ECONOMIC ANALYSIS OF THE EFFICIENCY OF VALENCIAN HOSPITAL CONCESSIONS

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Abstract

We study the relative efficiency of public and private hospitals. In the latter case, these include hospitals in private partnerships in the Valencian Autonomous Community. To do so, we analyze the association between hospital management and clinical and economic indicators for the hospitals of La Ribera, Vinalopó, and Torrevieja. Owing to a lack of public data within the Valencian Community, we carried out the comparative analysis based on the public hospitals of SISCAT in Catalonia (2012–2015). The analysis includes the following: (i) a network analysis for patient flows; (ii) a regression model with fixed effects; and (iii) a synthetic control to analyze the evolution of financing and mortality at discharge.
The results show that there are no statistically significant differences between the concession hospitals and the SISCAT hospitals.

Keywords: Alzira, Ribera, hospital efficiency, hospital management, public and private hospitals

JEL Classification Code: H42, H51,I18,I11.

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1. Introduction

Despite global interest in hospital management, analyses that include level I evidence on the effects of various forms of management are scarce. Most published studies include a bias as a result of omitting a key variable that cannot be controlled, owing to the complexity of patients. As such, the only prevalent result in the literature is that the quality of care increases with an increase in competition between centers.

The objective of this study is to analyze the results of three Valencian hospital concessions (La Ribera, Torrevieja, and Vinalopó) in terms of clinical and economic outcome indicators, controlling, as far as possible, for the observable characteristics of activity, complexity, and fixed effects, for the period 2012 to 2015.

Here, we combine several databases—the Minimum Basic Data Set (Conjunto Mínimo Básico de Datos de hospitalización – MBDS) for the Ribera, Torrevieja, and Vinalopó Hospitals, and the hospitalization and outpatient surgery MBDS—with the hospital results published by the Results Center (Central de Resultats) of the Catalonian Public Healthcare System (Sistema Sanitari Integral d'Utilització Pública de Catalunya – SISCAT) for the study period. Then, the concessions are compared with Catalan hospitals owing to a lack of public data on the Valencian Community for the period of interest.

We analyze the results of the three concession hospitals using three different approaches. First, we conduct a network analysis of patient flows between hospitals and the Valencian Community. Second, we employ a fixed-effects regression model in a panel data analysis that compares the clinical and economic outcomes of management methods at the group level with the groups present in the Catalan system. Third, we apply the synthetic control method to analyze the evolution of hospital finances and mortality at hospital discharge.

The network analysis shows that the three hospitals record, on average (adjusted for complexity), 1371 hospitalizations and 310 major outpatient surgery (MOS) cases more than those recorded in other centers of the Valencian Autonomous Community. The results from the panel data models indicate no significant differences in adequacy, safety, efficiency, or clinical effectiveness, nor in the economic indicators between the concession hospitals and the Catalan hospitals. Here, the hospitals are classified according to the Incident Command System 2 (ICS2), ICS3, and Private Not-Nor-Profit (PNFP) typologies. The synthetic control analysis shows that neither public funding nor mortality at hospital discharge have different evolutions to those of synthetic hospitals, at the individual hospital level.

The evidence reported in the present study leads us to conclude that there are no significant differences between the concession hospitals and the SISCAT hospitals in terms of either clinical or economic indicators, based on the available data.

2. Literature review

A review of the available literature on the relationship between ownership and hospital outcomes is described below. The search criteria are outlined in Table 1, and Table 2 shows the criteria used to select the articles for the literature review.

Table 1 Keywords, database searched, date, years of publication, and articles found

Database	Search date	Keywords	Years of publication	Articles found
Google Scholar	02/17/2017	“hospital health outcomes” AND “hospital ownership”	Any year	34
Google Scholar	02/17/2017	“hospital efficiency” AND “hospital ownership”	Any year	823
Google Scholar	02/24/2017	“public-private partnership” AND “hospital management”	2000–2017	831
Google Scholar	02/27/2017	“public” AND “private” AND “hospital management”	2000–2017	2,790
Google Scholar	03/06/2017	“hospital ownership” AND “quality of care”	2000–2017	2,780
Google Scholar	03/06/2017	“financial performance” AND “hospital ownership”	2000–2017	902
Pubmed	03/09/2017	“Health outcomes” AND "management" AND "public" AND "private" AND ("effectiveness" OR "adequacy" OR "safety")	2000–2017	21
Google Scholar	03/09/2017	(“Health outcomes” AND "hospital management") AND "public" AND "private" AND ("effectiveness" OR "adequacy" OR "safety")	2000–2017	2,600
Google Scholar	03/10/2017	“health outcomes” AND “hospital ownership” AND “private” AND “public” AND “effectiveness”	2000–2017	460
Google Scholar	03/10/2017	(“private for-profit” AND “public”) AND “health outcomes” AND (“effectiveness” OR "quality")	2000–2017	3,280
Google Scholar	03/14/2017	(“health outcomes” AND” hospital management” AND “hospital ownership”) AND ("effectiveness" OR "adequacy" OR "safety")	2000–2017	126
Google Scholar	03/14/2017	(“health outcomes” AND “hospital ownership”) AND ("effectiveness" OR "adequacy" OR "safety")	2000–2017	837
		TOTAL		15,484

