Assessing the impact of COVID-19 on the efficiency of state-owned enterprise hospitals

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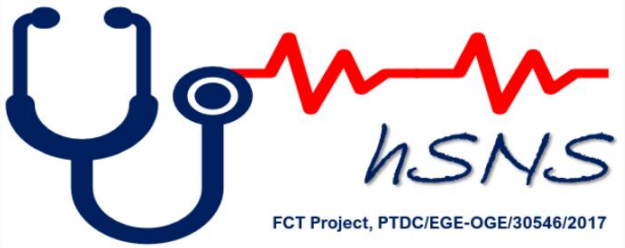


Outline

- Introduction
- Methodology
- Data
- Results
- Conclusions

Introduction

- COVID-19 has brought:
  - A substantial burden on the National Healthcare System (NHS).
  - It is also dictating the pace of the Portuguese economy, posing great challenges to economic and policy decision-makers.
  - NHS may once again be forced to contain costs.
  - Eventual cuts on this sector might preclude its preparedness for handling future COVID-19 outbreaks.
  - The severe economic and financial costs inflicted by the virus may limit the capacity of further funding the NHS.

Introduction

- Why assessing of SOE hospitals?
    - This type of hospitals absorbs 6,042 M Euros, representing 59.9% of the public budget dedicated to the NHS (Health Ministry, 2020).
    - These hospitals are one of the pillars of the public NHS which are aimed at providing universal healthcare and their assessment is particularly relevant under the current sluggish economic growth and public health crisis.

Methodology

- Why VBDA methodology?

  - DEA enables the detection of potential sources of inefficiency delivering public decision-makers (DMs) information on ways to surpass them.
  - The capacity of identifying the benchmarks of inefficient Decision-Making Units (DMUs) – the SOE hospitals in our case, presenting managers information on the best practices that can be pursued to reach efficiency.
  - To the best of our knowledge none of the studies reviewed to date and revised in other works specifically addressed the translation of the Decision-Maker's (DM's) preferences into value functions in the efficiency assessment of hospitals.

Methodology

- Why VBDA methodology?

  - Insofar, this is one of the novelties introduced by our study, which applies the VBDEA method in the assessment of the efficiency and productivity of SOE hospitals prior and after the COVID-19 emergency.
  - This modelling framework can be particularly suitable for supporting policymakers (when compared to other DEA models), since it enables the bring into the analysis different political priorities with repercussions on the identification of distinct benchmarks.
  - This potentiality of the model can be explored by setting a ranking order on the weights consistent with the political concerns of DMs.

Methodology

- **Preparatory phase:**

Convert inputs and outputs into value scales according to the preferences of the DM

- **Phase 1:**

Compute the efficiency measure **d**∗ of each DMU and the corresponding weighting vector, excluding itself from the reference set, in the spirit of super-efficiency.

$$\min_{d_k, w} d_k$$

$$s.t. \sum_{c=1}^{q} w_c v_c(DMU_j) - \sum_{c=1}^{q} w_c v_c(DMU_k) \leq d_k, j = 1, \dots, n; j \neq k \qquad (1)$$

$$\sum_{c=1}^{q} w_c = 1$$

$$w_c \geq 0, \forall c = 1, \dots, q$$

- **d**∗ = distance defined by the value difference to the best of all DMUs, excluding itself from the reference set.
  - If **d**∗< 0, the DMU is efficient.

Methodology

- **Phase 2:**

if **d**∗ >=0 then solve the "weighted additive" model (2), using the weighting vector resulting from phase 1, and determine the corresponding projected point of the DMU under evaluation.

$$\min_{\lambda,s} z_k = -\sum_{c=1}^{q} w_c^* s_c$$

$$s.t. \sum_{j=1, j\neq k}^{n} \lambda_j v_c(DMU_j) - s_c = v_c(DMU_k), \quad c = 1, \dots, q \qquad (2)$$

$$\sum_{j=1, j\neq k}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0, s_c, j = 1, \dots, k-1, k+1, \dots, n; c = 1, \dots, q$$

The variables λ_j, j=1,…,k-1,k+1,…,n define a **convex combination** of the value score vectors associated with the n-1 DMUs. The convex combination corresponds to **a point** on the **efficient frontier** that is better than the DMU k by a difference of value of s_c (slack) in each **criterion** ***c***.

