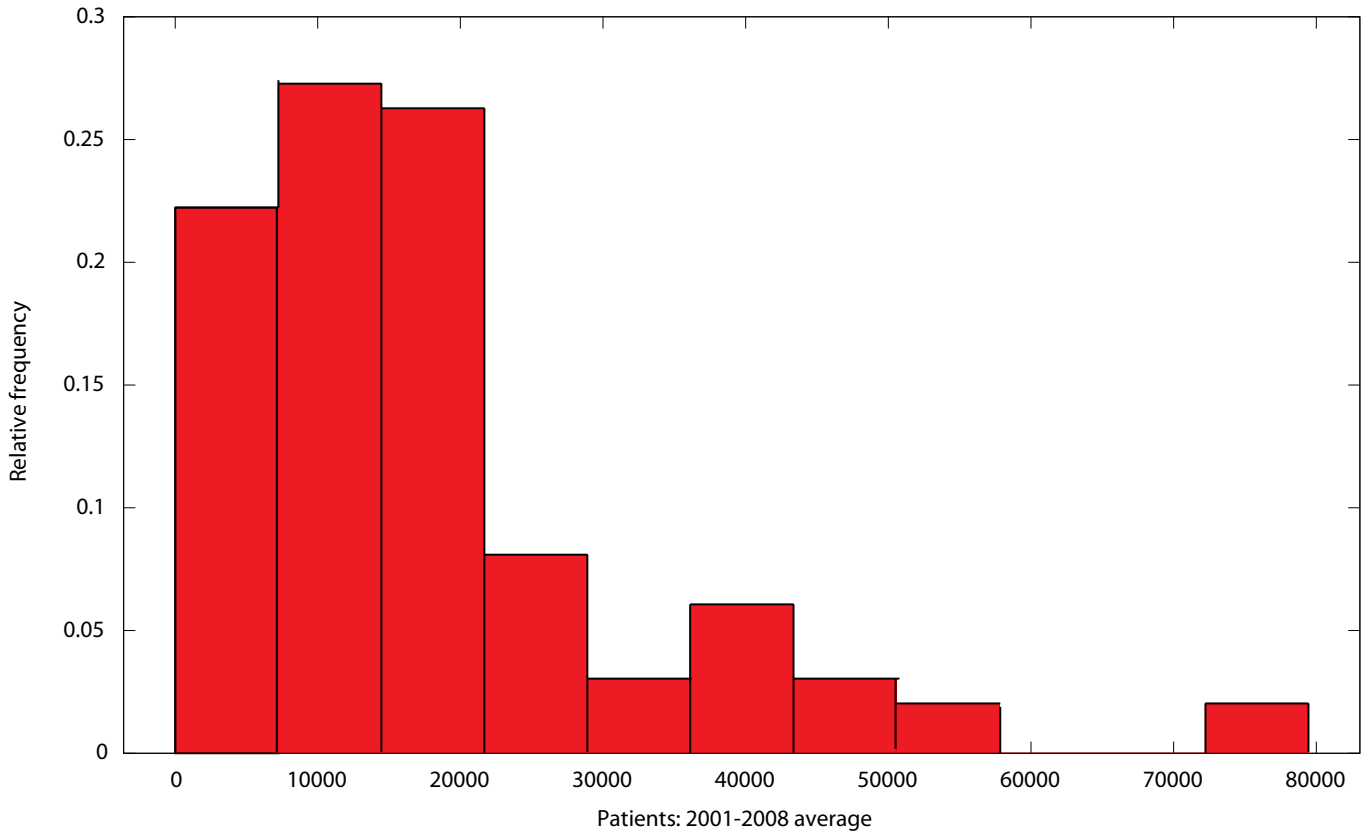
Model with Determinants inefficiency effect (Battese & Coelli, 1995):

$$u_{it} = \delta \mathbf{z}_{it} + \omega_{it}, \tag{4}$$

Data - Overview

- 99 General Hospitals: 2001–2008
- unbalanced panel: 661 observations
- data sources:
  - Institute of Health Information and Statistics of the Czech Republic
  - Czech Statistical Office
  - Registry of Companies of the Czech Republic
- adjustment for inflation using 2001 as a base
- estimation software:
  - Frontier Version 4.1 (Coelli, 1996)
  - R 2.8.1 (R Development Core Team, 2006)

Size Distribution of Hospitals



Data - Cost Function Variables

- Dependent Variable: total operating costs
- Independent Variables:
  - inpatient days – (operative + non–operative + intensive) + nursing days
  - per day doctor/bed ratio
  - per day nurse/bed ratio
- Input prices: average monthly wages for districts

Principal Component Analysis

	PC1	PC2	PC3	PC4
Eigenvalue	2.935	0.941	0.077	0.047
Proportion	0.734	0.235	0.019	0.012
Cumulative	0.734	0.969	0.988	1.000
non_op_days	0.566	0.139	0.559	0.589
op_days	0.568	0.048	−0.797	0.199
intense_days	0.570	0.119	0.218	−0.783
nursing_days	0.177	−0.982	0.067	−0.001