Table 2 Selection criteria

Object	Impact of the type of hospital management on health outcomes
Focus	Focus on ownership and hospital management method
Results	Clinical and economic outcomes are both included
Type of manuscript	Articles published in peer-reviewed journals
Language	English or Spanish

In a first review of the literature, 15,484 articles on hospital management models and their clinical or economic impacts were retrieved. After a preliminary analysis, 15,384 studies were excluded because they were not relevant to the present study, resulting in a sample of 100 articles for a more detailed analysis. In the reference lists of these 100 articles, a further nine studies of interest were identified, yielding articles for the analysis. Then, 80 publications were excluded based on the selection criteria. Thus, the final sample comprised 29 articles. Figure 1 shows the literature search strategy used and the exclusion criteria.

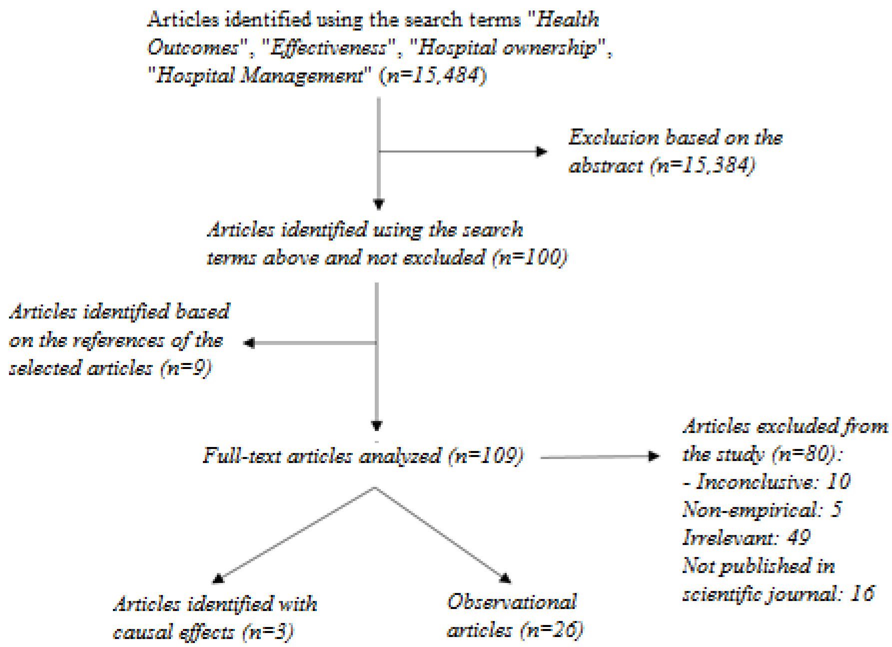


Figure 1. Flowchart of the literature selection process

In the following sections, we summarize the conclusions from the most relevant articles on this subject. First, we review previous studies, and examine several articles that empirically analyze the relationship between various hospital management or ownership models and the hospital results in different contexts. These studies are divided into two large groups, depending on the character of the analysis. The first group, which includes most studies, consists of observational studies that report associations between the type of hospital management and the hospital results. The second group includes articles that establish a causal relationship between both variables. Finally, studies on the Spanish and Valencian context are presented.

2.1 Meta-analysis

One of the first systematic reviews of the literature was provided by (Sloan 2000), who analyzes empirical evidence on the differences in results between for- and not-for-profit private hospitals. The author concludes that there are no significant differences in terms of cost or quality between these hospitals. Furthermore, the author indicates that ownership loses importance with an increase in competency among hospitals because the results from different types of hospitals are expected to converge. (Eggleston et al. 2008) published a similar review that focused on acute care in hospitals in the United States. These authors document great variability in the results of the studies, and conclude that the "actual" effect that management may have on quality is mediated by the institutional context. Therefore, these effects differ between regions and markets, and may vary over time. Lastly, and with a different framework, the review by (Basu et al. 2012) includes studies that analyze the association between hospital management and the health results in low- and medium-income countries. The authors conclude that, in the context of developing countries, there is insufficient evidence to indicate that private management is always better than public management in terms of healthcare efficiency or medical effectiveness, despite advantages of private management in terms of waiting lists and patient treatments.