Methodology

- **Robustness assessment**
  - **optimistic efficiency measure**

  is computed considering the best value of the intervals for the DMU k under evaluation and the worst value of the intervals for all the other DMUs

$$\min_{d_k, w} d_k^{opt}$$

$$s.t. \sum_{c=1}^{q} w_c v_c^L(DMU_j) - \sum_{c=1}^{q} w_c v_c^U(DMU_k) \leq d_k^{opt}, j = 1, \dots, n; j \neq k$$

$$\sum_{c=1}^{q} w_c = 1$$

$$w_c \geq 0, \forall c = 1, \dots, q$$

Methodology

- **Productivity analysis**

- TFP assessed by the Value-Based DEA model and the Luenberger productivity indicator is defined as follows:
- $TFP_{t,k}^{t+1} = \frac{1}{2}\{d^{*t}(DMU_k^{t+1}) - d^{*t+1}(DMU_k^{t+1}) + d^{*t}(DMU_k^t) - d^{*t+1}(DMU_k^t)\}$

where:

$$TECHCH_{t,k}^{t+1} = \frac{1}{2}\{d^{*t}(DMU_k^{t+1}) + d^{*t+1}(DMU_k^{t+1}) - d^{*t}(DMU_k^t) + d^{*t+1}(DMU_k^t)\},$$

$$EFFCH_{t,k}^{t+1} = d^{*t}(DMU_k^t) - d^{*t+1}(DMU_k^{t+1}),$$

$$TFP_{t,k}^{t+1} = TECHCH_{t,k}^{t+1} + EFFCH_{t,k}^{t+1}.$$

Data

Table 1. Descriptive statistics for the factors used in the evaluation of Portuguese SOE hospitals

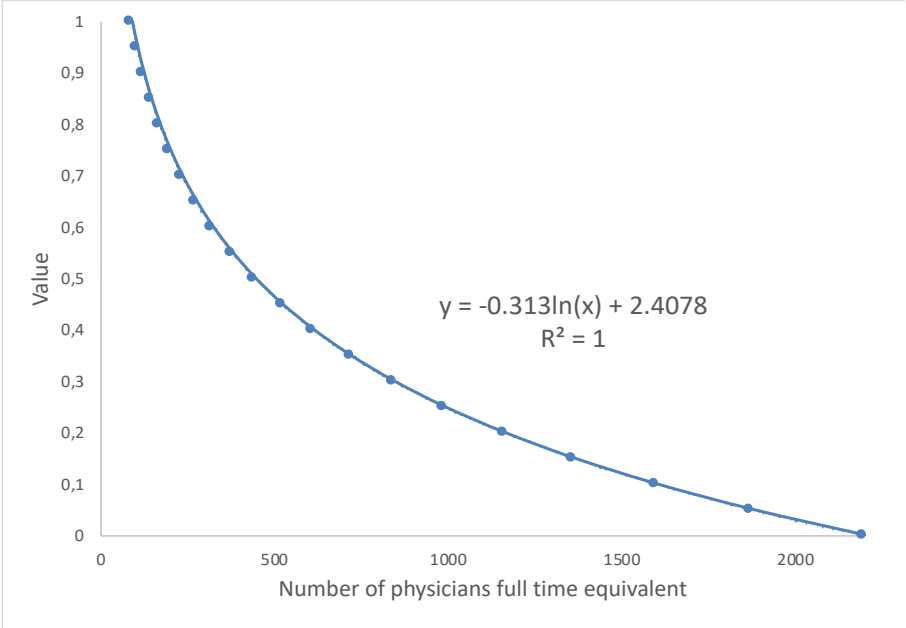
	Number of physicians x_1		*Number of nursing staff* x_2		*Number of Operational Staff* x_3		*Number of beds* x_4		*Number of inpatient discharges (until November)* y_1		*Number of outpatient visits (until November)* y_2		*Number of emergency visits (until November)* y_3	
	2019	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Mean	620	633	914	956	621	684	523	514	16651	14182	272014	242724	145420	105433
Standard Error	81	84	109	115	69	72	59	54	1721	1407	33303	30286	10742	7742
Median	438	457	686	738	516	581	400	412	14755	12354	230394	203509	144439	102729
Standard Deviation	494	511	666	697	418	438	362	329	10467	8558	202577	184224	65341	47095
Minimum	105	89	195	211	141	157	117	117	4481	4406	64268	59359	52703	41999
Maximum	1877	1903	2939	3096	1886	1975	1702	1550	51360	38021	828134	689600	332791	236356

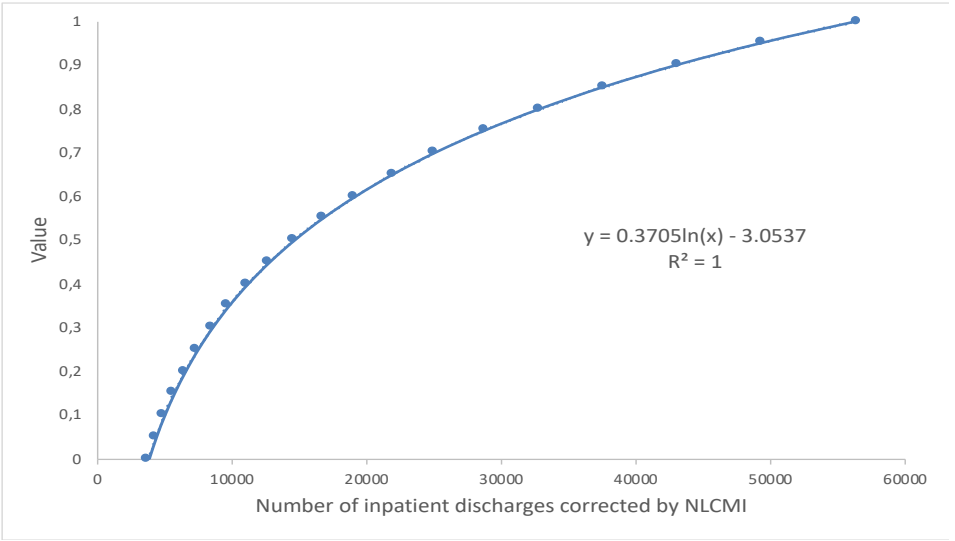
Source: https://transparencia.sns.gov.pt/ and https://benchmarking-acss.min-saude.pt/

