Health policy 126 (2022) 802–807

Contents lists available at ScienceDirect

Health policy

journal homepage: www.elsevier.com/locate/healthpol

# New legal forms in health services: Evaluation of a Spanish public policy

Sophie Gorgemans [a,*], Olga Urbina-Pérez [b]

[a] Department of Organisation and Management Business, Industrial Engineering School, Edificio Agustín de Betancourt, C/María de Luna s/n, Zaragoza 50018 Spain
[b] Department of Organisation and Management Business, Labour and Social Sciences School, C/Violante de Hungria 23, Zaragoza 50009 Spain

## 1. Introduction

The Spanish National Health System, structured by the General Health Law of 1986 and tax-funded, provides services to the insured population and their beneficiaries, and operates mainly within the public sector with coordination of health care provision assumed at the regional level and regulation and strategic planning hold by the Ministry of Health.

As in many others developed countries, the cost of delivering health has risen exponentially due to ageing populations, increases in chronic diseases, and rapid technological improvement. With restricted budgets, the Spanish government looked for solutions to contain costs and improve health outcomes and thereby meet some of the critical goals in their health policies. One key change was the introduction of market-driven mechanisms through the separation between the purchasers and health care services providers, steered by the "Abril Report" (1991). The social and professional controversy surrounding this measure has conditioned its withdrawal as a global strategy and its replacement by some initiatives of which New Public Management is part, promoting a shift from rigid administration to business-like professional management and creating a large variety of public semi-autonomous hospitals as stated by the Law 15/1997 of 25 April, in order of gradually moving away from bureaucratic production models. The main purpose of this cited law was to release administrative constraints for the public management according more autonomy to contract out services with providers and healthcare staff, which is governed by labour law, and to use their own financial and economic system [1]. These changes reflect similar trend of a wave of health system reforms triggered by efficiency and quality concerns which began in the late 1980s (Sweden) and the early 1990s (England) [2]. Consequently, the actual panorama of health providers is characterized by a prevailing governance model, the regular public hospital (hereinafter TH), centralised professional bureaucratic model which severely tie the hands of individual institutional administrators, and has elements of direct management as the programme-contract which makes more explicit the link between funding and performance but without real risk transfer [3]. Besides this predominant model, there are other forms of health providers still under direct management that are managed as private firms while the property is still public (new organisation forms). Additionally, there are some indirect management or contracting-out formulas, in which the production of public service is performed by the private sector, providing mainly diagnostic and ambulatory process as well as private finance initiative in some Spanish Autonomous Communities - ACs (the most sounded is the public-private partnership model of "Alzira" [4]). For a complete overview of the legislative framework behind the implementation of new hospital governance in Spain, see Alvárez and Durán [5].

The genuine intention by the way of contracts between purchasers and providers was to increase efficiency by allowing competition between providers, as in Holland, United Kingdom or Germany [6].

After two decades, in spite of the repeatedly efficiency improvement argument used by policymakers [7], there are only a few economic studies and there is no proof that new legal formulas (hereinafter NOF) are more efficient than the traditional one [8–12]. The essential aim of this paper is to evaluate whether NOF, under direct management and implemented yet on 1998 and still operating on 2007 in Spanish ACs where they coexist, are indeed associated with efficiency gains, assessing the relative hospital's technical efficiency by means of a non parametric approach. To conduct this study, we consider the following research question: are NOF more efficient than TH as regards hospital management? We may think that the management autonomy enjoyed by the NOF enables more effectiveness in the decision-making process, so this kind of hospitals could reach higher efficiency levels than traditional ones managed by administrative macro-structures based on inflexible public procedures.

To achieve this objective, we organized the paper as follows. The next section describes the methodology and data used for inference. In Section 3 we report the analysis results. Section 4 interprets and discusses the previous results. The final section summarizes our findings and sets out some possible direction for futher research.

* Corresponding author.
*E-mail address:* sgorge@unizar.es (S. Gorgemans).

https://doi.org/10.1016/j.healthpol.2022.05.014
Received 19 April 2018; Received in revised form 14 July 2018; Accepted 2 May 2022
Available online 31 May 2022

## 2. Methods and material

Talking about efficiency means distinguish two dimensions of efficiency: allocative, and technical. Technical efficiency (TE) reflects the success of a firm in producing as large as possible an output from a given set of inputs (output orientated) or in using as short as possible a set of inputs to produce a given output (input orientated) [13]. If information on prices is available, it is possible to consider allocative efficiency which involves selecting the set of inputs that produces a given quantity of outputs at minimum cost. In this paper, without cost information, we propose to apply the DEA methodology at first developed by Charnes et al. [14] and extended by Banker et al. [15] – to determine the TE of the sample of hospitals. DEA has been the norm for 30 years in many economic sectors, including the health sector (for a more extensive review of DEA literature in health sector see [16–22]). In the health sector, estimating hospital efficiency presents some difficulties due to the internal and external environmental factors that are likely to create more pressures for increased efficiency (patient severity, ownership and nature of health services offered).

