

# **Scale Efficiency of Public Hospital: A Content Analysis of 20 Years of Research**

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*In many countries, the hospital sector has been involved in a massive reform process marked by financial restructuring of existing hospitals, mergers and closures of several small hospitals. The opportunity to measure scale efficiency is crucial to address the question of optimal productive size and to manage a fair allocation of resources. This paper analyzes the stance of existing research on scale efficiency in public hospital sector. We focus on five research questions: (1) who has published most studies and which are their most influential papers; (2) what is the intellectual structure of research field; (3) what is the time evolution of research on scale efficiency of public hospital; (4) which are the future pathways in the research field. The search is divided in two main parties: in the first one – presented in this paper - we performed a content analysis of 20 past years (1994 – 2014) of research published into peer-reviewed scientific journals recorded by the Social Sciences Citation Index (SSCI), about this topic. The second part of the research will be aimed at elaborating a map showing most explored issues and future pathways of research field on scale efficiency of public hospitals. The result show that most of the studies was focused on the analysis of technical efficiency, or on the input / output ratio, through the use of Data envelopment analysis (DEA). We also find an increasing interest about the impact of possible changes in hospital size on quality of care. Our research provides several contributions for both research and practice. Identifying most contributing papers and authors we provide to young researchers a valuable starting point for understanding discipline main actors and their belonging to research streams.*

**Field of Research:** Accounting

## **1. Introduction**

The purpose of this paper is to illustrate the stance of existing research on scale efficiency in public hospital sector. We performed a content analysis of 20 past years of research published into peer-reviewed scientific journals recorded by the Social Sciences Citation Index (SSCI).

A literature review may be appropriate if a topic is widely researched and last review efforts have resulted in findings not completely covering the field (Short, 2009). In particular, literature reviews are useful for different purposes (Eisenhardt, 1989; Tahai & Meyer, 1999; Margolis & Walsh, 2003): to evaluate influence of various journal (Baumgartener & Pieters, 2003), to consider scientific impact of different publications (Van Dalen & Henkens, 2000), to learn about the intellectual structure of research field (Loche & Perera, 2000; Hill & Carley, 1999), to suggest possible future development of a particular topic.

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The aim of this paper is to assess the state of the research field, to reveal its internal subfields and to provide some conclusions about further developments in the research areas. Our contribution is to provide an instructional map which shows on one side, most discussed topics and, on the other side, fields still little explored or unexplored. More specifically, we focus on three research questions: (1) *who has published most studies on scale efficiency of public hospital and which are their most influential papers*; (2) *which is the intellectual structure of scale efficiency research in public hospitals, in order to identify internal subfield and their relations*; (3) *what is the time evolution of research on scale efficiency of public hospital*; (5) *which are the future pathways in the research field*.

Our paper departs from recent literature reviews of the scale efficiency of public hospital, such as Asmild et al (2013), and Kristensen et al (2012). The rationale for citing a reference could vary considerably, ranging from supporting to disapproving it (Nerur, Rasheed, & Natarajan, 2008). Therefore, we used a map of keywords. It permits to classify articles according to the covered issues (Furrer, Thomas, & Goussevskaia, 2008). To the best of our knowledge, this is the first systematic attempt to make this type of study also within the field of scale efficiency of public hospital. However, we coded all the papers to allocate each one in macro keywords (Furrer et al, 2008). To better understand factors that influenced the structure of the field, we identified most contributing authors, most influential articles and most relevant journal of articles collection. Finally, we identified most question explored. Results provide contributions for researchers and policy makers. Identifying most contributing papers and authors we provide to young researchers a valuable starting point for understanding discipline main actors and their belonging to research streams.

Researcher and policy maker could deepen knowledge on the topics in order to address the future hospital containment strategy. The rest of the paper is organized as follows. We present an overview of the importance of scale efficiency in public hospitals in section 2 and the method in 3. We illustrate our findings in section 4 and conclusion in section 5.

## 2. Literature Review

Healthcare organizations are required to achieve efficiency and effectiveness: they have to reduce costs and to offer quality health services (Kounetas, Papathanassopoulos, 2013). For this reasons, in many countries, the hospital sector has been involved in a massive reform process marked by financial restructuring of existing hospitals, mergers and closures of several small hospitals (Kristensen et al, 2008).

