Health Care Manag Sci (2011) 14:22–35
DOI 10.1007/s10729-010-9139-2

Efficiency and quality of care in nursing homes: an Italian case study

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Received: 7 May 2010 / Accepted: 22 September 2010 / Published online: 5 October 2010

Abstract This study investigates efficiency and quality of care in nursing homes. By means of Data Envelopment Analysis (DEA), the efficiency of 40 nursing homes that deliver their services in the north-western area of the Lombardy Region was assessed over a 3-year period (2005–2007). Lombardy is a very peculiar setting, since it is the only Region in Italy where the healthcare industry is organised as a quasi-market, in which the public authority buys health and nursing services from independent providers—establishing a reimbursement system for this purpose. The analysis is conducted by generating bootstrapped DEA efficiency scores for each nursing home (stage one), then regressing those scores on explanatory variables (stage two). Our DEA model employed two input (i.e. costs for health and nursing services and costs for residential services) and three output variables (case mix, extra nursing hours and residential charges). In the second-stage analysis, Tobit regressions and the Kruskall–Wallis tests of hypothesis to the efficiency scores were applied to define what are the factors that affect efficiency: (a) the ownership (private nursing houses outperform their public counterparts); and (b) the capability to implement strategies for labour cost and nursing costs containment, since the efficiency heavily depends upon the alignment of the costs to the public reimbursement system. Lastly, even though the public institutions are less efficient than the private ones, the results suggest that public nursing homes are moving towards their private counterparts, and thus competition is benefiting efficiency.

Keywords Efficiency · Quality · Data envelopment analysis · Nursing homes

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1 Introduction

Efficiency and quality of care in nursing homes is a growing concern in many industrialised Countries [1]. Ageing of population is substantially changing healthcare needs since an increasing number of citizens will require long-term care in the upcoming decade. This change has promoted a sense of urgency to extend our knowledge on the factors that affect the efficiency and quality of care in hospitals to the new context of nursing homes. Despite that, even a cursory review would identify that several studies have already investigated the various factors, such as size, ownership, staffing, reimbursement system and other policy interventions, may influence the efficiency and quality of care in nursing homes. These studies have applied different approaches to investigate the capability of nursing homes to deliver high quality and efficient care to residents, like as the Data Envelopment Analysis [2–4], the Stochastic Frontier Analysis [5–7], and the Bayesian Networks [1]. Contributions have also discussed how the structure of the health and social care system may affect efficiency and quality of care in nursing homes, with particular emphasis on the role of competition [8, 9].

Despite this body of evidence, there are two important puzzles that endure in the literature. First, scholars of productivity and operations analysis are still debating which

measures should be preferred to take into account the multidimensional nature of quality of care in nursing homes. A very recent contribution by Goodson and Jang [1] on *Health Care Management Science* proposed a survey of the most influential collections of measures for quality of care in nursing homes and acknowledged that the debate is still ongoing. The second puzzle deals with the difficulties to enable healthcare regulators to perform routine assessments of efficiency, particularly in those situations where resources, in terms of people and/or data, necessary to perform assessment are limited. In fact, many studies collected data through surveys to nursing homes to complete the missing information in the regulator's databases [10]. This issue is particularly intriguing for scholars of productivity and operations analysis who aim at having a concrete impact on decision makers and practitioners.

Our research addresses these puzzles, offering new elements for discussion by assessing the efficiency and quality of care in a peculiar sample of nursing homes within the Lombardy Region in Italy through a *Data Envelopment Analysis* (DEA). This research locus may be interesting for a wider audience for at least four reasons. First, the nursing homes deliver their services in a quasi market [11], since Lombardy is the only Italian Region that, contrarily to the other Regions, has implemented "managed competition" mechanisms to increase the efficiency and effectiveness of nursing homes. In fact, while the public reimbursement covers only the health and nursing services to a maximum of 901 min/week per resident, the cost for care that exceeds that maximum plus all residential services are paid by residents. Second, any Local Health territory within the Lombardy Region has peculiar contingencies that limits the possibility of data pooling for benchmarking and efficiency analysis. Each Local Health territory limited the assessment of performance to the nursing homes that deliver services within that specific area. Thus the sample of nursing homes that can be benchmarked is generally small. Third, the local healthcare regulator lacks longitudinal and reliable data about outcome-based quality indicators. The databases include mainly financial information about revenues and costs. Other information that is available are about the amount of monthly hours of care and the severity of any residents. Four, the sample of nursing homes has experimented negative financial performances during the last years, since costs for care and residential services largely exceed public and out-of-pocket payments, and the financial viability of the system is not taken for granted. Because of this, the healthcare regulator is dramatically interested to develop and adopt methodologically-rigorous and constraints-compliant assessments of nursing homes to support the policy making exercise.

The reminder of the article is structured as follows. A literature review about the measures that have been employed in DEA studies to take into account quality of care in nursing homes is provided in Section 2. Section 3 details the peculiar research locus of Lombardy Region, the sample of nursing homes and collected data. Section 4 presents the main results of our study. A discussion of the main implications is in Section 5, followed by concluding remarks in Section 6.

2 Literature review

Quality of care in nursing home is a relevant concern for decision makers [12]. Previous research has employed various measures in the attempt to take into account the tradeoff between efficiency and quality of care [5–7]. Different taxonomies have been proposed to classify the measures and help both academicians and practitioners to orientate themselves in this field [1, 13]. In their recent contribution on *Health Care Management Science*, Goodson and Jang [1:383] remarked that "factors influencing the quality of nursing home care delivery typically fall into one of Donabedian's [14] three aspects of quality of care assessment: Structure, Process, and Outcome measures (SPO framework)". Then, the authors detailed some relevant models that advanced our understanding about the measures of quality of care in nursing homes. They also acknowledged that the model developed by the Center for Health Systems Research and Analysis (CHRA) [15] had been largely employed. This model includes several quality indicators that can be easily referred and grouped according to the SPO framework.