The available empirical evidence on the relationship between management and results is shown below.

2.1.1 Observational studies

Existing empirical analyses of the relationship between ownership and quality provide mixed results. Consistent with the conclusions from previous literature reviews, the observed association seems to depend, to a large extent, on the specific context.

On the one hand, several studies find that public hospitals have better service quality than private hospitals do. Among these studies, (Tiemann and Schreyögg 2009) compare the efficacy of public and private (for- and not-for-profit) hospitals in Germany, for the period 2002 to 2006, concluding that German public hospitals are more efficient than all types of private hospitals. However, (Amirkhanyan, Kim, and Lambright 2008) studied the differences in quality and access to services between public and private (for- and not-for-profit) nursing homes in the United States, and found that the service quality was significantly lower in both public and private not-for-profit nursing homes than it was in their private for-profit counterparts. In addition, there are no significant differences between the first two groups. (Chang, Cheng, and Das 2004) analyze the relationship between ownership and operational efficiency of Taiwanese hospitals for the period 1996 to 1997. Their results also indicate higher efficiency of public hospitals. Lastly, (McKee, Edwards, and Atunc 2006) report the findings of experiments in countries with public-private partnerships (PPP) (Spain, United Kingdom, and Australia). The authors highlight that this model is a good alternative, enabling construction work to be completed on time, albeit with worse quality of services provided.

Other studies have found that private ownership is associated with better results than public ownership, including the study by (La Forgia and Harding 2009), which analyzed the introduction of the PPP model in São Paulo, Brazil, finding that it was associated with improved hospital results. The authors attributed this improvement primarily to the increased freedom in human resources management facilitated by this hospital management model. Concurrently, the study by (Jensen, Webster, and Witt 2009) analyzed the relationship between the type of hospital and the outcomes of patients with acute myocardial infarction from 2001 to 2003 in the hospitals of Victoria, Australia. Based on the results, they concluded that private hospitals are better than both university and non-university public hospitals in terms of readmission and mortality rates.

Lastly, several studies have found there is no significant difference in hospital results based on ownership. (Sloan et al. 2001) examined differences for Medicare patients between types of hospitals, and found no differences in terms of cost or quality between for- and not-for-profit private hospitals. Similarly, for the Italian National Healthcare System, (Barbetta, Turati, and Zago 2007) analyzed the differences between public and private not-for-profit hospitals from 1995 to 2000, after the diagnosis-related groups (DRGs) payment system was introduced in the 1990s. Their results show a converging trend in efficiency between different types of ownership. As in other studies, the authors indicate that the institutional context is more important than ownership in explaining the differences between the results. Lastly, (Gobillon and Milcent 2016) analyzed differences in mortality between university and non-university public hospitals and private hospitals in France. After controlling for risk factors, they found no significant differences in mortality between private and university hospitals, and also that both types of hospitals have lower mortality rates lower than those of non-university public hospitals. However, when including additional controls for the use of innovative procedures, they found higher adjusted mortality rates in private hospitals. Therefore, the authors conclude that the ability of private hospitals to adopt innovative practices is a key factor in explaining their quality. With regard to patient experience, (Pérotin et al. 2013) found that the differences between public and private hospitals vary among population subgroups, concluding that, on average, there are no differences between public and private hospitals in the British National Health System (NHS).

2.1.2 Studies on causal relationships

Only three of the articles included in this review analyze the causal relationship between the type of hospital management and its outcomes. Because the type of hospital management may be related to other observable and unobservable factors that also affect the outcomes, these studies adopt different methods (i.e., propensity score matching and the instrumental variables method) to overcome this limitation and to establish causality.

(Shen 2003) analyzes the changes in hospital performance after the ownership conversions that occurred in the United States between 1997 and 1998. The author found that public and private not-for-profit hospitals that became for-profit private hospitals reduced their operating costs. However, this was accompanied by a decrease in the bed-to-nurse ratio, which previous studies have indicated is related to service quality. However, the author found no evidence that private for-profit hospitals purposely avoid less profitable patients.

Conversely, (Lien, Chou, and Liu 2008) analyzed differences in the quality of treatment for stroke patients and for those with heart problems among hospitals with various ownership models in Taiwan for the period 1997 to 2000. Their results establish a robust causal relationship between public hospitals and improved patient care quality in terms of mortality. With regard to treatment costs, the authors found no significant differences in the rate of expenditure per standardized medical care unit between public and private hospitals. Furthermore, public hospitals have, at most, a 10% higher long-term expense per patient.