In this context, the opportunity to measure scale efficiency it's so crucial to address the question of the optimal productive size and to manage a fair allocation of resources hospitals to increase hospital's performance (O' Donnell, Nguyen, 2013; Kristensen et al, 2008; Preyra, Pink, 2006; Nguyen et al, 2005). Scale effects are potentially particularly relevant for hospital efficiency, given the nature of the production process (Cowing and Holtman, 1983), but the question about scale efficiency is whether larger hospitals are more or less efficient than smaller ones.

Some studies shows that, on the one hand, hospitals require large investments in capital such as buildings, equipment and specialized staff, which may make it more efficient to have one large hospital rather than two small ones. On the other hand, hospitals are complex organizations to manage, and at some point a smaller hospital may run more smoothly than a larger one (Weaver et al, 2004).

Also, there are many sources of potential economies of scale in hospitals. Some are related to capital (Dranove, 1998), for example the more efficient use of massed reserves, such as technology. Such production factors are often used more as a hospital grows, leading to economies of scale with larger hospitals potentially benefitting in efficiency terms.

However, some activities, such as labor use, may have few fixed costs to 'spread' as capacity increases, potentially leading to decreasing scale returns; that is smaller units may hold the advantage, because of potential co-ordination and congestion problems as a hospital increases in size (Asmild et al, 2013). Scale efficiency represents a tool to increase hospital's performance and constitutes the basic means of audit and rational distribution of human and economic resources (Athanasopoulos et al, 1999).

### 3. Methodology

#### 3.1 Literature Identification

Our investigation begins by identifying all relevant papers in the field of scale efficiency of public hospital. This has required definition of a series of aspects concerning the findings process, as illustrated below. Firstly, the choice of the database from which to find papers.

We chose SSCI database (Social Science Citation Index), incorporated in the Web of Science Internet library source, as most used in bibliometric studies (Ramos-Rodríguez & Ruiz-Navarro, 2004) by covering almost 3.000 world's leading journals of social sciences across more than 55 disciplines. Secondly, the definition of temporal extension of analysis and of criteria for articles selection.

Coherently with the development of research field, we have considered literatures production about this topic of the last 20 years (1994-2014) published on international journals in English language with impact factor (Fetscherin, Voss, & Gugler, 2010). The search covers only papers published into international scientific journals, as they are considered 'certified knowledge' with peer review (Fernandez-alles & Ramos-Rodríguez, 2009).

Moreover as scale efficiency is a multidisciplinary research, we selected articles from different research areas ("Health care science services", "Business", "Economics", "Mathematics", "Management", "Public administration", "Medical informatics"). Then, differently from the traditional approach, we have not chosen a sample of journals according to the topic.

We have extracted papers by the SSCI database, using in a crossed way 3 keywords related to scale efficiency (*scale efficiency*, *technical efficiency*, *optimal size*) as most used in articles focused on this topic, and 2 keywords about the healthcare setting (*Hospital*, *Healthcare organization*), using Boolean operator AND (All indexed records containing both search terms), to identify all relevant papers in the field, and to classify articles according to the covered issue. Using these keywords, the search on the database has been extended to title, keywords and abstracts (topics range). The initial record had a total of 989 articles (Table 1).

**Table 1: Initial record**

Keywords	<i>Hospital</i>	<i>Healthcare organization</i>
<i>Scale efficiency</i>	403	62
<i>Technical efficiency</i>	323	53
<i>Optimal size</i>	147	1
Total number	873	116

This large number is not surprising given the general nature of search. Anyway, it is common in review articles to find a large number of records in first rounds of searching (Bakker, 2010).

**3.2 Literature Selections**

There were many articles not properly related to the topic and then we needed a selection process. We have analyzed titles and abstracts, in order to identify relevant work or not with the topic of scale efficiency in public hospitals.

According to objective of our investigation, we have applied two others criterions of selection: we have selected papers about scale efficiency only when analysis is conducted with reference to public hospitals; papers about technical efficiency are excluded when investigation is not finalized to evaluate an optimal dimension of hospital, or when the investigation is not extending to scale efficiency.