Additionally, we analyse the impact of some variables beyond the control of managers on the efficiency levels of hospitals. The variables that can be considered are functional dependence, the age of the hospital, the location and the teaching status. These variables can explain some behaviours at hospitals and, therefore, can be reflected in the technical efficiency levels achieved.

### 2.1. DEA

The DEA approach allows estimating the technical efficiency of each decision-making unit (DMU) and comparing all DMUs without any price or cost information. The DMUs usually use a set of resources (capital and labour), referred to as input indices, and transform them into a set of outputs/outcomes (hospital activities/health expectancy), referred to as output/outcome indices.

With DEA, TE is computed solving a linear programming for each DMU that allows the construction of a non-parametric frontier, considering the previous sets to define the production function.

DEA models have been developed to use either the input or output orientation, and these models emphasize proportional reduction of excessive inputs (input slacks) or proportional augmentation of lacking outputs (output slacks). In this paper, we assume for convenience an input-orientated model, which is also far more consistent with improving public resource allocation [23–26].

To ensure a valid comparison between the hospitals and avoid size-bias, we impose VRS on the technology as the production processes are not linear (partly due to indivisibilities and unmotivated labour force) [27].

After estimating inefficiency and detecting efficient and inefficient hospitals, we will explain why some hospitals are more efficient than others. The answer can be found in the managerial capacity of providers. In this case, analysts commonly apply a two-stage approach to isolate the effects of the environmental variables [28]. DEA is solved using the traditional inputs and outputs, and the efficiency scores obtained at this first stage are then regressed on environmental variables (independent variables) with a censored Tobit model, as the efficiency scores are bounded at the end of a 0–1 distribution. This means that efficiency scores must be corrected by using the estimated regression coefficients to adjust the efficiency scores for the environmental factors.

Further developments include a three-stage approach to account for environmental effects over the excess use of inputs [29]. The slacks of each input (overconsumption) obtained by running DEA from the first-stage are introduced as the dependant variable in a censored regression (on the left side of the distribution cause values are between 0 and Infinity). Results obtained in this second stage allow us to establish which variable is really significant. In the third stage, inputs are adjusted by the estimated coefficients obtained in each regression. The coefficients are used to adjust each hospital's inputs, with the most unfavourable environment and, finally, the efficiency will be estimated once again using this new range of adjusted inputs.

### 2.2. Sample

The original data used in the analysis consists of all public hospitals located in Spanish regions where TH and NOF coexist. We have considered a 10-year period, with all hospitals operating before the beginning in 1998 (first full year after the publication of Law 15/1997) until 2007 (last year of activity for Galician hospitals as foundations). We ended up with a set of 125 hospitals distributed in nine ACs (101TH and 24 NOF). Catalonia has a longer tradition in new public management because this Spanish region created NOF long before the devolution of healthcare from the Social Security, devolution probably enhances the historical trend.

### 2.3. Inputs and outputs

The selection of variables to include in the model is critical in DEA, particularly in terms of outputs. We would like to use patient-level indicators of health outcomes to gauge the level and quality of final hospital production. Regrettably, suitably detailed information is unavailable for the entire period then we use basic activity components, those which are normally used in the hospital efficiency literature. Consequently, the entire model turns to be output-biased, instead of outcome-biased, which constitutes a shortcoming of the whole design. Secondly, we have to address a measurement problem of productivity of factors characterised by a multiplicity of outputs and inputs [30].

Therefore as input variables, we have used the *number of beds* as a proxy of size and capital (K) and *human resources in full-time equivalent* as the labour variable (L). As output variables, we have used indicators showing three main hospital output categories: inpatient (*discharges)*, outpatient (*outpatient visits* and *ambulatory surgical procedures)* and emergency activity (*emergencies)*. We have included ambulatory surgical procedures (ASP) because its use is increasing and reduces hospital costs by removing hospital stays. ASP involves some organisational changes, improving the hospital problem-solving capacity and reducing the waiting list in surgery [31]. Input and output data are obtained from the Spanish Hospital Survey (ESCRI) provided by the Health Ministry.

In Table 1, we present the descriptive figures of input and output variables included in the analysis. These data indicate that NOF are much smaller and homogeneous than their HT counterparts. Physicians' resources are very similar with a mean of 0.7 physicians per bed meanwhile NOF proportionally engage less nurses. In terms of activity, despite differences in discharges and outpatient visits, we observe a peer ASP for both types of hospitals what is obviously the consequence of being introduced at the same time in the same surgical procedures.