Lastly, (Bloom et al. 2015) focused on the quality of management models, rather than directly comparing different models. In the context of public hospitals in England, the authors found that greater competition between hospitals has a positive impact on management quality, which translates into improved outcomes. These authors use a new method, based on surveys, to measure quality in a quantitative manner. Their results indicate that when the number of hospitals operating in the same sector increases, the management quality also increases, thus increasing survival rates after emergency hospitalizations for heart attack by 9.7%. These results suggest that ownership may not be as crucial to hospital quality as the degree of competition in the sector.

2.1.3 Spanish studies

Lastly, we found a set of articles that analyzed the Spanish context. (Sánchez-Martínez, Abellán-Perpiñán, and Oliva-Moreno 2014) analyzed available evidence for Spain on differences in outcomes between hospitals according to the hospital management model employed, contextualizing their findings using those of studies from other countries. They highlighted that the ownership of hospital centers is not a determining factor in explaining their outcomes, with other factors, such as the quality of the institutions, the culture of the centers, and auditing, being more relevant. (Acerete et al. 2015) conducted a comparative analysis of the PPP experience in Spain, which includes both Valencia and Madrid. Their comparative analysis was based on financial information of seven concessions, although was limited by a lack of detailed information on costs and the difficulty of comparing the results of different hospitals directly. Their main conclusion is the difficulty of extracting lessons applicable to other countries or regions, given the specificity of the Spanish institutional context and the differences in financial outcomes, even within the same country. Conversely, an analysis of the Alzira model (NHS European Office 2011) showed that objectives set in terms of quality and safety (measured as waiting times and clinical activity), clinical outcomes (measured as mortality and immunization rates), and patient experience and satisfaction had been met. However, in drawing this conclusion, the NHS European Office bases most of its premises on reports from Ribera Salud, which is clearly not an unbiased source.

In summary, the literature review shows the difficulty of extracting conclusions generalizable to other contexts from cases studied. Most systematic analyses agree that other factors, such as institutional context and market structure, are more important than ownership in terms of explaining the differences in outcomes between hospitals, or at least in modulating the relationship between both variables.

In the next section, we contextualize the Alzira case within the Valencian model and analyze the Catalan model (the hospitals of the Ribera group are compared to Catalan hospitals). In addition, we analyze the background and studies comparable to the Alzira model.

2.2 Analysis context

Public–private partnerships (PPP) are collaboration protocols established between public administration and the private sector to provide infrastructure, its renewal and maintenance, and management or public services. In all cases, the private sector must assume, at least partly, the financial, technical, and operational risks of conducting those activities.

PPPs are common in Anglo-Saxon countries. Several initiatives emerged at the beginning of the 21st century in Spain, largely because these protocols enable a rapid increase in the supply of public services without a significant short-term budgetary impact.

This management protocol has several advantages for public administration. First, the concession company assumes the initial investment, which enables anticipating, maintaining, and boosting public investment. This may be particularly relevant during stages of budget deficit. Although the management is conducted by a private company, the service is financed by the public administration, which sets an annual amount per protected population of the Department of Health. Second, efficiency gains may result from the concession company's better know-how on building infrastructure and managing hospital resources. Lastly, there are benefits to transferring the risk from the public administration to the concession company using a contract with a closed amount, which can increase incentives to maximize hospital management efficiency.

2.2.1 The Valencian experience: The Alzira "model"

On January 1, 1999, the Valencian Community granted the first administrative concession for health management and public works in the Ribera region. The most relevant justification for the concession was the need for hospital infrastructure in the region because citizens (235,000 inhabitants spread over 29 municipalities) had to travel to the city of Valencia for specialized care.

The Alzira model, named after the Valencian city where the first public hospital managed under this protocol was built (Ribera University Hospital (Hospital Universitario de La Ribera)), is derived from this administrative concession. The key feature that characterizes this new model is the concept of a capitation payment, according to which the public administration pays the concession company an amount per year per inhabitant of the region in which it operates. The Ribera hospital was built on public land and belongs to the network of public hospitals of the Valencian Department of Health (Conselleria de Sanitat), although a private company was responsible for financing the construction and for providing healthcare services. In 2003, the concession was changed to one of integral management of public healthcare in Area 10 (Ribera region). The concession company Ribera Salud now manages the healthcare services in the area, including primary care for 15 years (2003–2018), renewable for a further five years (2018–2023). As a result, the per capita fee increased gradually from 379 euros/person in 2003 to 775 euros per capita in 2016 owing to the aforementioned integration.