Data

- In the VBDEA method, the purpose of converting factors into a value scale is to reflect the DM's preferences while putting the performances of the criteria in the same range [0,1].

- In this work we had the collaboration of an SOE hospital clinical board of direction to build the value functions.



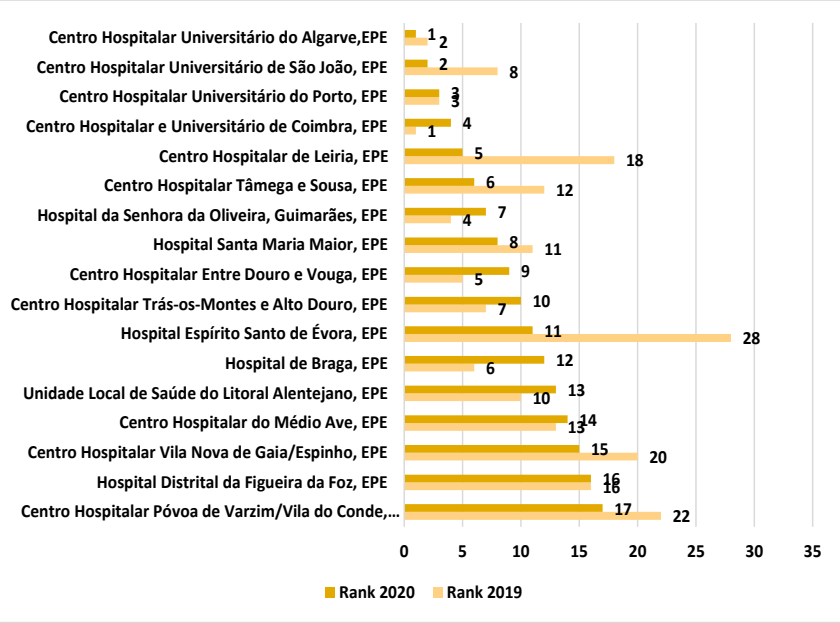


Results

Table 2. Average values of the evaluation factors of SOE Portuguese hospitals

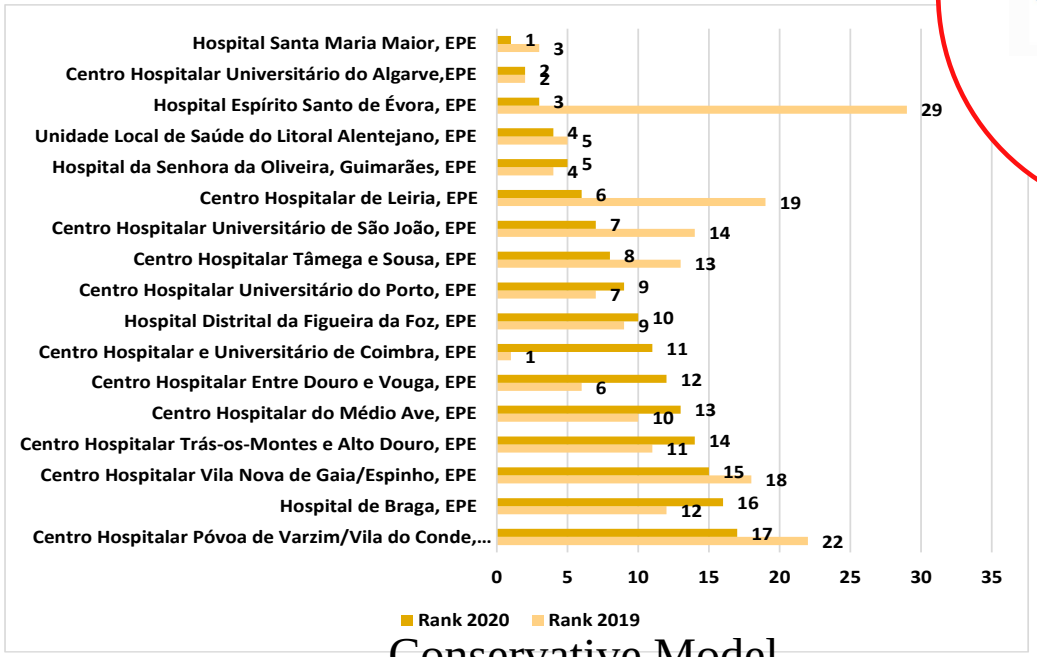
	Number of physicians x_1		***Number of nursing staff*** x_2		***Number of Operational Staff*** x_3		***Number of beds*** x_4		***Number of inpatient discharges (until November)*** y_1		***Number of outpatient visits (until November)*** y_2		***Number of emergency visits (until November)*** y_3	
	2019	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Average values for all hospitals	620	633	914	956	621	684	523	514	16651	14182	272014	242724	145420	105433
Average values for Efficient Hospitals	698	678	998	1014	662	688	568	546	19046	15914	322830	285031	165994	116419
Average values for Inefficient Hospitals	518	596	803	906	568	680	463	488	13507	12709	205319	206762	118415	96094