Grounding in the previous claims, we agree that the SPO framework is an useful taxonomy for collecting the measures for quality of care in nursing homes. We also believe that healthcare regulators should collect data about all the three aspects of the SPO framework to achieve a comprehensive overview of the quality of care in nursing homes. Despite that, this claim may be difficultly actionable in those situations where the healthcare regulators have limited information about the Process and Outcome measures, and can leverage mainly on Structure measures. For example, Cheesteen et al. [10] measured quality of care in nursing homes with deficiencies respect to the federally imposed standard, since these raw data were more available and reliable.

With this regard, we performed a literature review aimed at collecting those DEA studies that taken into account measures of quality care in the peculiar context of nursing homes. This review is not intended to provided an exhaustive review of such models. Rather, it offers a survey of contributions that may help to understand which of the three aspects of the SPO framework had been more employed within the assessment exercises. However, relevant studies about the efficiency and quality trade-off

(such as Laine et al. [5–7]) are not included since they did not apply a DEA model. For a more extensive review about quality of care in nursing homes, Saintfort et al. [13], Goodson and Jang [1], and Shimshak et al. [2] may be useful references.

Six DEA studies that employed measures of quality of care have been identified in the literature. The large body of DEA studies in nursing homes limited the analysis to efficiency, overlooking the quality performance. The six studies are detailed briefly in the followings, remarking which measures were employed for taking quality of care into account. These measures will be referred to the SPO framework. Contributions will be presented chronologically to make clear the trend of inclusion/exclusion of measures of quality of care within the DEA studies (Table 1).

In 1989, Nyman and Bricker [16] assessed a sample of 184 nursing homes in Wisconsin (US) in order to identify which factors may explain an efficient nursing home. The authors employed some measures of quality of care only in the second stage of their analysis. The regression analysis included the numbers of deficiencies respect to the federally imposed standard (i.e. a Process-related measure of quality of care) and the average number of empty beds (i.e. a Structure-related measure of quality of care).

In 1994, Kooreman [17] assessed the efficiency of 292 Dutch nursing homes by means of DEA. He implemented a two-stage analysis in order to understand the determinants of efficiency. The DEA scores were investigated using censored regression analysis. Kooreman employed four Process-related variables that are related to quality of care in the regression analysis: the presence of a patients' council, the presence a council of patients' relatives, the presence of a procedure to handle complaints and the presence of unrestricted visiting hours. The author claimed that these measures capture the orientation of nursing homes towards residents' needs. None of the measures is included in the taxonomy proposed by Goodson and Jang [1].

In 2003, Anderson et al. [18] assessed the efficiency of 487 nursing homes in Florida (US). The authors claimed that their study was the first to include measures of quality of care explicitly. Despite that, they employed as measure the multidimensional Medicare/Medicaid synthetic score of quality of care (http://www.medicare.gov/NHCompare/static/tabHelp.asp?activeTab=6). This measure was built on the results of inspections required for all facilities that receive Medicaid or Medicare reimbursement. This kind of measure has been employed both in DEA and non-DEA studies about efficiency and quality of care in nursing homes, moreover in those situations where data about outcome were not available or enough reliable (e.g. Lee et al. [3], Zhang et al. [4], Cheesteen et al. [10]).

In 2008, Zhang et al. [4] assessed 8,361 nursing homes in the US. The authors recommended that efficiency scores should be adjusted to take into account the quality of care. Quality was measured negatively by the summation of all deficiency citations, including clinical, administrative, resident rights, and physical environment. "Deficiencies were preferred because deficiencies are a more comprehensive indicator of quality of care" [4:1049].

In 2009, Shimshak et al. [2] published an efficiency assessment of 38 homes, all located in Massachusetts (US) and all having 90 or more total beds. The authors claimed that measures of quality of care are critical in assessment studies in nursing homes by means of DEA. They employed three Process/Outcome measures: the number of residents without a catheter, or without restraints or without pressure sores.

Finally, in 2009 Lee et al. [3] assessed the efficiency of a stratified random sample of 107 nursing homes from Kansas and Missouri (US) with at least 50 beds. Again, quality of care has been modeled as the planning deficiencies. They referred to failures to do comprehensive assessments, failures to do timely assessments, failures to review assessments, failures to do comprehensive care plans, failures to have interdisciplinary teams, failures to have qualified team members, and failures to execute the care plan. These Process-related measures of quality of care were selected since they were available in the federal databases.

The review of the above reported studies identifies three main results. First, the number of DEA studies in nursing homes that included measures of quality of care either in the DEA model or in the second stage regression analysis is very limited. Second, quality of care has been modelled mainly with Process measures. In particular, authors have preferred deficiencies respect to the regulators' standards as measure of quality of care. The most reported reason is the lack of reliable data in regulators' databases with respect to Outcome-related measures. This finding implies the need to improve the quality and richness of the sources of data for efficiency assessment in nursing homes. Despite the relevance of making long-term care affordable over the next decade, the empirical basis for evidence-based assessments seems to be limited. Third, quality of care has been mainly referred to care and nursing activities. Less is understood about the role that residential services (such as meals, laundry and cleaning) may play on quality of care and customer satisfaction. Kooreman [17] took in account the existence of a procedure for complaints management as a measure of quality as a proxy of customer-orientation. With this regards, Cheesteen et al. [10] invited scholars of productivity and operations analysis to develop and include measures that may capture customer satisfaction in their analysis of efficiency and quality of care in nursing homes. The authors remarked that this is particularly relevant for those studies that employed mainly Structure- or Process-related measures of quality of care.