At this point, it's necessary to make specific distinctions between the concept of “*technical efficiency*” and “*scale efficiency*”. Technical efficiency is a concept that aims to evaluate whether a productive unit is using minimum possible of resources.

**Tables 2: Articles collection. First selection**

Keywords	<i>Hospital</i>	Selected articles	Excluded articles
<i>Scale efficiency</i>	403	56	347
<i>Technical efficiency</i>	323	48	275
<i>Optimal size</i>	147	10	137
Keywords	<i>Healthcare Organization</i>	Selected articles	Excluded articles
<i>Scale efficiency</i>	62	3	59
<i>Technical efficiency</i>	53	0	53
<i>Optimal size</i>	1	0	1
Total number	989	117	872

Evaluation is achieved through the relationship between input (hospital beds, hours of work for physician, etc) and output (number of ordinary admissions, medical outpatient, etc.).

One productive unit it's so much more efficient (in technical sense) how much higher it's this relation. Differently, scale efficiency is a concept regarding operational scale, in other words the dimension of hospital productive unit. One inadequate technical efficiency score might depend on an operational scale wrong (too large or too small). In this case, it's necessary to address the question of “economies/diseconomies of scale”. Increasing the size of hospital

unit, the product increases more than double or more than triple, and unit production costs decrease.

**Table 3: Articles collection. Second selection**

	No. Initial selection	Number	Number
Keywords	<i>Hospital</i>	<i>Selected</i>	<i>Excluded</i>
Scale efficiency	56	40	16
Technical efficiency	48	23	25
Optimal size	10	7	3
Keywords	<i>Healthcare Organization</i>	<i>Selected</i>	<i>Excluded</i>
Scale efficiency	3	3	-
Technical efficiency	-	-	-
Optimal size	-	-	-
Total Number	117	73	44

Achieved a given size, start to occur diseconomies of scale: an additional increase in the available resources produces less than proportional increases of the product and, consequently, the unit cost of production increases.

In conclusion, optimal size it's that for which have already been exploited all economies of scale and diseconomies are not submitted. In other words, is dimension which allows obtaining simultaneously maximum number of admissions for bed, and maximum number of hospitalizations for medical. For this characteristic to maximize the productivity of all available, optimal size is defined as the "Most Productive Scale Size" (MPSS).

According to this rule, we have selected 117 papers and we have excluded 872 papers (Tables 2). Of 117 articles, we included only those journals with the Thomson Reuters Impact Factor published in 2013, as a proxy of the influence of publications. According to this rule, we cleared 44 papers (Table 3). At last, the final list consisted of 73 articles published in 28 journals.

### 3.3 Coding Process

We coded all the papers to allocate each one in macro-keywords (Furrer et al, 2008). The process of coding and the creation of a list of new keywords were necessary for two reason. First, the collection had a large number of individual keywords. Second, there were some papers without keywords (13 articles of 73).

We draft a list of major keywords (Table 4) and then we grouped them into macro-keywords, leading to a final list of 18 macro – keywords: 17 active variables, 1 illustrative variables. The matching was carried out considering at the same time the content of the abstract, the keywords and the body of the article (Furrer et al, 2008). At the end, on average, each paper presented 3,5 keywords and this justify the use of multivariate approach to data analysis.