Torrevieja Hospital was the second hospital to start operating in the Valencian Community under the concession model, and the first to adopt integrated care from the beginning. The Vinalopó Hospital, which opened to the public in 2010, is in Elche, and was the fifth project of public hospitals managed by private companies.

2.2.2 Descriptive evidence of the concession model

The 2015 Report of the Regional Audit Office (Informe Sindicatura de Comptes 2015)[1] analyzed and provided economic data on the total expenditure of the the Manises Hospital and that of other Valencian concessions. The report shows that the administrative concessions of Valencia have a lower per capita expenditure than the mean per capita expenditure of the Valencian Community.[2] The per capita expenditure of the administrative concessions in 2015 was 841 euros in the Ribera Hospital, 634 euros in Torrevieja Hospital, and 743 euros in Vinalopó Hospital. The mean per capita expenditure of the Valencian Community is 922 euros, considering all regional health departments. In terms of average cost per employee, which includes all personnel concepts and categories, the concessions show 8.5% lower personnel than that of the Valencian Community (48,873 euros) and 9.6% lower than that of regional hospitals.[3]

Conversely, the number of hospital services under administrative concession is higher than the average of the Valencian Community (59): Ribera Hospital offers 73, Vinalopó Hospital 60, and Torrevieja Hospital 67, and all have shorter waiting lists for structural surgery (36 days in Vinalopó Hospital, 33 days in Torrevieja Hospital, and 46 days in Ribera Hospital). The average waiting list is 67 days in the Valencian Community. According to the same report, the technological endowment (inventory of high-tech health equipment) of concession hospitals is considerably higher than the average endowment of regional hospitals, and slightly higher than that of hospitals with similar capacity. The average investment effort in technological equipment of the Valencian Community is 36 euros per inhabitant, whereas the Ribera Hospital spends 59 euros per inhabitant, Torrevieja 39 euros, and Vinalopó 58 euros.

In terms of patient satisfaction, concessions also show better results. Mean patient satisfaction was 81.05% in the 2014–2015 period, whereas concession hospitals score above average, with 82.14% for Ribera, 86.06% for Torrevieja, and 89.49% for Vinalopó. In terms of achievement of objectives, the average in the Valencian Community stands at 58.6%, varying markedly with the type of hospital and management. In concession hospitals, the mean is much higher, with an overall mean score of 72.9% (in

[1] http://www.sindicom.gva.es/web/informes.nsf/0/EBC215323BD21746C12580FE002DCF3A/$file/Manises_C.pdf.

[2] Per capita expenditure is calculated by dividing the estimated net expenditure on health care of the protected population of the specific health department by the protected population.

[3] Note that the liquidations of the Manises and Denia hospitals have been court appointed, thus precluding us from concluding definitively that the results are better than those of the rest of the Valencian Community.

the five hospitals); Vinalopó Hospital has the lowest mean, 70.2%, followed by Ribera Hospital (72.2%) and Torrevieja Hospital (84.4%).

Data from the Ribera, Torrevieja, and Vinalopó hospitals are analyzed in the following sections. Because no data from the Valencian Community are available, as a comparator at the hospital level, we use the Catalan hospitals, whose information is publicly available at the Results Center (Central de Resultats).

2.2.3 The reference of the Catalan health system

The hospital network of Catalonia has a total of 66 hospitals, including public, concession, and private hospitals. The Catalan Health Service (Servei Catalá de la Salut – SCS) manages 36 of these hospitals, including eight hospitals under direct public management (Catalan Institute of Health 1 (Instituto Catalán de la Salud 1 – ICS1)), 20 hospitals of public companies or consortia with more than a 50% public shareholding (SCS2), and eight hospitals with less than a 50% public shareholding (SCS3). This hospital network also includes 24 hospitals belonging to private not-for-profit (PNFP) foundations or associations and six private for-profit (PFP) hospitals. In contrast to other communities, the Catalan healthcare network was already extensive before the decentralization of services, which makes a difference in terms of the types of services and hospitals. Catalonia, unlike the Valencian Community, is characterized by a system with more centralized specialized care and small centers (albeit with highly active hospitals and a high number of beds).

2.3 Data

We use administrative data from different sources for the quantitative analysis of the present study. First, the data on the Ribera, Vinalopó, and Torrevieja hospitals are taken from the MBDS[4] and from MOS data for 2011–2015. These data contain information for each hospital and year related to hospitalizations and on the activity of outpatient surgery units. During the 2011–2015 period, 386,264 discharges were recorded in the three hospitals, including 262,681 from hospitals and 123,583 from the respective outpatient surgery units. The non-parametric distributions of discharges by gender and age are shown in Figure 2. The pattern of discharges is expected, thus following an asymmetric unimodal distribution for men, and a bimodal distribution for women.