Table 1 SPO framework and quality variables

		Aspects of the SPO framework	Nyman and Bricker [16]	Kooreman [17]	Anderson et al. [18]	Zhang et al. [4]	Lee et al. [3]	Shimshack et al. [2]
Measures proposed by Goodson and Jang (1)								
1	The overall quality of care as determined by the total observable indicators of nursing home care quality instrument	All						
2	Number of beds in a facility Structure	Structure						
3	Number of beds occupied in a facility	Structure						
4	Indicates whether or not a facility accepts Medicare residents	Structure	X					
5	Indicates whether or not a facility is part of a nursing home chain	Structure						
6	The number of registered nurse hours per resident day	Structure						
7	The number of certified nurse assistant hours per resident day	Structure						
8	The number of total staff hours per resident day	Structure						
9	Indicates for-profit (FP) facilities	Structure						
10	Indicates not-for-profit (NP) facilities	Structure						
11	Indicates government (GOV) facilities	Structure						
12	The number of deficiencies issued to a facility	Process	X		X	X	X	
13	Prevalence of indwelling catheters	Process						X
14	Prevalence of tube feeding	Process						
15	Prevalence of antipsychotic use, in the absence of psychotic and related conditions	Process						
16	Prevalence of anti-anxiety/hypnotic use	Process						
17	Prevalence of hypnotic use more than two times in last week	Process						
18	Prevalence of daily physical restraints	Process						X
19	Prevalence of little or no activity	Process						
20	Prevalence of any injury	Outcome						
21	Prevalence of falls	Outcome						X
22	Prevalence of behavioral symptoms affecting others	Outcome						
23	Prevalence of diagnosis or symptoms of depression	Outcome						
24	Prevalence of depression with no treatment	Outcome						
25	Use of nine or more different medications	Outcome						
26	Onset of cognitive impairment	Outcome						
27	Prevalence of bladder/bowel incontinence	Outcome						
28	Prevalence of occasional bladder/bowel incontinence without a toileting plan	Outcome						
29	Prevalence of fecal impaction	Outcome						
30	Prevalence of urinary tract infections	Outcome						
31	Prevalence of weight loss	Outcome						
32	Prevalence of dehydration	Outcome						
33	Prevalence of bedfast residents	Outcome						
34	Incidence of decline in late loss activities of daily living	Outcome						
35	Lack of training/skill practice	Outcome						
36	Prevalence of stage 1–4 pressure ulcers	Outcome						X
Others								
	Patients Council	Process		X				
	Council of patients' relatives	Process		X				
	Procedure for complaints	Process		X				
	Unrestricted visiting hours	Process		X				

3 Methods

3.1 Study design

The present study assessed the efficiency and quality of care in 40 Italian nursing homes. They are all located in the Lombardy Region in the north-western territory of the Milan Local Health Authority (LHA). As stated in the Introduction Section, this research locus may be interesting for a wider audience. In fact, Lombardy is one of the most advanced Regions in Italy and has been committed to improve the efficiency of public services, such as healthcare, during the last years. In particular, the healthcare regulator implemented "managed competition" mechanisms to improve the efficiency and effectiveness of healthcare organisations (e.g. hospitals, nursing homes etc.). The nursing homes in the north-western Milan area experimented negative financial performances during the last years, since costs for care and residential services exceeded public and out-of-pocket payments.

Our study had been conducted in mid 2009 and the analysis covers the years since 2005 to 2007. Data were not pooled, but assessed year by year. The factors that affect the efficiency in nursing homes have been investigated by means of a two-stage analysis, as did by many previous studies (e.g. Ozcan et al. [19], Zhang et al. [4]). A DEA model has been defined in the first stage to generate the efficiency scores. DEA—a nonparametric method—was chosen over Stochastic Frontier Analysis (SFA)—a parametric method—because SFA requires assumptions about the distribution between specific outputs and inputs, which are not well known, and because DEA is commonly used in nursing home studies [4]. A single bootstrap procedure had been implemented to verify the robustness of the traditional DEA scores and to avoid biases on these scores. A Tobit regression analysis and Kruskall–Wallis tests of hypothesis had been made in the second stage to investigate the determinants of efficiency.

Before detailing the measures and the data sources, the Lombardy elderly care system is detailed in the followings. This description is necessary to clarify the development of the model and the choices of the input/output and explanatory measures.

3.2 The Lombardy elderly care system

Nursing home services are paid partly by the Regional Government and partly by the residents with out-of-pocket costs. This happens for those beds for which the nursing homes have stipulated an accreditation contract with the Region, otherwise the residents pay all the received services. Each Region has the autonomy to define the structural and organisational standards that nursing homes must meet for being accredited and defines the reimbursement system.

Lombardy is the only Region in Italy in which the healthcare regulators implemented a quasi-market, in which the Local Health Authorities Plan, Purchase and Control the services delivered by accredited healthcare providers, such as hospitals and nursing homes. The regulator fixed a weekly standard time of care of 901 min per resident and the Regional Government reimburses only this standard to the nursing homes. Residential services, such as meals, laundry and cleaning of the facilities are paid by the residents according to tariffs that the nursing homes can define by their own. This reimbursement structure has been implemented in 2003 to promote competition among the nursing homes in terms of extra hours of care and quality of the residential services. Moreover, the regulator fixes the number of accredited beds that each nursing home may own. The regional reimbursement is based on both the length of stay and the severity of each resident. Severity is measured according to a peculiar scale that has been developed by the Lombardy Region, that is called SOSIA. This scale differs from RUG-III, that is the most common international scale for case-mix classifications (e.g., Laine et al. [5]). The main difference is that RUG-III scale includes also outcome and process quality measures—that are contained in the Resident Assessment Instrument (RAI)—to define the case mix, while the SOSIA scale includes also measures about three main conditions of the patient: mobility, cognitivity, and comorbidity. A score is assigns to each of these conditions in terms of dichotomous level of severity, i.e. moderate vs. severe, by means of specific cut offs. The combinations of the three conditions places the patient in one of eight different SOSIA classes. Each SOSIA class represents an homogeneous group of residents, whose severity is assumed as similar. The eight SOSIA classes ranges from low (class 8) to high severity patients (class 1).

Finally, a standard reimbursement has been defined for each class. With this regard, the healthcare regulator periodically audits the nursing homes in order to control that patients were classified in the right SOSIA class. The main goal is to avoid—or at least to contain—opportunistic behaviours by the nursing homes that could "work the system" to receive higher reimbursements by classifying residents in high severity classes.