Results



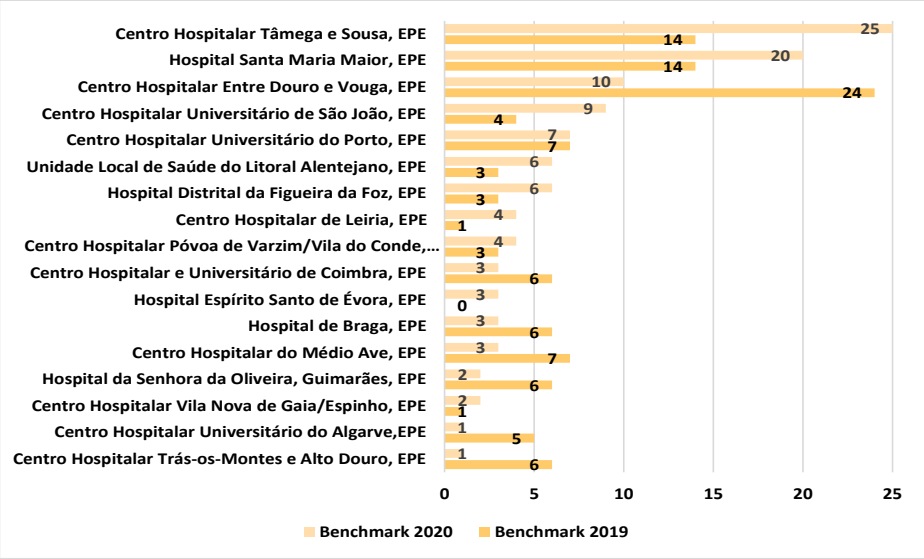
Neutral model

Ranking



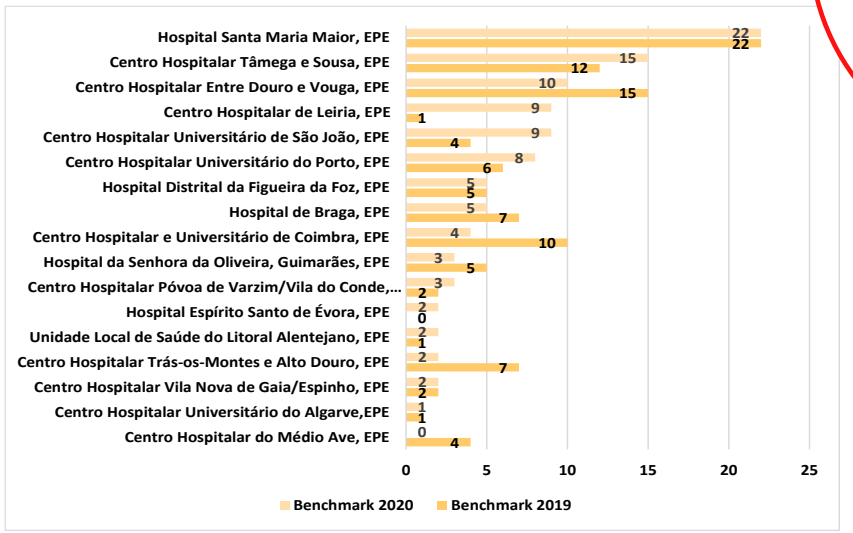
Conservative Model

Results



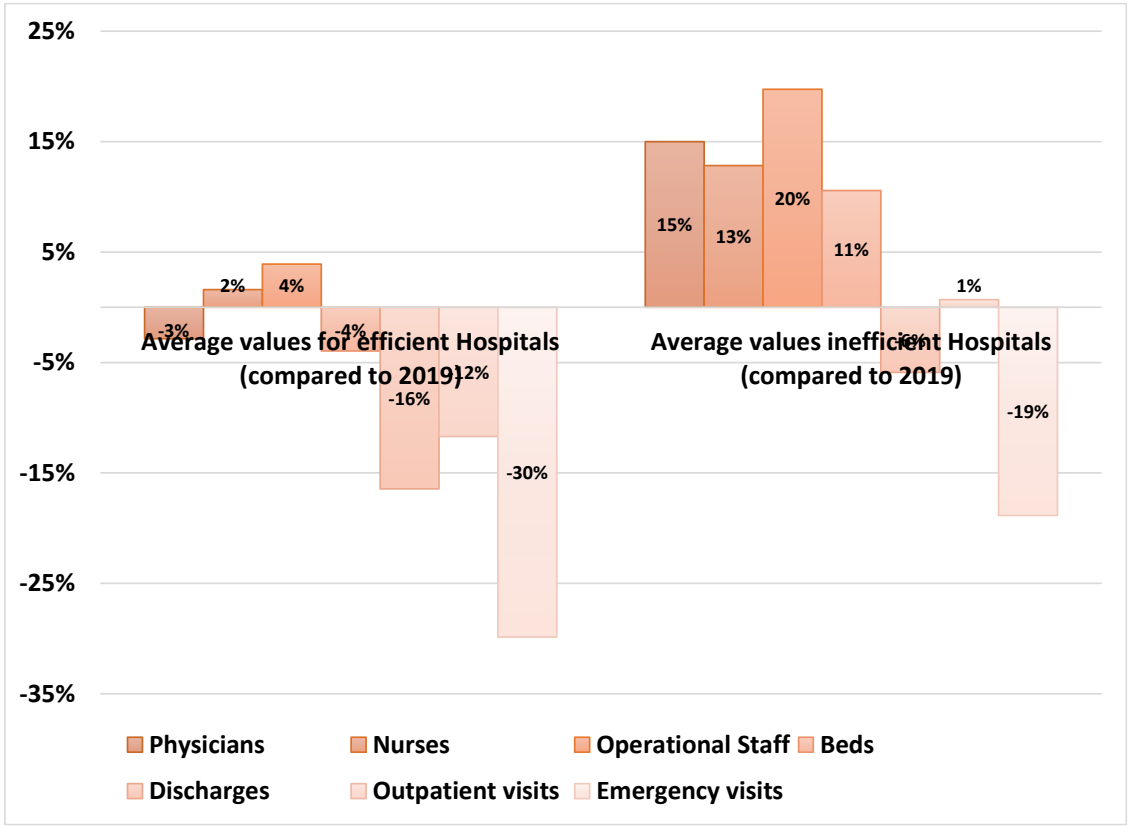
Neutral model

Benchmarks