With regard to the distribution of comorbidities of the patients treated, Figure 3 shows the Charlson comorbidity index histogram (Charlson et al. 1994) and its review (Quan et al. 2011), based on ICD-9 codes contained in the MBDS in the five-study year. The index has proved to be a very good predictor of in-hospital mortality (Sundararajan et al. 2004), with a positive relationship between the highest values of comorbidity and mortality (85.5% on the ROC[5] curve). The index includes 11 numerical levels of severity for which the association with in-hospital mortality increases significantly: level 0 is associated with mortality rates of approximately 1%, and levels higher than 6 are associated with 20–30% mortality rates. The results show that 82.63% of hospital discharges are of level 0, 8.88% are level 1, 6.39% are level 2, and the remaining levels have an incidence of less than 1% in the sample of **CON** hospitals.

We do not have the same level of detail for the group of Catalan comparators (i.e., patient-level microdata), which limits comparisons at the individual process level. However, data published by the

[4] Data provided by Ribera Salud.
[5] Receiver Operating Characteristic.

Observatory of the Catalan Health System (Observatorio del Sistema de Salud de Cataluña), the Results Center (Central de Resultados) for all SISCAT hospitals, are available from 2012 to 2015.

We used indicators with greater time availability, higher homogeneity between years, and with minor endogeneity problems. Thus, for example, we used gross caesarean rate instead of cesarean rate in low-risk deliveries because results of the comparator group are only available for 2015.[6] The chosen indicators, both clinical and economic, are detailed below.

Figure 2 Kernel density estimates of hospital discharges by age and gender (Ribera (1), Torrevieja (2), Vinalopó (3), 2011–2015, n = 386,264)

(1)

(2)

(3)

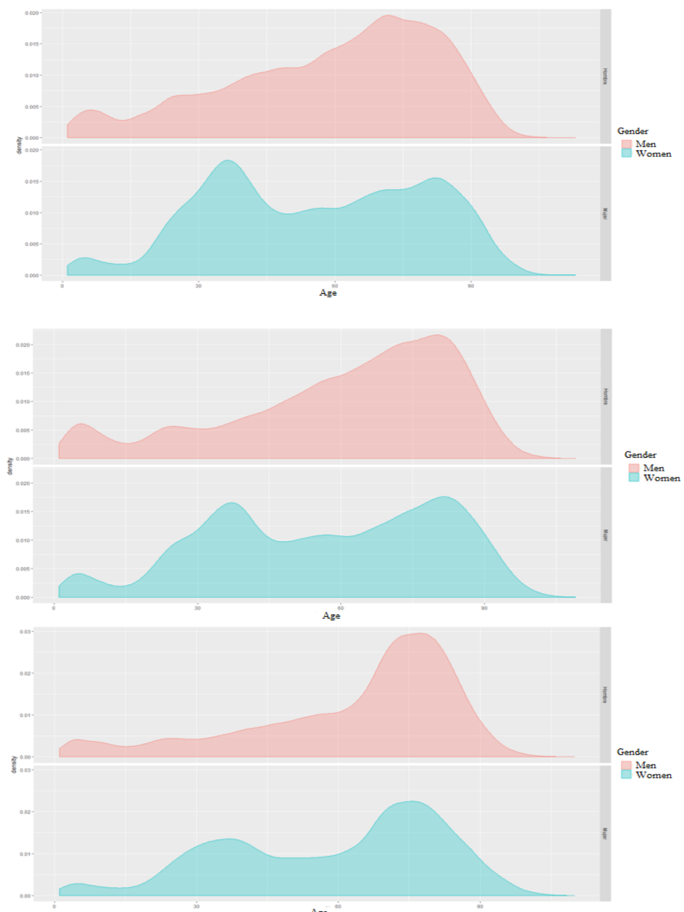
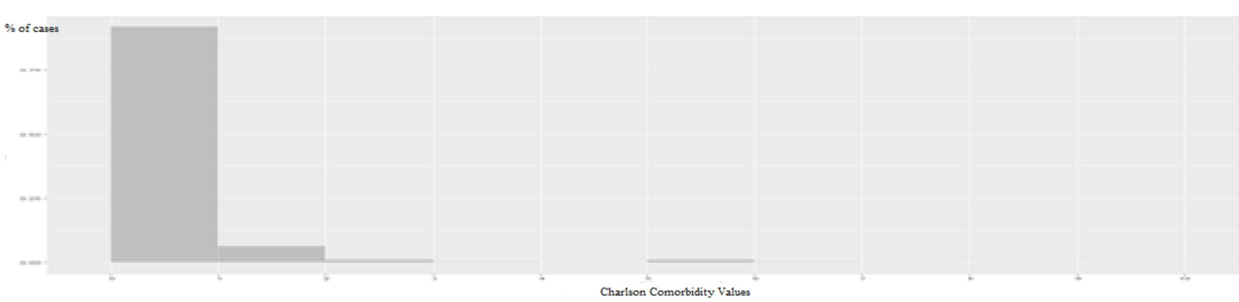