**Table 1**
Means of the input and output variables by functional dependence.

| | TH | NOF |
|---|---|---|
| *INPUTS* | | |
| Beds | 549 | 304 |
| Physicians | 393 | 208 |
| Nurses | 1081 | 496 |
| Non health personal | 547 | 218 |
| *OUTPUTS* | | |
| Discharges | 18,997 | 11,869 |
| Outpatient visits | 210,082 | 158,208 |
| ASP | 2730 | 2559 |
| Emergencies | 97,121 | 68,385 |

Note: All variables are expressed in physical units.

## 3. Results

In this section, we present the efficiency scores under VRS and observe the yearly evolution for each direct management group throughout the period.

DEA has some limitations [32] and an erroneous data may result in an incorrect measure of technical efficiency and, therefore, an improper interpretation of the results. To check the robustness of the results we have used the study of the frequency with which an efficient hospital appears as a benchmark for inefficient hospitals [33] and the jack-knife technique to ensure its thoroughness. The results of both tests allow us to confirm that the technical efficiency levels analysed in this paper are robust and the range of the efficiency results is not significantly different ($p < 0.01$).

Table 2 shows, on the upper side, the productive efficiency of Spanish hospitals for each year in the decade 1998–2007. The yearly level of inefficiency, indicates the level of misuse of resources. The NOF, year after year, obtain better efficiency levels than TH (respectively the mean is 95.8% and 82%). During the entire period, 77% of the NOF are efficient; meanwhile, only 23% of TH achieve the 100% limit. Moreover, more hospitals join the efficiency line along the different years.

The worst results for TH during the first four years of the study are constrained by the amount of TH with an efficiency level lower than 70% (40.6% of them). This situation is completely different for the NOF. Only 8.3% of them are misusing more than 30% of the inputs. It is important to note that efficiency levels have increased drastically in 2002.

Therefore, these results show a better performance of NOF and the difference seem to be statistically significant: the Spearman rank correlation coefficient, between both groups, is low and significant (0.407, $p < 0.01$) and the Mann-Whitney test confirms that we cannot reject the null hypothesis. Consequently, the way the hospital is managed could well lead to important differences in terms of productive efficiency.

The main appeal of an efficiency analysis derives from its utility for management. Usually, health professionals and hospitals managers are responsible for controlling the quantity of inputs in the production process. However, some contextual variables can influence the activity hospitals provide, and thus also influence the level of efficiency. As external variables, we included functional dependence, the age of the centre, location and teaching status. Functional dependence measures the effect of management autonomy level on technical efficiency. To determine whether there are differences that depend on the legal nature, we suggest a specific analysis for both types of management: direct (foundation, public health company, or consortium) and traditional (hospitals managed by the public health authorities) to discover which would be the most effective form (the control group is formed by TH). Through the age of the hospital, we want to capture the effect of the cumulative experience of health personnel in providing health services. On one hand, with learning, trainee medical practices will generally progress over time, and practitioners will make more efficient use of hospital resources (the control group will, therefore, be the first group 1 formed by hospitals created before the General Health Law 14/1986 and compared with those created between 1986 and 1995 and those created after 1995). On the other hand, the hospital age is a vector for more aged personnel, less enthusiastic physicians and more experienced doctors, which excellence does not include necessarily more efficient use of resources. We have estimated the effect of hospital location since the pace of transfer of health competencies varies and the autonomous local governments have to assign health budgets and define the terms of the health service production contract with each hospital. This has a direct influence on managerial efficiency (here Catalonia is the control group). Using this measure, we will show the effect of the transfer to the regions that were still dependant on INSALUD (National Institute of Health) at the beginning of our study period until 2002. We created a dummy variable to congregate all the hospitals in the sample in Aragon, Asturias, Balearic Islands and Madrid, that is, INSALUD areas (control group), to compare this group with the hospitals located in other regions (Andalusia, Valencia, Catalonia, Canary Islands and Galicia). Finally, we incorporate another dummy variable for the teaching status that takes the value 1 when there are medical staff, midwives or other health staff in postgraduate training programmes at the hospital, and the value 0 when there are not. Teaching hospitals use more human resources for the same activity levels since, in addition to their usual health workers, they employ university training staff [34].