Data - Determinants of Inefficiency

- teaching status
- size
  - small: below 10,000 patients (size1)
  - medium: 10,000–20,000 (size2)
  - big: above 20,000 (size3)
- not–for–profit ownership status
- population size in municipality
- share of the elderly in municipality
- number of hospitals in the region

Descriptive Statistics

Inputs & outputs	No. obs.	Mean	Median	Minimum	Maximum	Std. Dev.
costs	661	5.072E+08	2.971E+08	4.037E+07	3.506E+09	6.090E+08
non_op_days	661	68771	46666	6759	296140	59798
op_days	661	52111	39272	5124	227318	41510
intense_days	661	14318	7918	723	109552	17355
sum_3_days	661	135200	93795	16062	607026	115660
nursing_days	370	17490	14937	3892	52470	10472
doctor_10_beds	660	1.4728	1.3998	0.4370	3.7606	0.3878
nurse_10_beds	660	5.3495	5.1632	2.6329	13.7757	1.0805
salary	661	15897	15463	11894	24416	2572
Determinants						
teaching	661	0.1241	0	0	1	0.3299
size1	661	0.3147	0	0	1	0.4647
size3	661	0.3570	0	0	1	0.4791
not_profit	661	0.7216	1	0	1	0.4485
population	661	65255	27544	3107	373272	89686
over_65	661	14.173	14.250	8.800	18.300	1.650
competition	661	15.9123	14	5	28	6.7074

Baseline Model

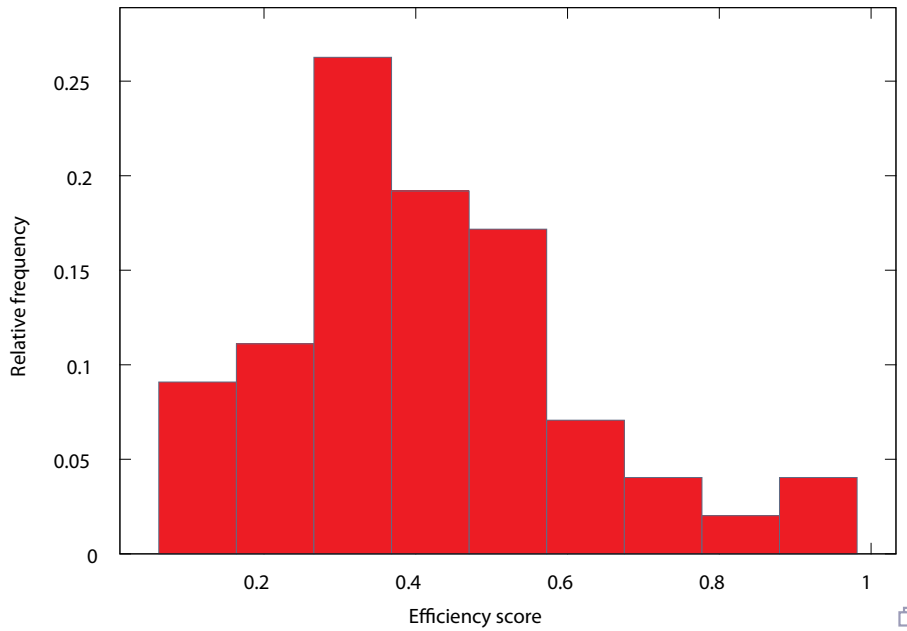
	Coefficient	S.E.	t-ratio	
β_0	6.66479	0.81254	8.202	***
sum_3_days	0.53309	0.04292	12.42	***
nursing_days	−0.00989	0.00788	−1.255	
doctor_bed	0.07115	0.03835	1.855	*
nurse_bed	0.20919	0.07111	2.942	***
salary	0.62413	0.07079	8.817	***
σ^2	0.22084	0.01669	13.23	***
$\gamma = \frac{\sigma_u^2}{\sigma_v^2+\sigma_u^2}$	0.93729	0.00852	110.06	***
μ	0.90993	0.07609	11.96	***
Log likelihood function			229.61	
LR one-sided error			612.79	***

Note: *** significant at 1% level, * significant at 10% level.