3.3 Data sources

Two data sources have been employed for this study: the SOSIA reports and the Nursing Home Reports. The first data source collects all the information that the Local Health Authority (LHA) requires every 3 months from each

nursing home. Information deal with length of stay and severity of each resident. Data about outcomes are mandatory but they are generally modestly reliable. With this regards, this kind of measures could not be employed in this study. The second data source collects annual information about the nursing home, in terms of facility (size, number of rooms, number of bathrooms etc.), staffing (full time equivalent for the different healthcare and social professionals) and economics (i.e. revenues and costs).

Data about deficiencies respect to the regional standards from random audits were incomplete and thus could not be employed in this study.

3.4 The sample of nursing homes

This study is an efficiency analysis in 40 Italian nursing homes. They cover more than 90% of the total number of beds within the north-western territory of the Milan Local Health Authority (LHA). Five more facilities (the remaining 10%) were excluded because the data about them in the LHA databases were largely incomplete and thus unsuitable.

With respect to the 40 facilities, the size varies from 35 to 300 beds, with an average occupancy rate that increased from 92% (2005) to 95% (2007). The sample size is limited, but it is comparable with other previous DEA studies about nursing homes (e.g. Bjorkgreen et al. [9] and Shimshak et al. [2]). The sample consists of 13 small (35–60 beds), 20 medium (61–120 beds) and seven large (over 120 beds) facilities. There are six public and 34 private facilities. Only three of the private nursing homes are profit oriented. Table 2 shows some figures about the sample, as the percentage of extra nursing hours respect to the regional standard, revenues and costs.

3.5 Measures: input/output ratios (stage-one)

The ratio of nursing home outputs over inputs formed the basis for the generation of DEA efficiency scores in the first stage of this analysis. Our analysis covers both the care and nursing activities, and the residential (hotel) services (e.g. meals, laundry, and cleaning). The model consisted of five variables: two inputs and three outputs. They are summarised in Table 3. The total number of variables (i.e. five) was chosen in order to solve the trade-off between the descriptive and the discriminatory power of the model; in fact, it is generally agreed that three times the sum of the inputs and outputs should be less than the number of decision making units [20].

The input variables were: (a) the health and nursing costs and (b) the accommodation costs. These kinds of costs accounted for more than 73% of yearly total costs that were incurred by the nursing homes over the 3 years under analysis. Both the variables have been largely employed input variables in DEA studies about hospitals and nursing homes [18, 19].

In our analysis, the health and nursing costs measured the yearly amount of money employed by the nursing homes for care and nursing activities. These costs included materials for care and nursing activities, and healthcare and social professionals. They accounted for more than 55% of yearly costs. In particular, the cost for labour represented the 90% of these costs. This confirmed that nursing homes are labour intensive organisations. This variable captured also the costs incurred for providing extra hours of care and nursing respect to the regional standard of 901 min/week per resident. About 20% of these costs were for extra nursing hours.

The residential costs measured the yearly amount of money employed by the nursing homes for hotel activities,

Table 2 Sample description

Indicators	Mean (%)			Standard deviation		
	2005	2006	2007	2005	2006	2007
Extra nursing hours	22.55	28.28	29.04	0.208	0.175	0.222
Regional reimbursement revenues	40.90	40.37	40.67	0.061	0.057	0.050
Residential charges revenues	58.27	56.33	57.46	0.062	0.075	0.059
Other revenues	0.83	3.30	1.87	0.018	0.047	0.043
Total health and nursing costs	53.07	54.10	55.06	0.077	0.067	0.072
Standard staff costs	74.24	72.08	72.05	0.117	0.095	0.102
Material supplies costs	9.26	9.05	9.06	0.033	0.032	0.032
Extra nursing staff costs	16.49	18.86	18.89	0.120	0.086	0.096
Residential costs	16.89	17.98	17.65	0.052	0.046	0.038
Other operative costs	25.66	23.66	23.48	0.109	0.092	0.081
Depreciation	4.38	4.26	3.81	0.038	0.034	0.028

Table 3 Summary statistics of input and output values

			Mean	St.dev.	Min	Median	Max
INPUT (€)	Health and nursing costs	2005	1,655,933.11	1,283,714.04	466,008.02	1,187,325.24	6,491,917.00
		2006	1,802,604.37	1,353,498.47	389,269.96	1,225,104.38	6,423,601.00
		2007	1,808,583.78	1,226,476.80	427,936.00	1,432,595.60	6,536,105.00
	Residential Costs	2005	519,842.97	455,537.72	160,071.73	388,818.50	2,430,000.00
		2006	568,861.88	392,999.03	156,633.91	433,952.11	2,167,360.02
		2007	559,272.93	366,319.14	196,370.00	444,333.20	2,095,852.46
OUTPUT (€)	Case-mix	2005	1,212,611.15	873,006.46	318,542.80	967,796.15	4,503,776.50
		2006	1,233,833.12	831,843.69	320,610.80	938,800.30	4,157,542.10
		2007	1,243,010.65	772,061.66	351,083.10	919,875.85	4,051,587.70
	Extra nursing hours	2005	28,667.06	24,296.62	0.00	20,347.22	98,156.72
		2006	29,198.75	20,281.35	240.77	22,979.86	82,831.03
		2007	30,377.12	23,322.60	576.59	21,550.57	96,329.16
	Residential charges	2005	1,661,007.27	1,093,256.77	436,415.49	1,297,169.17	5,087,838.37
		2006	1,721,249.03	1,062,402.94	470,996.17	1,338,505.95	4,670,507.00
		2007	1,789,766.49	1,031,956.00	479,432.00	1,342,365.51	4,500,845.67

such as meals, laundry and cleaning of rooms. These costs accounted for more than 18% of total costs.