We use the two-stage model proposed by Ray [35]. In the first step, we find whether these variables influence efficiency levels. We run the

**Table 2**
Technical and managerial efficiency by functional dependence.

| Year | TH ($n = 101$) | | NOF ($n = 24$) | | TOTAL ($n = 125$) | |
|---|---|---|---|---|---|---|
| | TE (%) | Number of efficient | TE (%) | Number of efficient | TE (%) | Number of efficient |
| 1998 | 73.1 | 13 *(13)* | 91.0 | 13 *(54)* | 76.6 | 26 *(20.8)* |
| 1999 | 76.3 | 18 *(18)* | 97.2 | 20 *(83)* | 80.3 | 38 *(29.6)* |
| 2000 | 74.4 | 14 *(14)* | 93.8 | 17 *(71)* | 78.1 | 31 *(24.8)* |
| 2001 | 75.4 | 17 *(17)* | 90.9 | 13 *(54)* | 78.4 | 30 *(24)* |
| 2002 | 86.8 | 27 *(27)* | 97.5 | 20 *(83)* | 88.9 | 47 *(37.6)* |
| 2003 | 86.7 | 29 *(29)* | 97.8 | 19 *(79)* | 88.8 | 48 *(38.4)* |
| 2004 | 85.6 | 25 *(25)* | 97.2 | 20 *(83)* | 87.8 | 45 *(36)* |
| 2005 | 86.4 | 30 *(30)* | 97.4 | 20 *(83)* | 88.5 | 50 *(40)* |
| 2006 | 85.8 | 24 *(24)* | 97.7 | 22 *(92)* | 88.1 | 46 *(36.8)* |
| 2007 | 89.0 | 32 *(32)* | 97.7 | 21 *(88)* | 90.6 | 53 *(42.4)* |
| MEAN/Total | **82.0** | 229 *(23)* | **95.8** | 185 *(77)* | **84.6** | 414 *(33.1)* |
| Var. 98–07 | 21.7 | | 7.4 | | 18.4 | |
| Year | TH ($n = 101$) | | NOF ($n = 24$) | | TOTAL ($n = 125$) | |
| | MTE (%) | Number of efficient hospitals (%) | MTE (%) | Number of efficient hospitals (%) | MTE (%) | Number of efficient hospitals (%) |
| 1998 | 80.7 | 24 *(24)* | 70.1 | 2 *(8)* | 76.6 | 26 *(2)* |
| 1999 | 83.4 | 26 *(26)* | 77.5 | 5 *(21)* | 80.3 | 31 *(2)* |
| 2000 | 82.9 | 29 *(29)* | 73.7 | 3 *(12)* | 78.1 | 32 *(2)* |
| 2001 | 80.4 | 23 *(23)* | 68.2 | 1 *(4)* | 78.4 | 24 *(2)* |
| 2002 | 91.1 | 36 *(36)* | 76.4 | 3 *(12)* | 88.9 | 39 *(3)* |
| 2003 | 89.8 | 37 *(37)* | 76.1 | 3 *(12)* | 88.8 | 40 *(3)* |
| 2004 | 90.6 | 39 *(39)* | 77.9 | 5 *(21)* | 87.8 | 44 *(4)* |
| 2005 | 90.2 | 35 *(35)* | 76.3 | 4 *(17)* | 88.5 | 39 *(3)* |
| 2006 | 91.2 | 37 *(37)* | 78.8 | 7 *(29)* | 88.1 | 44 *(4)* |
| 2007 | 91.0 | 35 *(35)* | 79.1 | 4 *(17)* | 90.6 | 39 *(3)* |
| MEAN/Total | **87.1** | 321 *(32)* | **75.4** | 37 *(15)* | **84.6** | 358 *(29)* |
| Var. 98–07 | 12.8 | | 12.8 | | 18.3 | |

censored regression for three models: (a) the first (MOD1) takes into account external variables, such as those established in this text; (b) the second (MOD 2) takes into account the two groups of regions according to their seniority in managing health-care services; (c) in the last model (MOD 3), we regress, as in the MOD 1, but break down by functional dependence, according to the legal nature of the hospital (foundation, public health company or consortium). All results are presented in Table 3.

It should be noted from MOD 1 coefficients that the efficiency of NOF differs significantly from that of the TH ($p < 0.01$). This result confirms the previous results achieved by calculating Spearman rank correlation.

In MOD 3, the differences according to the hospital's legal status are all positive and significant ($p < 0.01$). Hospitals managed by a foundation or public entity have a higher efficiency level than hospitals run by the public authority. For the consortia, the results show a lower value than the previous forms, although they are significant. This situation is mainly due to a consortium whose efficiency levels are relatively low (between 52 and 62%).

The age of the hospital also plays a decisive role in the average level of efficiency obtained. Hospitals with a higher learning experience differ significantly from other hospitals with a lower length of service. Hospital efficiency in Aragon, Asturias, Canary Islands, Balearic Islands, Galicia and Madrid differs significantly from that of Catalonia and is systematically identified with lower levels (at $p < 0.01$ and $p < 0.05$). However, the efficiency of hospitals in Andalusia and Valencia does not differ significantly from hospitals in Catalonia (MOD 1). It seems that autonomy in managing health-service providers before 1996 has significant consequences on productive efficiency levels.

Teaching status is associated with a lower efficiency, irrespective of the model chosen.