**Table 4: Keywords Categories**

<u>Active variables</u>	
1) Hospital organization	<i>Organizational efficiency, Hierarchical Organization</i>
2) Dea analysis	<i>Panel data, Non parametric analysis, Cross efficiency, Boodstrapped dea</i>
3) Hospital mergers	<i>Agglomeration economies, Hospital mergers, Economies of diversification, Multiproduct firms, Hospital closure, Economies of scope</i>
4) Technical efficiency	<i>Hospital productivity, Quasi fixed input, Total factor productivity, Allocative efficiency, Undesiderable output</i>
5) Quality of care	<i>Quality, Clinical efficiency, Hospital specialization</i>
6) Hospital management	<i>Ownership forms, Health administration, Managed care, Policy, Decision analysis</i>
7) Hospital prices	<i>Implicit price, Payment system, Efficient prices, Single payer, Shadow prices</i>
8) Hospital cost	<i>Cost efficiency, Cost function, Hospital cost structure, Shadow cost model</i>
9) SFA	<i>Stochastic frontier analysis, Parametric analysis</i>
10) Hospital environment	<i>Competition, Geographic markets, Market Concentration, Benchmarking</i>
11) Physician analysis	<i>Physician behavior, Physician Profile, Report card</i>
12) Technology impact	<i>Technological efficiency, Production technology, Technology changes</i>
13) Hospital size	<i>Smaller hospital, Larger hospital, Size inefficiency, Optimal hospital size, Scale efficiency, Return to scale, Structural inefficiency</i>
14) Translog cost function	<i>Translog cost function, Translog</i>
15) Malmquist index	<i>Malmquist index, Total factor productivity, Distance function</i>
16) Tobit analysis	<i>Tobit analysis, Tobit regression, Censored regression model</i>
17) Beds capacity	<i>Excess bed capacity</i>
<u>Illustrative variable</u>	
18) Non profit organizations	<i>Non profit organization as research setting</i>

## 4. Findings

In this section we aim to provide answers to questions raised in Section 1.

### 4.1 Most Relevant Authors, Papers and Journals of the Field

To better understand factors that influenced the structure of the field, we identified most contributing authors, most influential articles and most relevant journal of articles collection.

### 4.2. Most Contributing Authors

We identified authors whose articles have appeared most frequently in our collection (Table 5). 176 authors have written the articles of our collection. Twelve of them have more than

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one paper in our database. According to Furrer et al. (2008) we identified two measures to rank authors: total number of published papers (i.e. total number of appearances) and the adjusted number of appearances.

The latter considers the co-authorship phenomena and it is the amount of published articles weighted by a score assigned to each paper (1 in case of only one author, 0,5 in case of two authors, 0,33 in case of three, and so on).

**Table 5: Most relevant authors**

<i>Authors</i>	<i>Total appearances</i>	<i>Adjusted appearances</i>	<i>Total Global Citation Score</i>
1 Hollingsworth B	2	1,33	85
2 Mobley LR	2	1	32
3 Ferrier GD	2	0,83	3
4 Nayar P	2	0,75	22
5 Ozcan YA	2	0,75	22

First 3 most influential authors of collection are: Hollingsworth B, Mobley LR, and Ferrier GD. TGCS (Total Global Citation Score) show a the total number of citations to a paper in Web of Science. Hollingsworth Bruce is the most contributing writer. His focus is the measurement of efficiency and productivity in health care sector: he investigates about scale efficiency and optimal size of hospitals. Also, his contribution is among the most recent (2008, 2013).

Mobley LR analyses productive efficiency of Norwegian hospitals and discuss the problem of differences about hospital size. He uses Data Envelopment Analysis (DEA) to estimate efficiency measures across groups of hospitals. He fined that scale and scope regulation of Norwegian hospitals improves long-run efficiency, primarily due to better utilization of capital.

Finally, Ferrier GD instead makes studies about technical and structural efficiency of hospitals. In his works, Tobit analysis is used to assess possible correlates among costs, technical, allocative and scale efficiencies. These specialist authors are relevant because they could have an influence on the research evolution, providing new insights in the specific field (Furrer et al, 2008).

### 4.2.1 Most Influential Paper

Besides author's analysis, we identified also most influential articles in our collection. We ranked papers according the number of citations in the SSCI citation data files between 1984 and 2014. Due to their impact, most cited articles should assume key roles in the evolution and development of a field (Bergh, Perry, & Hanke, 2006; Furrer et al., 2008). In table 6 we ordered the first three influential papers according to total number of citations per year, undoing the time effect (Furrer et al., 2008). It provides the most relevant articles.