For the outputs, we used three different measures: (c) case-mix, (d) extra nursing hours, and (e) out-of pocket charges for residential services. The choice of these variables took into account the contingencies of the Lombardy elderly care system, that has been detailed briefly in the previous section.

Case-mix is a largely employed output measure in both DEA and SFA analyses. In our study, this measure reflected both the regional standard of 901 min/week per patient and the SOSIA system for patient severity. This measure captured the revenues for a nursing home as the products of the length of stay of each resident for the associated SOSIA class.

Quality was measured with two other variables. As described above, the healthcare regulator does not collect data about outcomes and process performance in a systematic way. This limited the possibility to employ Outcome-related or Process-related measures for quality of care according to the SPO framework [1]. In particular, data about deficiencies respect to the regional standards were incomplete and partially reliable. Thus we decided to employ Structure-related measures. These choices are detailed in the followings.

The first measure for quality was built around the concept of extra nursing hours (i.e. the hours of care that exceed the weekly regional standard). We posited that these extra nursing hours were not a mean of inefficiency, but as a proxy of higher quality of care. In fact, the regional standard is generally perceived as too severe by nursing homes administrators. This hypothesis—accepted by practitioners—was supported also by the literature. In fact, previous studies found a positive correlation between quality of care and number of healthcare professionals per patient. In 1977, Linn et al. [21] conducted a study on 1,000 patients who had been discharged from the Veterans Administration Hospital in Florida (US), and who were in 40 different nursing homes. The authors evaluated patients' health at the beginning of their stay and 6 months later. They found that those facilities with more resources per patient achieved better results in terms of outcomes. The followings studies by Gertler [22]—who assessed 455 nursing homes in the State of New York (US)—and by Zinn et al. [23]—who published a study on 383 nursing homes in Pennsylvania (US)—confirmed this result. In 1991, Spector and Takada [24] assessed 80 Rhode Island (US) nursing facilities over a 6 months. Results showed that an higher presence and a lower turnover of healthcare professionals were positively related to patients' higher functional improvements. In 2000, another study [25] on nursing home staff showed that those facilities that had less full time equivalent healthcare professionals per patient were also less able to produce outcome improvements.

Grounding on the previous claims, we decided to measure quality with a variable built around the concept of extra nursing homes, in order to capture the potential capability to deliver a superior quality of care. The extra nursing hours were adjusted by the daily case-mix in order to take into account the specific degree of severity of residents for each nursing home.

Quality was also captured with another variable. Cheesteen et al. [10] invited to measure quality of care also as "customer satisfaction" in those studies that do not employ

Structure- or Process-related measures of quality of care. Since the previous measure of quality of care is Structure-related, we developed a measure for quality of care that was related to customer satisfaction. Residents are obliged to pay for residential (hotel) services, since the regional reimbursement covers also health and nursing costs. The nursing homes are obliged to clarify which residential services are delivered in a Service Charter and which are the relative costs. The charge for the residential services can be fixed by the nursing homes by their own.

With this regard, we posited that the price (i.e. the residential charge) was able to capture the quantity and the quality of these services and thus could be used as a proxy of patients' satisfaction with these services. Moreover, the Local Health Authority is responsible to verify that the residential charge were not misaligned with the value of delivered residential services. Concluding, we employed the residential charge as a proxy of customer satisfaction with those services. To our knowledge, this is the first study that incorporates a measure for quality of care that refers to non health and nursing activities, but to residential services.

3.6 Measures: explanatory variables (stage-two)

Given the small size of the sample, three variables were regressed. These variables are among the most employed in the literature with respect to DEA studies about nursing homes. First, we chose the size of the facilities (i.e. the number of beds). This variable has frequently been used in DEA models in order to directly define the optimal size of the facilities when variable returns to scale affect the industry and resource consumption depends to the number of beds [16]. In Lombardy, the healthcare regulator promoted a linear relationship between time standards of care and number of patients. In fact, we employed a CCR model in first stage of the analysis. In order to verify the robustness of this hypothesis about constant returns to scale, we introduced this variable in the second stage of the analysis. Second, we chose the nature of ownership, which is widely used in the second stage of the analysis in US studies, where facilities were classified into profit and non profit. We chose to classify the facilities into public and private, because there were only three profit oriented units. Thus we measure the impact of ownership on the efficiency to verify that private nursing homes were more efficient than the public ones, as assumed by the quasi-market paradigms and by those healthcare regulators that implement "competition mechanisms" to improve performances. Third, we chose the percentage of patients relative to lower severity SOSIA classes, in order to understand whether this type of patients could represent an opportunity for increasing efficiency. Less complex patients could represent an opportunity to reduce costs since the time standards are not related to patients' severity. The impact on efficiency of different types of patients had been widely investigated in DEA studies (e.g. Nyman and Bricker [16] and Ozcan et al. [19]).

3.7 Analysis

For the first stage analysis, we employed a CCR input oriented model. This model has been introduced by Charnes et al. [20]. The CCR model generates the efficiency scores by means of a linear system, maximising the ratio of outputs over inputs. The efficiency frontier is not affected by the size of the decision making units, since the underlying hypothesis is that the industry is affected by constant returns to scale. A CCR input oriented model generates the input reductions that should be applied to the inefficiency units to become efficient.

A CCR model is coherent to the peculiarities of the Lombardy elderly care system. In fact, nursing homes are affected by constant returns to scale since the regional standards tend to align the total costs to the number of patients (or beds). The choice for a CCR model is also supported by Banker et al. [26], who argued that for samples with less than 50 units, this model should be preferred. Finally, an input orientation has been chosen, taking into account that inputs reductions are usually preferred by policy makers as interventions to reduce costs for long-term care.

DEA analysis was performed using Frontier Efficiency Analysis with R (FEAR, version 1.0) software [27].

DEA scores had been tested using a bootstrap procedure as proposed by Simar and Wilson [28–30]. In fact, DEA is a deterministic method that attributes all deviances from the frontier to inefficiency, regardless of any possible random noise. The bootstrap method involves re-sampling the sample observations to establish confidence intervals of the efficiency scores calculated via DEA. This approach has already been applied to healthcare. An example is the study by Pilyavsky et al. [31], who employed bootstrap to adjust the efficiency scores of 65 hospitals in Ukraine.