The study has shown that efficiency levels are influenced by contextual variables beyond managerial control; however, the two-stage model does not provide a measure of managerial efficiency. Subsequently, we apply the proposal of Fried et al. [28] to calculate the managerial technical efficiency (MTE) by subtracting the effect of external variables on inputs slacks obtained with DEA. To determine the censored regression, we create dummies combining functional dependence with the teaching status of hospitals, as we first saw that the length of service did not have a significant effect on the inputs slacks. Additionally, these dummies facilitate the calculation of estimators and adjusted inputs. Tobit model results are presented in Table 4.

Slacks for any of the input variables differ significantly and negatively in the NOF compared with the consumption made by teaching TH (Table 4). Therefore, these hospitals consume fewer excess resources ($p < 0.01$). The behaviour of non-teaching TH compared with teaching hospitals is also statistically different, at least in the use of beds, physicians and non-health-care professionals.

When we focus our attention on hospital location, the vast majority of input slacks in all regions are negative and statistically significant ($p < 0.01$). We identified only five cases in which resource consumptions are not significantly different from those observed in Catalonia: the number of beds in Asturias; medical professionals in the Balearic Islands and Madrid; nurses in Asturias and non-health-care staff in the Balearic Islands.

We can also highlight the sign of the difference. Indeed, the ACs use a lower volume of beds and physicians than Catalan hospitals. In contrast, the excess use of other personnel (nurses and non-health-care professionals) is consistently higher in all ACs except in Asturias and in the Balearic Islands where the difference is not significant.

In the third stage, we proceeded to adjust the inputs, for after re-run the DEA model using those adjusted inputs. On the bottom side of the Table 2, we give the MTE scores, that is, the efficiency subtracted from the effects of environmental variables.

On analysing the results, we observe that the TH improve their efficiency by about 6.3%, while the NOF lost more than 21%. We conclude that the legal status of the hospital directly influences the level of MTE. The number of efficient hospitals changes positively for TH and negatively for NOF. NOF seems to operate under more favourable external conditions, as the managerial efficiency is lower than the previous technical efficiency.

## 4. Discussion

Despite twenty years of existence, NOF remain unrated in Spain and there are no study to confirm that new legal status provide a higher efficiency for being beyond the rigid public rules. The actual transversal study explores efficiency scores estimated in a long-10-year period. In general, hospitals were operating in a more unfavourable environment from 1998 to 2001. TH were probably being damaged by the influence of contextual variables, particularly teaching status and tough pressure of the Health Ministry on inputs through a well-organised and staffed agency for health. This phenomenon could be also related with the ratchet effect observed in successive contract negotiations which means a yearly goals increase for hospitals with better degree of compliance

**Table 3**
Censored regression.

| Variables | Coefficients MOD 1 | Coefficients MOD 2 | Coefficients MOD 3 |
|---|---|---|---|
| Constant | 0.972*** | 0.854*** | 0.996*** |
| Functional Dependence (NOF) | 0.255*** | 0.257*** | |
| Foundation Public firm | | | 0.499*** |
| Consortium | | | 0.476*** |
| | | | 0.171*** |
| Age Created between 1986 and 1996 (G2) | −0.050*** | −0.044*** | −0.042*** |
| Created after 1996 (G3) | −0.053** | −0.049* | −0.111*** |
| Location Andalusia | 0.010 | 0.111*** | −0.042**- |
| Aragon | −0.154*** | | 0.186*** |
| Asturias | −0.147*** | | −0.201*** |
| C. of Valencia | 0.001 | 0.104*** | −0.033 |
| Catalonia | | 0.103*** | |
| Canary Islands | −0.196*** | −0.092*** | −0.209*** |
| Balearic Islands | −0.077** | | −0.150*** |
| Galicia | −0.061*** | 0.044** | −0.114*** |
| C. of Madrid | −0.056** | | −0.108*** |
| Teaching status | −0.084*** | −0.067*** | −0.064*** |
| σ | 0.178 | 0.179 | 0.174 |
| Log L | −42.25 | −55.74 | −15.87 |