Efficiency Scores – Baseline Model

- Summary Statistics

	Whole sample	Size 1: $\leq$ 10,000	Size 2: 10,000–20,000	Size 3: $>$ 20,000
mean	0.4105	0.5895	0.3993	0.2428
min	0.1124	0.3730	0.1124	0.1132
max	0.9305	0.9138	0.9305	0.3794
st.dev.	0.1922	0.1452	0.1533	0.0768
no. obs.	99	33	33	33



Model with Determinants

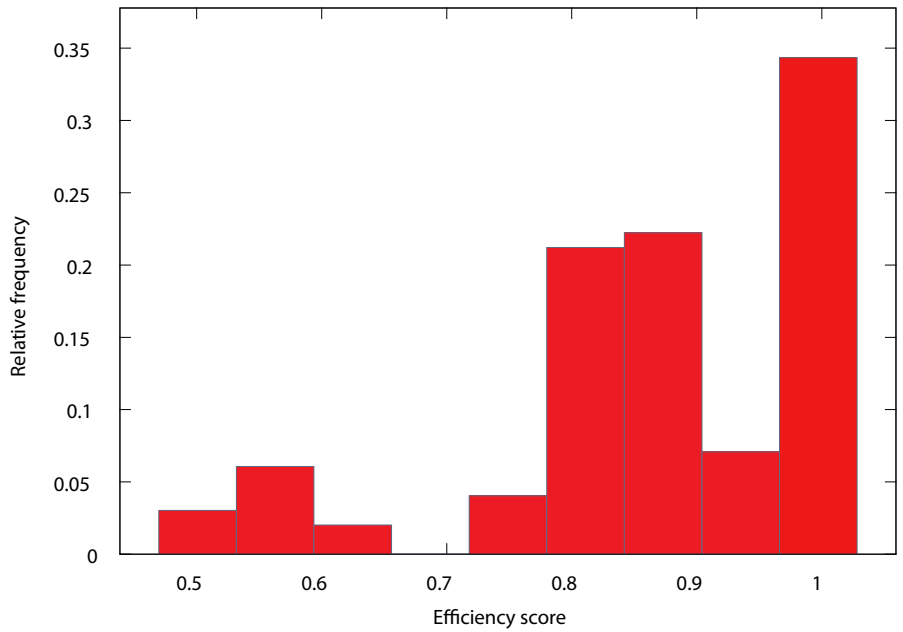
	Coefficient	S.E.	t-ratio	
β_0	6.33286	1.02738	6.164	***
sum_3_days	0.84386	0.03293	25.63	***
nursing_days	0.01676	0.00235	7.132	***
doctor_bed	0.37563	0.05380	6.982	***
nurse_bed	0.68356	0.06603	10.35	***
salary	0.45600	0.09724	4.689	***
δ_0	0.03765	0.08395	0.448	
teaching	0.42822	0.05008	8.551	***
size1	−0.23717	0.06650	−3.567	***
size3	0.08460	0.04144	2.042	**
not-profit	0.14022	0.04417	3.174	***
population	−4.89E-07	0.00000	−3.062	***
over_65	0.00566	0.00424	1.336	†
competition	−0.00413	0.00268	−1.540	†
σ^2	0.06313	0.00393	16.06	***
γ	0.01387	0.00627	2.214	**
Log likelihood function			−24.19	
LR one-sided error			105.16	***

Note: *** significance at 1% level, ** significance at 5% level, † one-tail significance at 10% level.

Efficiency Scores – Model with Determinants

- Summary Statistics

	Whole sample	Size 1: $\leq$ 10,000	Size 2: 10,000–20,000	Size 3: $>$ 20,000
mean	0.8634	0.9926	0.8753	0.7223
min	0.5007	0.9820	0.8086	0.5007
max	0.9972	0.9972	0.9818	0.8982
st.dev.	0.1328	0.0038	0.0379	0.1213
no. obs.	99	33	33	33



Discussion

- with determinants, efficiency increased on average
- Spearman's Rank Correlation Coefficient for the whole sample only 0.8091
  - average shift in rank by 13.5 for the whole sample
  - major improvements not groups specific
  - deteriorations within medium and large hospitals
- Czech hospitals not on average overly inefficient when determinants included
- teaching hospitals, in particular, still inefficient even with determinants
- considerable disparity in the group of big hospitals

- Number of Hospitals in Intervals

	Whole sample	Small	Medium	Big	Teaching
<0.6	10	0	0	10	10
0.6–0.7	1	0	0	1	1
0.7–0.8	10	0	0	10	0
0.8–0.9	37	0	25	12	0
0.9–1	41	33	8	0	0
Total	99	33	33	33	11

Conclusions

- Output variables increase costs as expected
- Inefficiency increases with:
  - teaching status
  - being very big
  - not–for–profit status
  - share of the elderly
- Efficiency increases with:
  - being very small
  - population in municipality
  - competitive pressures
- With determinants efficiency increased
- Asymmetric shifts
- Czech hospitals not overly inefficient
- Group of teaching and big hospitals deserves further attention

Further Research

NEW DATA WILL BE AVAILABLE SOON (2006–2009)

- Additional Determinants:
  - index of costly procedures per patient
- Alternative Determinants
  - competition variable - regarding distance
  - effect of the process of transformation, rather than only ownership
- Additional and Alternative Cost Function Variables
  - DRG Case–Mix index
  - number of patients

REPLICATE THE ANALYSIS USING DEA

THANK YOU FOR YOUR ATTENTION ☺

Jana Votápková
Charles University in Prague
Czech Republic

procj7as@fsv.cuni.cz