The second stage of the analysis was to regress DEA scores on the selected explanatory variables. In particular, a Tobit regression had been performed on the bootstrapped DEA scores. The Tobit regression consists of a censored regression. This regression is coherent to this study since the DEA efficiency scores varied from between 0 and 1. The same approach had been employed by Blank and Valdmanis [32] in their assessment of Dutch hospitals, and by Borge and Haraldsvik [33], who assessed the efficiency of municipalities in Norway.

Within the second stage of the analysis, hypothesis tests had been performed to verify the impact that the misalignment between the regional reimbursements and the healthcare costs incurred by the nursing homes mean may have on the efficiency performances.

4 Results

4.1 Traditional and bootstrapped DEA scores

During the 3-year period, the mean level of efficiency decreased from 0.85 to 0.84. The bootstrapped DEA scores shows the same trend, with the mean efficiency that decreased from 0.80 to 0.79. The mean difference between traditional and bootstrapped DEA scores is about 5%. These results imply that nursing homes should reduce their costs about 15% (or 20% according to the bootstrapped scores). The robustness of the traditional DEA results has verified by means of a Spearman correlation analysis between the traditional and the bootstrapped DEA scores. The results showed a high level of correspondence (Table 4). This results allow the use of traditional DEA scores to rank the nursing homes in order to further investigate the factors that describe the best and worst nursing homes. Traditional DEA scores were preferred since the bootstrapped DEA scores consist of intervals of confidence that make difficult the ranking exercise. Vice versa, for the Tobit regression and the hypothesis tests, the bootstrapped DEA scores were employed.

4.2 Best and worst groups

The peer group, which includes the efficient facilities, has been identified for each year. In the first and third years, the peer group was composed of 15% of the sample, whereas in the second year it was composed of 20%. Changes within the peer groups were minimal. In fact, the nursing homes that flowed through the peer groups for each year had a score higher than 0.9, and thus indicative of marginal changes to reach the top.

Observing a 3-year period, the best group has been identified as those nursing homes that were efficient for at least 2 years, in order to point out any practices or behaviours that were common to all the efficient units and which could be useful for the improvement of the inefficient facilities. It was also possible to define the worst group, composed of those units with a score lower than 0.75 for at least 2 years. The thresholds were coherent to the suggestion by Norman and Stoker [34]. The presence for at least two years in the peer group allowed to limit the effects of singular occurrences on the performance of one specific year.

The best group is composed of six nursing homes, and includes all three of the profit facilities. In general, the best facilities are medium sized, host higher severity patients and have higher residential charges. The best facilities show different percentages of extra nursing hours. The best units mostly have a policy of containment of health and nursing costs that allows them to be aligned with the regional reimbursements. The residential costs are below the sample average, although, in general, the level of quality was higher.

The worst group is composed of eight nursing homes, with different sizes. Three of them are public, while other three are private not-for-profit. Patient severity is higher and also the percentage delivered extra nursing hours is higher. The level of residential charges is lower. Health and nursing costs are misaligned to the regional reimbursements and, similarly, the accommodation costs are above the sample average, revealing weak cost containment strategies.

4.3 Results of the second-stage analysis

The second stage of the analysis was to regress the bootstrapped DEA scores on three explanatory variables: size, ownership and percentage of patients who are in low severity SOSIA classes (Table 5).

Results from the Tobit regression led to the conclusion that only the nature of the ownership significantly affected the efficiency scores. Private facilities are more efficient than the public ones. This result confirms the previous findings by Nyman and Bricker [16] and Lee et al. [3]. Moreover, this result seems to confirm that the implementation of "competition mechanisms" and the creation of a quasi-market for nursing homes could produce positive effects on efficiency. The p-value increased between the second and third year. This finding suggests the existence of a progressive alignment of public nursing homes towards the private facilities. However, further and more accurate investigations of this issue could not be performed since the adoption of the SOSIA reimbursement system in 2003—the same year for the implementation of a quasi-market—radically changed the data collected by the healthcare regulator and thus is impossible to compare efficiency scores before and after the adoption of these initiatives.

On the other side, the non significance of the relationships between efficiency and size confirms the hypothesis of constant returns to scale. Finally the non significance of the relationships between efficiency and the percentage of lower severity SOSIA classes suggests that facilities could be efficient, regardless of the severity level of the patients. This result implies that nursing homes have no actual need to select patients, preferring high or low severity classes.