Figure 3 Distributions of Charlson Comorbidity Values



[6] The strategy used to extract the clinical indicators is detailed in the Appendix 1.

2.3.1 Indicators used

- Clinical:
  - Adequacy
    - Cesarean delivery rate: in accordance with international guidelines (World Health Organization 2015), the rate of caesarean sections of the population must not exceed 15% deliveries, because higher rates have shown no benefits for maternal or neonatal health. This is a clear indicator of procedural adequacy, because the procedure can cause permanent complications, disability, or even death, in some cases.
  - Safety
    - Mortality at hospital discharge: this is a general indicator of safety; associations between volume and mortality have been observed, as well as with 30-day mortality (EA, PP, and JD 2003; Rosenthal et al. 2000). However, this gross indicator, by definition, contains the heterogeneity of the treated diseases and, thus, must be interpreted with caution.
    - Mortality at hospital discharge for selected diseases:[7] this is a safety indicator for diseases for which procedures and clinical practice guidelines are well defined and established, both nationally and internationally, and allow a more standardized comparison of patient care safety.
  - Effectiveness
    - 30-day readmissions for selected diseases: we also use the rate of hospital readmissions at 30 days after discharge as an indicator of the effectiveness of comprehensive patient management. Recent international studies (Benbassat and Taragin 2000; Halfon et al. 2006; Tsai et al. 2013) have shown that from 12 to 75% of hospital readmissions may be prevented by patient education, pre-discharge assessment, and in-home care. Therefore, it is appropriate to study readmissions for specific diseases with a broad consensus on clinical practice, which can be relatively reliable indicators of care quality or clinical effectiveness. The following three indicators refer to chronic pathologies on which patient education has a strong impact (Healy et al. 2013):
      - 30-day readmissions for diabetes episodes.
      - 30-day readmissions for chronic heart failure (CHF).
      - 30-day readmissions for chronic obstructive pulmonary disease (COPD).
  - Efficiency
    - Mean hospital stay: although this is a controversial indicator, the mean hospital stay is an intermediate measure of coordination between care level and treatment quality that can be affected strongly by both clinical practice and the incentives of healthcare systems. We use two additional procedures for the analysis, where their efficiency is relevant to their association with either 30-day readmission rates or the use of health resources (Healy et al. 2013; Kossovsky et al. 2002; Roberts et al. 2004).
    - Mean hospital stay, acute myocardial infarction.
    - Mean hospital stay, femur neck fracture.

[7] Includes acute myocardial infarction (AMI) with ST elevation, acute myocardial infarction without ST elevation, congestive heart failure, stroke, gastrointestinal hemorrhage, femoral neck fracture, and pneumonia.

- Economic[8]
    - Public contract: public contract sum paid for services provided.
    - Debt: ratio between non-current liabilities plus current liabilities and liabilities plus equity.
    - Liquidity: ratio between current assets and current liabilities.
    - Economic profitability: ratio between operating results and assets, excluding land.
    - Solvency: ratio between total assets and non-current liabilities plus current liabilities.

2.3.2 SISCAT management models analyzed

We identified five management models in the SISCAT (*n* = 66)[9] and the management model of the three Valencian concessions (*n* = 3):

- Direct public management (**ICS1**): Catalan Institute of Health (**ICS1**) *n = 8. Volume of hospitalizations in the system: 26.3% (2015).*
- Consortia and Public Companies (**SCS2**): *n = 20, includes consortia, public companies, Catalan Institute of Oncology (Instituto Catalán de Oncología – ICO), and centers with majority participation by the Catalan Government (Generalitat Catalana). Volume of hospitalizations in the system: 33.2% (2015).*
- Other Public Companies (**SCS3**) *n = 8, different models of public ownership, with minority or no participation of the Catalan Government. Volume of hospitalizations in the system: 7.7% (2015).*
- Private Not-For-Profit (**PNFP**) *n = 24. Volume of hospitalizations in the system: 25.6% (2015).*
- Private For-Profit (**PFP**) *n = 6. Volume of hospitalizations in the system: 7.1% (2015).*
- Valencian Community Concession (**CON**) *n = 3. Hypothetic volume of hospitalizations in the SISCAT, 8.7%.*