*** : $p < 0.01$.
** : $p < 0.05$.
* : $p < 0.1$.

**Table 4**
Censored regression of the inputs slacks over external variables.

| Variables | Bed Slacks | Phys Slacks | Nurse Slacks | NHP Slacks |
|---|---|---|---|---|
| Constants | −119.09*** | −3.74 | −212.83*** | −46.17*** |
| Non-teaching TH | −56.17** | −132.49*** | −15.83 | −21.28** |
| Teaching NOF | −107.48*** | −76.94*** | −201.96*** | −68.15*** |
| Non-teaching NOF | −193.14*** | −207.48*** | −327.00*** | −160.39*** |
| Location | | | | |
| Andalusia | −79.69*** | −91.37*** | 99.00*** | 57.35*** |
| Aragon | −92.44** | −102.99*** | 148.24*** | 29.99* |
| Asturias | −8.37 | −97.11*** | 27.34 | 61.71*** |
| C. of Valencia | −166.90*** | −32.80** | 85.53** | 34.07** |
| Canary Islands | −77.55* | −47.66* | 325.96*** | 95.09*** |
| Balearic Islands | −86.43* | −32.84 | 230.82*** | 26.50 |
| Galicia | 107.16*** | −79.70*** | 169.69*** | 67.39*** |
| C. of Madrid | −68.49** | 21.77 | 155.80*** | 69.92*** |
| σ | 147.60 | 120.10 | 236.40 | 100.80 |
| Log L | −1117.3 | −2463.4 | −3054.7 | −3892.8 |

*** : $p < 0.01$.
** : $p < 0.05$.
* : $p < 0.1$.

[36]. From 2002, Autonomous Communities lost comparisons terms for contracting with their hospitals and had to deal with unexperienced governments. With the absence of an incentive system and the lack of consequences for compliance or non-compliance of the objectives, program contracts were less exigent.

Various causes for the higher NOF technical efficiency and progressive loss may be mentioned. First, the institutional autonomy may have implications to go beyond the service structure by creating quasi-independent Supervisory Board that could make a range of operating and financial decisions without obtaining political approval. NOF can operate the day-to-day life of the hospital with more ability. Nonetheless, some studies on the evolution of the decision-making autonomy of the public health companies of Andalusia, indicate a progressive loss of it because of a greater interference of the political class and public financial backers in decision-making process [37]. At once, the Public Procurement Law in 1999 established new limits on the autonomy of contracting for the NOF and the Law 30/2007 on Public Sector Contracts, overrode the room for manoeuvre in their negotiation with suppliers. This situation is similar in United Kingdom where foundation trusts (FTs), hospital-care providers with greater financial and managerial autonomy, are regulated, since 2004, by an independent body (known as Monitor) to ensure that they are financially strong and well-managed [38]. In the case of the Swedish health decentralized system, it was claimed that increased efficiency reflected formidable political pressure to increase productivity, not because hospitals began to compete for contracts [39].

Secondly, NOF have been created recently (overall foundations and public health companies) sometimes incorporating the more enthusiastic health personnel from TH. Futhermore, applying the private employment relations, NOF enjoy a greater labour flexibility allowing them to adapt continuously to changing conditions in health-care demands and paying non-statutory health care professionals as staff with performance-related incentives amounting from 8 to 15% of their income [4] to 35% for managers in public health company [40]. However, in the last ten years, appears a growing convergence with the statutory framework defined by the Law 55/2003, which ensured that salaries remained not performance-related, with an additional local negociation, resulting in a real tournament between ACs. Already, the Galician and Balearic foundations turned back to the regional authority.

Finally, NOF are smaller than TH, thus, in principle, more manageable and controllable with more flexible structures [40].

The results we have obtained confirm previous studies: (a) IASIST [41] compares hospitals dimensions such as the scientific and technical quality of care and efficiency and show that there are no significant differences between the two management models in terms of quality while new organisational forms have better results in terms of functional efficiency and cost; (b) the results of Arias et al. [42] indicate the same trends; (c) Sanchez and Martin [43] compare the performance of hospitals managed with the legal status of foundations with traditional hospitals in Galicia and conclude that foundations are not more efficient than other health centers. Unfortunately, this empirical evidence on the effectiveness of different ways of managing health organisations is insufficient and inconclusive.

## 5. Conclusion

The measure of hospital efficiency is a topic of great relevance for funders, policymakers and health-facilities providers. DEA has been used in several areas to identify the efficiency of organisations and set a hospital range.

In this study, DEA has been used to estimate the technical efficiency of public general hospitals in Spain with different forms of functional dependence, from 1998 to 2007. The devolution of health functions to the ACs was completed during this period.

Results reveal a clear pattern regarding the existence of a relationship between management formulas and technical efficiency. The differences between the TH and NOF efficiency are significant. The proximity between policy-makers and health-service providers should have positive effects on efficiency but, at the same time, experience shows that the regional health authorities often engage with the NOF management as much as they do with any other public hospital generating growing political pressures to improve the overall performance. Furthermore this closeness between stakeholders leads to an increasing bondage from political interference reducing the ability to contract out services, as well as pressures from trade-unions to equate personnel management status The self-governance have been eroded by strong centralising forces at regional level, reducing gradually their autonomy.