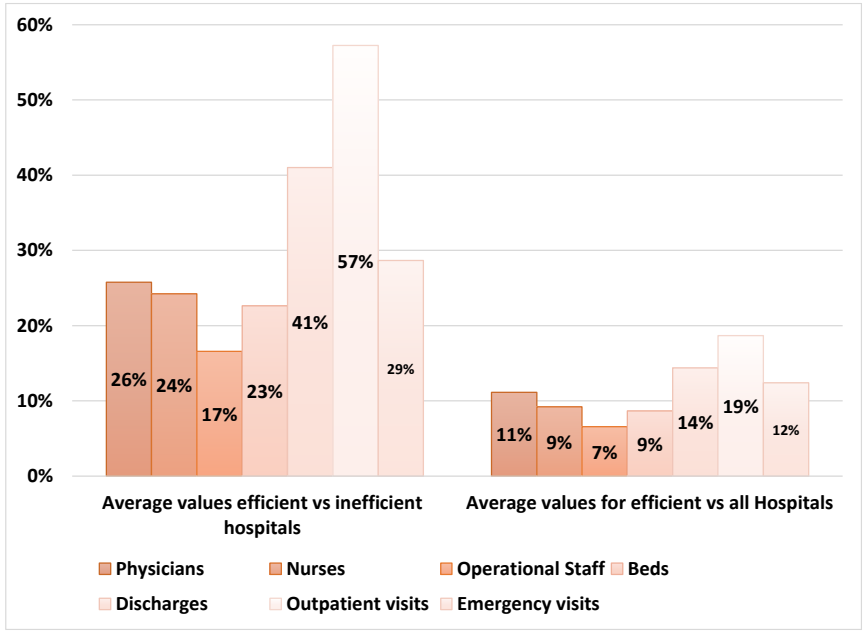
Conservative Model

Results

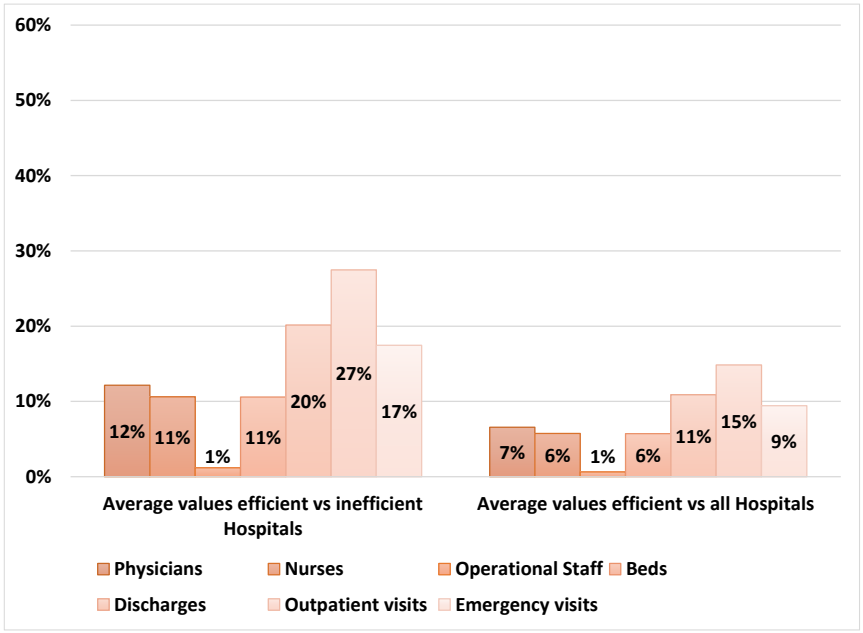


Variation of the average values attained for the factors of efficient and inefficient hospitals between 2019 and 2020