Table 4 Traditional and bootstrapped DEA efficiency scores

DMU	2005		2006		2007	
	Traditional	Boot	Traditional	Boot	Traditional	Boot
1	0.788	0.765	0.702	0.68	0.665	0.643
2	0.755	0.733	0.723	0.698	0.659	0.632
3	0.862	0.834	0.696	0.671	0.741	0.718
4	0.833	0.8	0.808	0.762	0.855	0.798
5	0.726	0.664	0.762	0.72	0.724	0.668
6	0.771	0.744	0.702	0.673	0.811	0.787
7	0.94	0.914	0.834	0.803	0.806	0.774
8	0.977	0.946	0.941	0.913	0.898	0.859
9	0.842	0.821	0.835	0.812	0.788	0.764
10	0.677	0.651	0.704	0.664	0.668	0.624
11	0.644	0.624	0.65	0.616	0.714	0.682
12	0.738	0.714	0.673	0.644	0.634	0.599
13	0.878	0.849	0.847	0.817	0.914	0.88
14	0.683	0.629	0.697	0.649	0.712	0.662
15	0.904	0.872	0.78	0.754	0.785	0.764
16	0.675	0.639	0.798	0.75	0.789	0.749
17	0.845	0.793	0.915	0.863	0.816	0.77
18	1	0.872	1	0.866	1	0.915
19	0.763	0.735	0.816	0.749	0.833	0.781
20	0.772	0.747	0.789	0.755	0.754	0.722
21	0.846	0.788	1	0.901	0.941	0.869
22	0.939	0.873	1	0.926	1	0.928
23	1	0.958	0.951	0.917	0.94	0.905
24	0.753	0.72	0.615	0.588	0.894	0.828
25	0.833	0.803	0.885	0.853	0.82	0.779
26	0.864	0.828	0.836	0.785	0.847	0.802
27	1	0.885	1	0.86	1	0.862
28	0.978	0.922	1	0.916	1	0.902
29	0.76	0.732	0.795	0.761	0.789	0.762
30	0.774	0.739	0.814	0.774	0.744	0.707
31	1	0.895	1	0.882	1	0.859
32	0.841	0.79	0.947	0.896	0.836	0.788
33	0.977	0.925	1	0.91	1	0.913
34	0.788	0.758	0.828	0.778	0.752	0.7
35	1	0.904	1	0.902	0.997	0.934
36	0.995	0.962	1	0.936	0.961	0.917
37	0.798	0.754	0.857	0.807	0.837	0.787
38	0.979	0.901	1	0.901	0.96	0.88
39	1	0.866	0.837	0.792	0.897	0.85
40	0.83	0.764	0.882	0.83	0.813	0.76
Mean	0.851	0.803	0.848	0.794	0.84	0.788
Std.D	0.109	0.094	0.118	0.097	0.11	0.093
Min	0.644	0.624	0.615	0.588	0.634	0.599
Median	0.842	0.796	0.836	0.798	0.826	0.784
Max	1	0.962	1	0.936	1	0.934
Spearman's correlation	0.949		0.959		0.966	

Table 5 Tobit regression

	2005	2006	2007
LRchi2(3)	5.63	10.75	7.75
Prob.>chi2	0.131	0.013	0.051
	Estimates	Estimates	Estimates
Const	0.772 (0.000)	0.741 (0.000)	0.737 (0.000)
Number of beds	−0.000 (0.383)	−0.000 (0.105)	−0.000 (0.296)
Ownership	0.080 (0.059)	0.104 (0.011)	0.094 (0.022)
Lower severity SOSIA cl.	−0.055 (0.537)	−0.001 (0.985)	−0.022 (0.809)

5 Discussion

5.1 Efficiency and quality of care

Best and worst facilities showed an heterogeneous percentage of extra nursing hours respect to the regional standards. This finding seems to suggest that this variable may play less than a role in affecting the efficiency scores and that measures for quality of care should be employed as explanatory variable in a second-stage analysis rather than directly in the DEA model [2]. The sensitivity of efficiency scores respect to the extra nursing hours variable, the efficiency scores were re-calculated using a second DEA model, in which this variable was excluded and the other four were maintained. The mean efficiency decreases of about 3%. Moreover, those peer units that has an high percentage of extra hours became inefficient. This finding obliges to further investigate these units. The scores of all the nursing homes with a percentage of extra nursing hours above the mean that were generated by the first and second DEA models were compared with a Kruskall–Wallis test. This is a non parametric test of hypothesis that examines the equality of two populations. The test confirmed that the impact of extra nursing hours on efficiency is almost null (Table 6).

Moreover, the nursing homes with the highest number of extra nursing hours showed lower costs for healthcare assistants. This finding may be controversial. In fact, the cost per hour of ancillary staff can be assumed as a proxy of their competences. This could suggest that the lower labour costs warn that a lower level of care is delivered to the residents. Less skilled staff would require more hours to achieve outcomes that were comparable to those achieved by more talented healthcare professionals. However, this claim must be rejected since the Local Health Agency ensures, by means of periodic audits, that healthcare professionals have an adequate level of competences for their job tasks. Moreover, the healthcare regulator implemented compulsory annual trainings.

A better explanation is provided by the previous study by Blank and Eggink [35], who found that quality of care was negatively related to labour price. They found that the coefficients of the relationship between quality indicators and costs for healthcare professionals were negative and significantly different from zero. The authors affirmed that when the price of labour input increases, the quantity of the this input tends to decrease. Essentially, quality of care declines when the price of labour increases.

5.2 Efficiency and residential charge

Residential charges—that contribute to operational income—largely affect efficiency scores, coherently to previous studies (e.g. Kleinsorge and Karney [36]). Most of the peer units have daily charges for residential services that are above the mean. The inefficient units are thus recommended, in addition to reduce the input, to increase the residential output. Because the occupancy rate is close to 100%, this output can be increased mainly by means of increasing the out-of-pocket costs for residents. Inefficiency has two main sources. On the one hand, it comes from the resource employed for the residential services and, on the other hand, from the misalignment between the residential charge and the costs. With this regards, nursing homes seem to follow other goals—such as accessibility to services—rather than economic profit in fixing the residential charge. Since the LHA ensure that residential charge reflect at least the

Table 6 Kruskall–Wallis test of extra nursing hours impact

	2005		2006		2007	
	5 var. mod	4 var. mod	5 var. mod	4 var. Mod	5 var. mod	4 var. mod
Obs	17	17	15	15	15	15
R.sum	350	245	272	193	248	217
Chi-2	3.270		2.684		0.413	
P	0.071		0.101		0.520	

Table 7 Kruskall–Wallis test of residential quality

	2005		2006		2007	
	Charge < mean	Charge > mean	Charge < mean	Charge > mean	Charge < mean	Charge > mean
Obs	20	20	19	21	20	20
R.Sum	355.5	464.5	349.5	470.5	355.5	464.5
Chi-2	3.795		2.049		3.795	
P	0.051		0.152		0.051	

quantity and quality level of residential services, this finding suggests that some of not-for-profit facilities fixed the residential charge below the costs incurred for delivering these services. This finding is coherent to Ozcan et al. [19], who found that healthcare organisations are also interested to maximise social goals. The worst facilities show lower levels of residential charges. According to our initial hypothesis, the price captures customer satisfaction for the residential services. To confirm this claim, we invited the Local Health Agency to assess the quality of residential services according to the available audit reports. Quality of residential services was measured by three dimensions: living environments, technology available to the patients, and optional services. Each dimension was measured by a list of items. The final rating was on scale that ranged from 0 to 3 (0 = poor, 1 = discrete, 2 = good, 3 = optimum). The facilities were classified into two clusters depending on the mean value of the residential charge. A Kruskall–Wallis test was implemented and the results are shown in Table 7. The null hypothesis—i.e. the equality of the two populations—was rejected for the first and third years with a significance level of about 0.051. Thus, our hypothesis was confirmed for only 2 years. This finding suggests that residential charges may depend by the profit orientation of each facility. In fact, the social mission of facilitating accessibility to long-term care could negatively affect the homogeneity of the sample.