Table 6: Most Influential Papers

Rank	Authors	Article	Global Citation Score	Citation Index
1	Hollingsworth B, 2008	<i>The Measurement of efficiency and productivity of Health Care Delivery</i>	85	14,3
2	Barbetta GP, Turati G, Zago AM., 2007	<i>Behavioral differences between public and private not-for-profit hospitals in the Italian National Health Service</i>	28	4,15
3	Herr A, 2008	<i>Cost and technical efficiency of German hospitals: Does ownership matter?</i>	23	4

Most of articles were published after 2000. This finding is in line with the observation of increasing publications in this field. The three most cited papers are: Hollingsworth Bruce (2008), Barbetta et al (2007) and Herr A (2008). Hollingsworth Bruce (2008) was published on *Health Economics*. He presents a review of 317 published papers on frontier efficiency measurement. The techniques used are mainly based on nonparametric data envelopment analysis, but there is increasing use of parametric techniques, such as stochastic frontier analysis. Applications to hospitals and other health care organizations and areas are reviewed and summarized, and some meta-type analysis undertaken. Cautious conclusions are that public provision may be potentially more efficient than private, in certain settings. The paper also considers conceptualizations of efficiency, and points to dangers and opportunities in generating such information. Finally, some criteria for assessing the use and usefulness of efficiency studies are established, with a view to helping both researchers and those assessing whether or not to act upon published results.

The second most cited paper is Barbetta et al (2007) and it appeared on *Health Economics*. Papers aims to identify behavioral differences between public and private not-for-profit hospitals, by exploiting the introduction of the DRG-based payment system in the Italian NHS during the second half of the 1990s. The introduction of the new payment system was aimed at increasing producers' efficiency, and thus controlling public spending growth. Technical and scale efficiency of hospitals is assess considering an output distance function, and adopting both parametric (COLS and SF) and nonparametric (DEA) approaches. Results show a convergence of mean efficiency scores between not-for-profit and public hospitals, and seem to suggest that differences in economic performances between competing ownership forms are more the result of the institutional settings in which they operate than the effect of the incentive structures embedded in the different proprietary forms.

Finally, Herr A (2008) is published on *Health Economics*, and is the first paper to examine the cost and technical efficiency of German general hospitals and its variation with type of ownership, location, and patients' characteristics. More specifically, it deals with the question how hospital efficiency varies with ownership, patient structure, and other exogenous factors, which are neither inputs to nor outputs of the production process. Results for the years from 2001 to 2003 indicate that private and non-profit hospitals are on average less cost efficient and less technically efficient than publicly owned hospitals. Conducting a Stochastic Frontier Analysis assuming both Cobb–Douglas and Translog

production technologies and using a newly available and multifaceted administrative German data set derives results.

#### 4.2.2 Most Relevant Journals

Dataset articles have appeared in 28 journals. “Health Care Management Science”, “Applied Economics”, “European Journal of Operational Research”, “Health Economics”, “Journal of Productivity Analysis”, e “Journal of Medical Systems” are the most relevant journals (Table 7).

**Table 7: Most influential Journals**

<i>Rank</i>	<i>Journal</i>	<i>IF</i>	<i>N. of articles</i>
1	<i>Health Care Management Science</i>	0,705	9
2	<i>Applied Economics</i>	0,469	7
3	<i>European Journal of Operational Research</i>	2,038	7
4	<i>Health Economics</i>	3,028	7
5	<i>Journal of Productivity Analysis</i>	1,068	7
6	<i>Journal of Medical Systems</i>	1,783	6

#### 4.3 Structure of the Field

Table 8 reports how papers are distributed among keywords. Most questions explored are: *Technical efficiency*, *Quality of care*, *Hospital mergers* and *Hospital size*.

*Technical efficiency* is the most frequent keyword with 44 articles, followed by *Dea analysis* with 42 articles, *Quality of care* with 27 articles, *Hospital mergers* and *hospital size* with 22 articles and *Hospital cost* with 14 articles. It’s not surprising to find articles developed in non-profit organizations, due the field and objective of our analysis.

Most of the studies is therefore focused on the analysis of *technical efficiency*, or on the input / output ratio, through the use of *Dea analysis*. *Data envelopment analysis* (DEA) is a non parametric method in operations research and economics for the estimation of production frontiers. It is used to empirically measure productive efficiency of decision-making units. 27 articles explore about the relationship between *proper use of resources* and *quality of care*.