Results

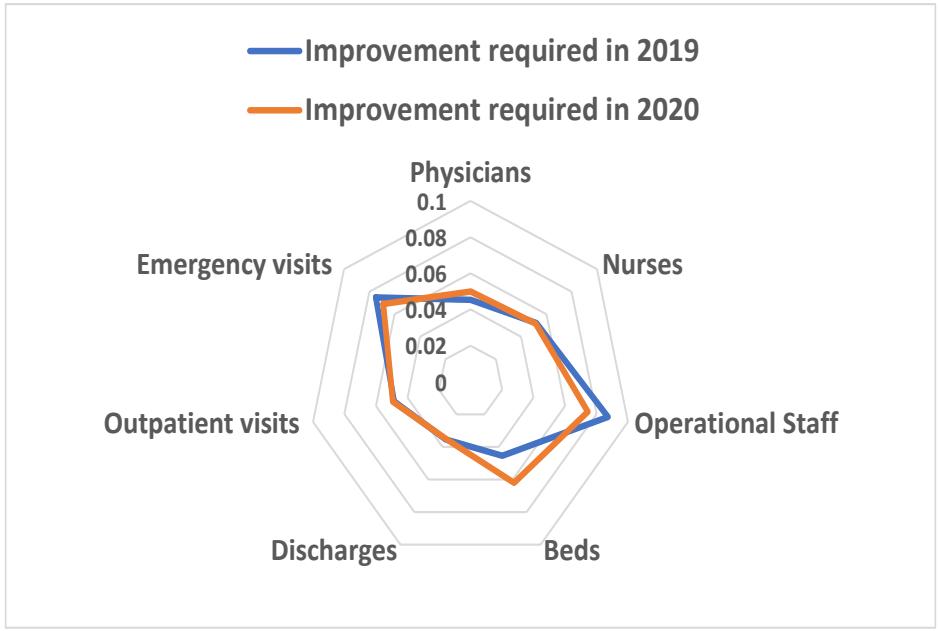


Neutral model



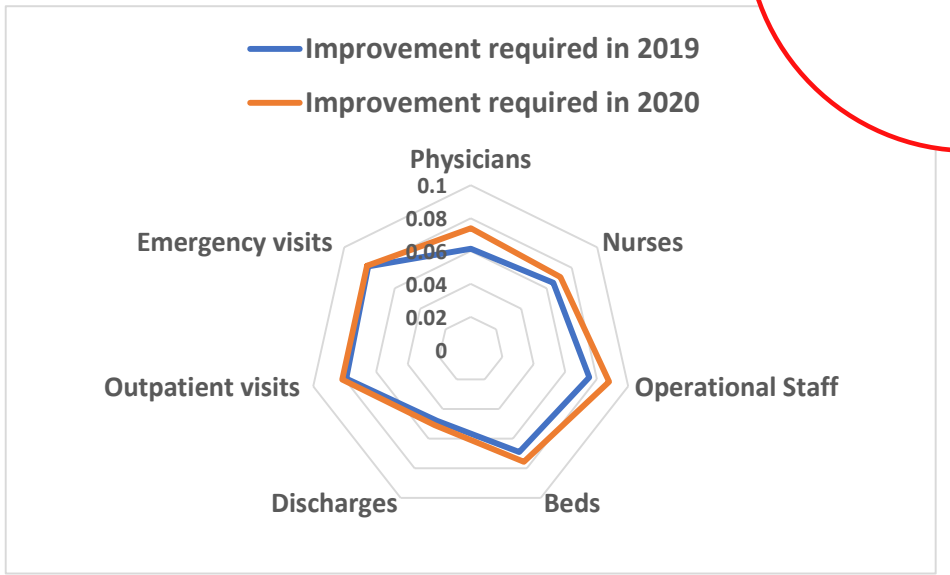
Conservative Model

Results



Neutral model

Adjustments

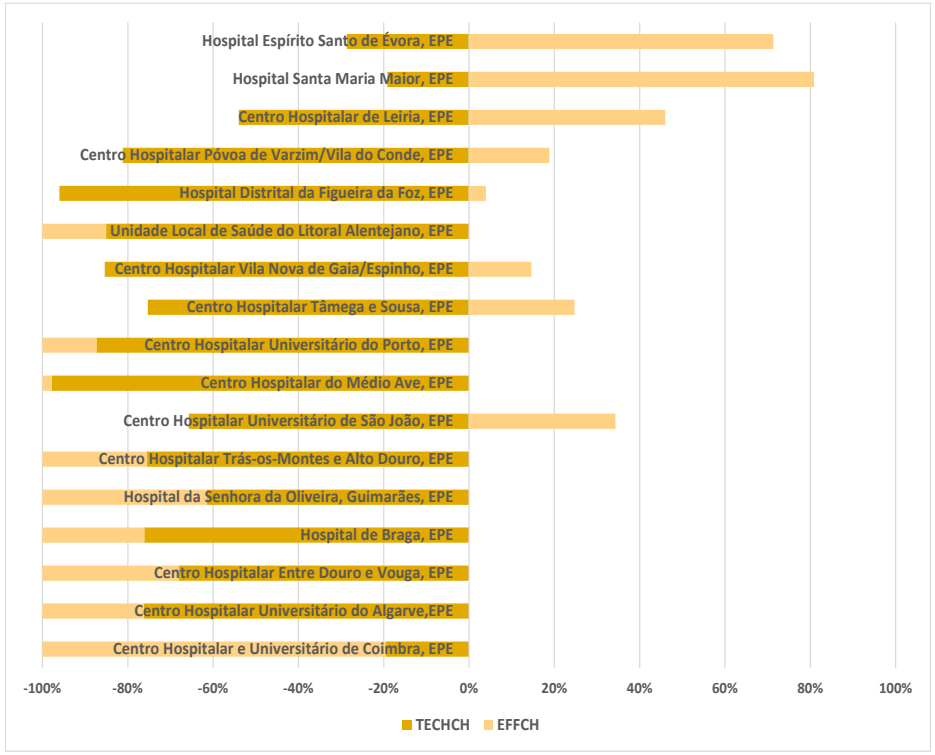


Conservative Model

Results

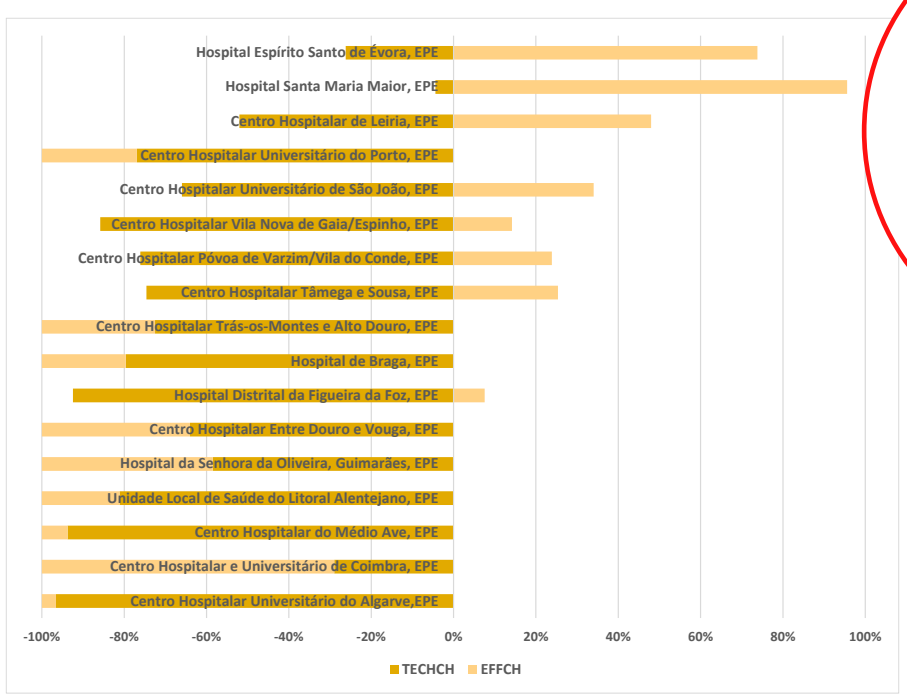
		Conservative Model		Neutral Model		Conservative Model		Conservative Model		Neu Mo
		Efficiency Score	Efficiency Score	Efficiency Score	Efficiency Score	5%	10%	5%	10%	5%
DMU	Hospital	2019	2020	2019	2020	2019	2019	2020	2020	2019
18	Centro Hospitalar Universitário do Algarve,EPE	-0.1085	-0.1042	-0.2203	-0.1620	E++	E++	E++	E++	E++
17	Centro Hospitalar Universitário de São João, EPE	-0.0127	-0.0394	-0.0288	-0.0750	E+-	E+-	E++	E+-	E+-
19	Centro Hospitalar Universitário do Porto, EPE	-0.0377	-0.0322	-0.0678	-0.0626	E++	E+-	E+-	E+-	E++
8	Centro Hospitalar e Universitário de Coimbra, EPE	-0.1095	-0.0259	-0.2494	-0.0487	E++	E++	E+-	E+-	E++
2	Centro Hospitalar de Leiria, EPE	-0.0029	-0.0410	-0.0031	-0.0353	E+-	E+-	E++	E+-	E+-
12	Centro Hospitalar Tâmega e Sousa, EPE	-0.0152	-0.0350	-0.0150	-0.0325	E+-	E+-	E+-	E+-	E+-
22	Hospital da Senhora da Oliveira, Guimarães, EPE	-0.0738	-0.0432	-0.0484	-0.0296	E++	E++	E++	E+-	E++
29	Hospital Santa Maria Maior, EPE	-0.0846	-0.1263	-0.0172	-0.0226	E++	E++	E++	E++	E++
9	Centro Hospitalar Entre Douro e Vouga, EPE	-0.0483	-0.0226	-0.0412	-0.0207	E++	E+-	E+-	E+-	E++
26	Hospital Espírito Santo de Évora, EPE	0.0267	-0.0552	0.0128	-0.0171	E+-	E+-	E++	E+-	E+-