5.3 Efficiency and containment of health and nursing costs

DEA assesses efficiency by means of outputs over inputs ratios. In this study, multiple outputs and multiple inputs were employed to assess efficiency. The virtual inputs showed that many nursing homes focused on health and nursing costs to reach efficiency, while the virtual outputs revealed that many of them focused on the case-mix, measured as product between the length of stay and the SOSIA class reimbursement. The combination of these results suggests that efficiency is mainly addressed through strategies of alignment between the regional standards of reimbursement and the costs incurred for health and nursing activities. For each nursing home we calculated a standard margin. This measure was defined as the ratio between earnings from health and nursing activities (calculated as the difference between case mix and costs incurred for delivering the weekly standard of 901 min per resident) and case mix. Nursing homes were grouped in two clusters, using −10% as threshold. A Kruskall–Wallis test was performed with the null hypothesis of equality of the two populations. Results suggested the hypothesis was to reject, since there was a significant difference between the two populations (Table 8), confirming the previous results coming from the analysis of virtual inputs and outputs.

Concluding, nursing home efficiency depends mainly by the policy of cost containment with respect to health and nursing services. Since the reimbursement system is fixed by the regional regulator, the level of efficiency depends by the capability to align costs and reimbursements. The costs for healthcare professionals represent the 90% of the total costs for health and nursing services. This is implies that nursing homes administrators should act to contain the cost of labour, without lowering skills and quality of care. Private nursing homes seem more able to align labour costs

Table 8 Kruskall–Wallis test of standard margin

	2005		2006		2007	
	Sd.m. <−10%	Sd.m. >−10%	Sd.m. <−10%	Sd.m. >−10%	Sd.m. <−10%	Sd.m. >−10%
Obs	23	17	25	15	28	12
R.Sum	318	502	378	442	465	355
Chi-2	17.638		14.119		10.349	
P	0.000		0.000		0.001	

to the reimbursement system introduced by the regional regulator, while public facilities experience difficulties to develop and implement policies of cost containment.

6 Conclusions

This study offers new elements to the growing debate about efficiency of nursing homes. The progressive ageing of population and the urgency to contain expenditures for healthcare delivery, obliges healthcare regulators and practitioners to implement strategies for improving efficiency. Our investigation addressed two main puzzles in the literature. First, the multidimensional nature of quality of care has been mainly measured with respect to health and nursing activities. We employed a measure of quality of care that refers also to residential services (e.g. meals, laundry and cleaning), addressing the invitation by Cheesteen et al. [10] to include in studies about efficiency in nursing homes also measures that may capture customer satisfaction. Second, we developed measures for outputs and inputs that are coherent to previous literature and to data that are available in the Local Health Agency databases. This is particularly relevant, since efficiency studies could be limited in those situations where resources, in terms of data and time, are scarce. Considering the SPO framework proposed by Donabedian [14], quality of care has been modelled mainly with Process measures. We developed a Structure-related measure that takes into account the extra nursing hours (adjusted by the daily case-mix in order to take into account the specific degree of severity of residents for each nursing home).

The study assessed a sample of 40 nursing homes by means of DEA over a 3-year period. These facilities are located in the Lombardy Region, that is the only Region in Italy that implemented "competition mechanisms" to create a quasi-market in order to improve efficiency of nursing homes.

Results revealed that the efficiency scores depended by the capability of the nursing homes to implement strategies for labour cost containment. The regional healthcare regulator defined a reimbursement system that is based on a standard of weekly 901 min of care and nursing activists per resident. Nursing homes are thus incentive to align their health and nursing costs to the regional reimbursement rates. This means that the reduction of labour prices is a major need for achieving efficiency. While for-profit and private not-for-profit nursing homes had already complied with it, the public facilities are experiencing more difficulties because of the organizational inertia at changing and the negotiations with labour trade unions. These results are coherent to previous studies, such as Nyman and Bricker [16] and Lee et al. [3].

Quality of care is positively related to efficiency when nursing homes can implement strategies for labour cost containment. Nursing homes that deliver more extra nursing hours showed a mean cost for healthcare professional that is lower the mean. On the contrary, public nursing homes show higher costs for healthcare professionals. This means that these facilities are obliged to reduce the number of extra nursing hours—and thus the quality of care delivered to residents—to align their costs to the regional reimbursements. Finally, for-profit and some private not-for-profit nursing homes achieved higher efficiency scores because of higher residential charges. This measure captures the quantity and quality of residential services, and may be assumed as a proxy of customer satisfaction.

Concluding, we believe that efficiency studies should be promoted in the next decade with respect to nursing homes. Moreover, healthcare regulators and practitioners urge to know which factors and strategies may affect efficiency and quality of care. With this regard, our understanding about hospitals should be translated to nursing homes, promoting the diffusion of methodologically-rigorous and industry-relevant results. Finally, we believe that studies about nursing homes should take into account the numerous limitations, in terms of data, recourses and also sample size, that decision-makers have to cope with. Our study offers an example of how an efficiency analysis, by means of a DEA, could be developed and performed on a routine basis, in a context characterised by 45 nursing homes, and limited data with respect to Outcome- and Process-related data about quality of care.

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