With the introduction of contextual variables we assumed a feasible influence these would exercise on efficiency levels. This impact was confirmed by applying Ray's two-stage model. The external variables considered were all significant. The results confirm that the functional dependency positively influences efficiency levels when the legal status is NOF. After a detailed study of the legal forms included in NOF, the results show that foundations and public organisations have a higher influence on efficiency than consortia, but this could be due to the effect of one of these consortia, because the others obtain similar efficiency levels. The age of the hospital may have positive effects on the hospital's technical efficiency as the staff has more accumulated experience on medical practices unlike is inclined to use more expensive technologies especially in times of economic growth. For hospitals created after 1986 and even more for those created after 1996 the age has a negative influence on efficiency levels. The third variable considered in the analysis was the location of hospitals, namely the autonomous region they receive funds from. In the proposed regressions, hospitals located in the INSALUD area have lower efficiency levels highly due to the tough authorities' pressure. After completion of the transfer process of health functions, hospital efficiency levels increase in each region but evenly more in former INSALUD regions, probably still inmature in the health management.

In the case of teaching status, the results demonstrate that this feature has a negative impact on efficiency due to their human resources overconsumption. All the previous conclusions can ratify that technical efficiency is significantly influenced by contextual variables beyond managers' control.

Finally, we have presented the MTE levels and concluded that TH are working in unfavourable environments that worsen their efficiency levels. By correcting the effect of these contextual variables, the previous efficiency results tend to be reversed - NOF levels worsen by 22.3%, while TH improve by 6.3%.

Next steps for future research, overcoming some of the limitations of this study, include an analyse of efficiency changes over time; the introduction of case-mix to adjust inputs and outputs as well as quality indicators; in addition examine the relation between efficiency and scale of operations and the evolution of residual control rights.

Hospital comparisons and benchmarking are initiatives that should be taken into account for the proper functioning of the health system with a desire to promote a new transparency in information .

## Acknowledgment

This research was completed thanks to the data support of the Spanish Health Ministry and the Aragon Health Sciences Institute (IACS).

## References

[1] Gomez de Hita J.L. Formas juridicas de la organizacion sanitaria., Escuela Andaluza de Salud Publica 2000; Serie Monografias n 25 (p. 361).
[2] Saltman RB, Bankauskaite V. Conceptualizing decentralization in European health systems: a functional perspective. Health Econ Policy Law 2006;1(2):127–47.
[3] García-Armesto S, Abadía-Taira M, Durán A, Hernández-Quevedo C, Bernal-Delgado E. Spain: helath system review. Health Transit 2010;12(4):1–295.