23	Hospital de Braga, EPE	-0.0211	-0.0108	-0.0316	-0.0169	E+-	E+-	E+-	E+-	E+-
35	Unidade Local de Saúde do Litoral Alentejano, EPE	-0.0630	-0.0483	-0.0174	-0.0137	E++	E+-	E++	E+-	E++
36	Unidade Local de Saúde do Nordeste, EPE	0.0101	0.0399	0.0018	0.0118	E+-	E+-	E--	E+-	E+-
31	Unidade Local de Saúde de Castelo Branco, EPE	0.0379	0.0519	0.0105	0.0136	E--	E+-	E--	E+-	E+-
15	Centro Hospitalar Universitário Cova da Beira, EPE	0.0184	0.0356	0.0049	0.0140	E+-	E+-	E--	E+-	E+-
37	Unidade Local de Saúde do Norte Alentejano, EPE	-0.0246	0.0571	-0.0079	0.0167	E+-	E+-	E--	E+-	E+-
34	Unidade Local de Saúde do Baixo Alentejo, EPE	0.0267	0.0564	0.0104	0.0181	E+-	E+-	E--	E+-	E+-
30	Unidade Local de Saúde da Guarda, EPE	0.0915	0.0610	0.0407	0.0183	E--	E--	E--	E+-	E--
33	Unidade Local de Saúde do Alto Minho, EPE	0.0198	0.0372	0.0129	0.0239	E+-	E+-	E--	E+-	E+-
13	Centro Hospitalar Tondela-Viseu, EPE	0.0463	0.0344	0.0392	0.0252	E--	E+-	E+-	E+-	E--
4	Centro Hospitalar de Setúbal, EPE	0.0323	0.0452	0.0212	0.0258	E+-	E+-	E--	E+-	E+-
27	Hospital Garcia de Orta, EPE	0.0581	0.0467	0.0525	0.0397	E--	E+-	E--	E+-	E--
3	Centro Hospitalar de Lisboa Ocidental, EPE	0.0386	0.0426	0.0465	0.0481	E--	E+-	E--	E+-	E+-
20	Centro Hospitalar Universitário Lisboa Central, EPE	0.0358	0.0329	0.0717	0.0717	E--	E+-	E+-	E+-	E+-

Results



Neutral model

TFP



Conservative Model

hSNS
FCT Project, PTDC/EGE-OGE/30546/2017