44 articles explore about *Hospital mergers* and *Hospital size*. In many countries, the hospital sector has been involved in a massive reform process marked by financial restructuring of existing hospitals, mergers and closures of several small hospitals (Kristensen et al, 2008). In this context, the opportunity to measure scale efficiency it’s so crucial to address the question of the optimal productive size and to manage a fair allocation of resources hospitals to increase hospital’s performance (O’ Donnell, Nguyen, 2013; Kristensen et al, 2008; Preyra, Pink, 2006; Nguyen et al, 2005).

**Table 8: Number of paper for keyword**

Keywords	Number of articles
<i>Technical efficiency</i>	44
<i>Dea analysis</i>	42
<i>Quality of care</i>	27
<i>Hospital mergers</i>	22
<i>Hospital size</i>	22
<i>Hospital cost</i>	14
<i>Non profit organization</i>	14
<i>Hospital management</i>	10
<i>Stochastic frontier analysis</i>	9
<i>Hospital environment</i>	6
<i>Malmquist index</i>	5
<i>Hospital organization</i>	5
<i>Hospital prices</i>	5
<i>Technology impact</i>	4
<i>Translog cost function</i>	2
<i>Tobit analysis</i>	2
<i>Beds capacity</i>	1
<i>Physician analysis</i>	1

#### 4.4 Evolution of the Field and Future Pathways

Once described the structure of the field we aim to enlighten its evolution. We divided the sample period of 20 years into sub-periods, to observe the papers and keywords' distribution over time. Our purpose was not to pick out significant periods but only register changes.

Therefore following Furrer et al. (2008), and Ramos-Rodríguez and Ruíz-Navarro (2004) we opted to divide the study period into three sub-periods (1995-2000, 2001-2007 and 2008-2013). By table 9, we evidence that while there is strong growth of numbers of papers from the first (19) to the second sub-period (20), then the growth rate is lower (34 papers in the third sub-period). Table 2 also shows the number of articles per keywords for each sub-period. Keywords with increasing relevance are DEA analysis, technical efficiency and quality of care. Most of studies use DEA analysis to determining technical efficiency. We observe, also, in recent years, an increasing interest about the impact of possible changes in hospital size on quality of care. Instead, important keywords with decreasing relevance are Beds Capacity.

Our paper was a first step of a research aimed to estimate optimal number of beds in hospital sector. None study has been able to answer the following question: *what is the optimal number of hospital beds which allows maximum exploitation of economies of scale?* We suggest, in this regard, to increase research and to investigate about this aspect. This is an important question to improve hospital performance.

**Table 9: Temporal distribution of articles for macro keywords**

Keywords	1995 – 2000	2001 – 2007	2008 - 2013
Number of Articles	19	20	34
<i>Dea analysis</i>	10	10	22
<i>Technical efficiency</i>	9	13	22
<i>Quality of care</i>	3	5	19
<i>Hospital mergers</i>	5	1	16
<i>Hospital size</i>	5	8	9
<i>Hospital cost</i>	4	5	5
<i>Non profit organization</i>	3	5	6
<i>Hospital management</i>	2	3	5
<i>Stochastic frontier analysis</i>	3	2	4
<i>Hospital environment</i>	2	2	2
<i>Malmquist index</i>	0	1	4
<i>Hospital organization</i>	2	1	2
<i>Hospital prices</i>	0	3	2
<i>Technology impact</i>	1	1	2
<i>Translog cost function</i>	1	0	1
<i>Tobit analysis</i>	0	0	2
<i>Beds capacity</i>	1	0	0
<i>Physician analysis</i>	1	0	0

## 5. Conclusions

Our research provides several contributions for both research and practice. Identifying most contributing papers and authors provides to young researchers a valuable starting point for understanding discipline main actors and their belonging to research streams. From a practical point of view, instead, practitioners could find a guide to deepen most analyzed topics, their conceptual bases, and to identify elements that deserve special attention.

However, paper presents some limitations. First, we used only ISI web of knowledge database. In the future we are going to perform a multiple correspondence analysis (MCA) in order to analyze the relationship between keywords and papers. The output of the statistical analysis will be a *keywords map* useful to understand the structure of the field. The map will allow to identify most and little explored issues and future pathways of research field on scale efficiency of public hospitals.

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