[4] NHS European Office 2011. The search for low-cost integrated healthcare. the Alzira model. http://www.nhsconfed.org/Integratedhealthcare141211.pdf [access on 17 june 2016].
[5] Alvarez A, Duran A, Spain in Saltman RB, Duran A, Dubois HFW. Governing Public Hospitals. Reform Strategies and The Movement Towards Institutional Autonomy. Copenhagen: WHO; 2011. p. 241–60 [chapter 12].
[6] Oliver A. The english national health service: 1979–2005. Health Econ 2005;14: S75–99. Suppl 1.
[7] Garcia-Rada A. Is Spanish public health sinking? Br Med J 2011;343:d7445.
[8] Dalmau E, Puig-Junoy J. Market structure and hospital efficiency: evaluating potential effects of deregulation in a national health service. Rev Ind Org 1998;13: 447–66.
[9] Puig-Junoy J, Ortun V. Cost efficiency in primary care contracting: a stochastic frontier cost function approach. Health Econ 2004;13(12):1149–65.
[10] IASIST (2007-2012) Hospitales top 20. Available at: http://www.iasist.com.es/es/top-20/ [accessed 05.06 2015].
[11] Catalan Health System Observatory (2012) Central de resultados ámbito hospitalario. Available at: http://observatorisalut.gencat.cat/web/content/minisite/observatorisalut/ [accessed 08.06.2015].
[12] Herrero L, Martin JJ, Lopez del Amo MP. Eficiencia tecnica de los hospitales publicos y de las empresas publicas hospitalarias de Andalucia. Gaceta Sanit 2015; 29(4):274–81.
[13] Farrell MJ. The measurement of productive efficiency. J R Stat Soc 1957;20(3): 253–90.
[14] Charnes A, Cooper WW, Rhodes E. Measuring the efficiency of decision making units. Eur J Oper Res 1978;2:429–44.
[15] Banker RD, Charnes RF, Cooper WW. Some models for estimating technical and scale inefficiencies in data envelopment analysis. Manag Sci 1984;30:1078–92.
[16] Emrouznejad A, Parker BR, Tavares G. Evaluation of research in efficiency and productivity: a survey and analysis of the first 30 years of scholarly literature in DEA. Socio Econ Plan Sci 2008;42(3):151–7.
[17] Gattouffi S, Oral M, Reisman A. Data envelopment analysis litterature: a bibliography update (1951-2001). Socioecon Plan Sci 2004;38:159–229.
[18] Seiford LM. A bibliography for data envelopment analysis (1978-1996). Ann Oper Res 1997;73:393–438.
[19] Hollingsworth B, Dawson P, Maniadakis N. Efficiency measurement of health care: a review of non-parametric methods and applications. Health Care Manag Sci 1999;2(3):161–72.
[20] Hollingsworth B. The measurement of efficiency and productivity in health care delivery. Health Econ 2008;17(10):1107–28.
[21] Jacobs R, Smith PC, Street A. Measuring Efficiency in Health Care: Analytic Techniques and Health Policy. Cambridge: Cambridge University Press; 2006.
[22] O'Neill L, Rauner M, Heidenberger K, Kraus M. A cross-national comparison and taxonomy of DEA-based hospital efficiency studies. Socio Econ Plan Rev 2008;42 (3):158–89.
[23] Chern JY, Wan TT. The impact of the prospective payment system on the technical efficiency of hospitals. J Med Syst 2000;24:159–72.
[24] Harris JM, Ozgen H, Ozcan YA. Do mergers enhance the performance of hospital efficiency? J Oper Res Soc 2000;51:801–11.
[25] Ozgen H, Ozcan YA. Longitudinal analysis of efficiency in multiple output dialysis markets. Health Care Manag Sci 2004;7:253–61.
[26] White KR, Ozcan YA. Church ownership and hospital efficiency. Hosp Health Serv Adm 1996;41:297–310.
[27] Ferrier GD, Valdmanis V. Rural hospital performance and its correlates. J Product Anal 1996;7:63–80.
[28] Fried H, Schmidt SS, Yaisarwarng S. Incorporating the operating environment into a nonparametric measure of technical efficiency. J Product Anal 1999;12:249–67.
[29] Blank J, Valdmanis V. A modified three-stage data envelopment analysis. Eur J Health Econ 2005;6(1):65–72.
[30] Sexton TR, Silkman RH, Hogan AJ, Silkman RH. Data envelopment analysis: critique and extensions (editor). Measuring efficiency: an assessment of data envelopment analysis. San Francisco: Jossey-Bass; 1986. p. 73–105.
[31] VILA-BLANCO JM Desarrollo e implantación de la CMA en España: evolución en los hospitales del Insalud, 2004, Cir Esp., 76(3):177–83.
[32] Smith P, Mayston D. Measuring efficiency in the public sector. Omega Int J Manag Sci 1987;15(3):181–9.
[33] Berg SA, Førsund FR, Hjalmarsson I, Suominen M. Banking efficiency in the nordic countries. Oslo: Department of Economics. University of Oslo; 1993. Memorandum n 35/2001.
[34] Lobo M, Ozcan Y, Silva A, Lins M, Fiszman R. Financing reform and productivity change in Brazilian teaching hospitals: malmquist approach. Cent Eur J Oper Res 2010;18(2):141–52.
[35] Ray SC. Resource use efficiency in public schools: a study of Connecticut data. Manag Sci 1991;37(12):1620–8.
[36] Ventura J, Gonzalez E, Carcaba A. Efficiency and program-contract bargaining in Spanish public hospitals. Ann Public Coop Econ 2004;75(4):549–73.
[37] Martín J.J. Nuevas formulas de gestión en las organizaciones sanitarias. Fundación Alternativas 2003; V.
[38] Seán Boyle.HiT– United Kingdom, European observatory on health systems and policies 2011; 13(1). Available at http://www.euro.who.int/_data/assets/pdf_file/0004/135148/e94836.pdf [accessed 10.12.2015].
[39] Harrison MI, Calltorp J. The reorientation of market-oriented reforms in Swedish health care. Health Policy 2000;50(3):219–40 (New York).
[40] Cámara de cuentas de Andalucía 2010. Análisis comparativo de la actividad realizada por dos hospitales del sistema sanitario público de andalucía: hospital virgen de valme y hospital costa del sol. Ejercicio 2008 (OE/04/2009). Sevilla. file:///E:/usuario/Downloads/analisis-comparativo-de-la-actividad-realizada-por-dos-hospitales-del-sistema-sanitario-publico-de%20 (3).pdf, [accessed 17.06.2016].
[41] IASIST. Evaluación de la eficiencia y calidad científico-técnica de los hospitales en españa según su modelo de gestión 2007. Available at: www.iasist.com/es/recursos/ [accessed 15.10.2009].
[42] Arias A., C. Illa, C. Sais y M Casas . Evaluación de la eficiencia y calidad científico-técnica de los hospitales en España según su modelo de gestión. A Coruña: XXVII Jornadas de Economía de la Salud: el buen gobierno de la sanidad; 2007.
[43] Sanchez-Bayle M. & M. Martin. Nuevas formas de gestión: las fundaciones sanitarias en galicia. Fundación Alternativas 2004; n 43.