Results

Weight restrictions

- According to the DM, the criterion with the highest scaling constant is "Number of Beds" and after this one comes "Number of Inpatient Discharges" (an alternative way of obtaining additional beds), followed by "Number of emergency and outpatient visits", Number of outpatient visits", "Number of nursing staff", "Number of physicians" and in the last position we have the "Number of operational staff".

- In this new setting, the number of hospitals which remains efficient becomes reduced to 6:
  - Santa Maria Maior (15 times as benchmark), Évora (7 times as benchmark), São João (12 times as benchmark), Douro e Vouga (8 times as benchmark), Tâmega e Sousa (21 times as benchmark) and Litoral Alentejano (3 times as benchmark).

Conclusions

- Out of the 37 SOE hospitals, 21 and 17 were efficient in 2019 and 2020, respectively.
- Irrespective of the value functions considered, the hospitals more often viewed as a reference of best practices were Santa Maria Maior, Tâmega e Sousa and Entre Douro e Vouga.
- Santa Maria Maior and Algarve were the only hospitals found to be robustly efficient for both years.
- Overall, the majority of SOE hospitals showed negative productivity (except for Évora and Santa Maria Maior) and all of them presented negative technological change, thus highlighting the massive impact that the COVID-19 outbreak has had on the performance of these hospitals.

Thank you!!