2.4 Descriptive Statistics

Table 3 Descriptive statistics of the sample (2012–2015); n = 69 per group

Variable	**CON**	**ICS1**	**SCS2**	**SCS3**	**PNFP**	**PFP**
Hospitalizations	17512.07	19742.38	10633.14	6484.55	6730.41	6825.32
Surgical Hospitalizations	6387.67	12315.34	7233.34	4327.34	4879.85	6452.32
Medical Hospitalizations	11107.73	12099.28	7074.72	4411.97	4497.93	3656.50
MOS Hospitalizations	8238.87	4672.25	3777	2254.76	3647.37	3283.5
Casemix	0.95	1.11	1.06	0.80	0.87	0.73
Contract M€	127.7	156.7	81.6	36.8	37.08	17.04
% Cesarean sections	20.16	23.81	22.11	34.95	20.37	38.91
Mean stay (*days*)	4.80	6.32	6.48	4.86	6.72	4.60
Mean stay *FCF*	9.03	10.54	9.45	9.92	10.06	11.97
Mean stay *AMI*	6.59	6.98	7.50	6.99	7.42	8.20
% Mortality at hospital discharge	7.72	9.59	10.23	9.38	10.85	7.71
% *SD* Mortality at hospital	9.30	8.47	9.31	7.72	8.68	5.82

[8] Owing to various legal, budgetary, and accounting issues, we are cautious in our interpretation of the results, considering the measurement error of these indicators in the SISCAT system.
[9] The list of hospitals and managing entities is provided in the supplementary material.

discharge						
% 30-day read. for *Diabetes*	8.88	7.70	5.73	6.98	7.00	8.79
% 30-day read. for *COPD*	13.52	15.57	15.84	17.37	16.28	13.81
% 30-day read. for *CHF*	11.24	13.99	12.85	14.75	14.09	12.83
% 30-day read. for *SD*	8.81	9.94	9.87	10.36	9.94	7.78
N · (2012-2015)	3	8	20	8	24	6

Table 3 presents the means of the main variables of the analysis according to the management model group. In general, we observe that the activity levels of the Valencian concessions, measured in terms of conventional hospitalizations, similarly to the public contract sum, are among the hospitals of the **ICS1** and **SCS2** groups. The comparison of the level of hospitalizations for major outpatient surgery show activity levels of approximately 180% of that observed in **ICS1**. With regard to the complexity measured using the case mix (the method used to calculate this indicator for the Valencian concessions is explained in the following section), we observe that the weights of patients treated in Valencian concession hospitals (**CON**) are among the **SCS2** and **SCS3** groups.

With regard to the cesarean section rates, we observe that the levels are very similar to those of the Catalan group **PNFP**, with a gross mean rate of approximately 20%. The mean hospital stay is similar to that of **SCS3** and **PFP** hospital centers. With regard to the mortality at hospital discharge, the concession hospitals (**CON**) have a gross rate of approximately 7.72%, which is almost identical to that of the Catalan **PFP** centers (7.71%). Then, 30-day hospital readmissions for diabetes have the highest mean of the sample, nearly one percentage point above all other groups. However, the possible differences in means cannot be analyzed without considering the multifactorial character of the problem and the structure and idiosyncrasy of the system and, thus, must not be interpreted causally.

To put the hospitals in context, the Valencian public system has 35 hospitals for a population of 4,959 million inhabitants, whereas SISCAT has 66 hospitals for a population of 7,518 million[10]. These data show that the level of decentralization of hospitals is higher in the SISCAT, which implies that the production function concentrates activity in smaller centers. In contrast, the healthcare supply is more centralized in the Valencian system, producing higher average activity levels than those in the Catalan system.

Figures 4–7 show the kernel density estimates of the variables of interest as a function of the hospital group: Figure 4 shows the kernel density estimates of conventional hospitalizations, Figure 5 shows estimates of surgical hospitalization, Figure 6 shows estimates of MOS, and Figure 7 shows the casemix estimates. Figures 8–11 show the local regression (LOESS) estimates of the indicators as a function of time for each group. Figure 8 shows the casemix estimates. Figure 9 shows the percentage of cesarean sections. Figure 10 shows the mortality at hospital discharge, and Figure 11 shows the 30-day hospital readmissions.

[10] INE (2016) http:// www.ine.es/jaxiT3/Datos.htm?t=2853.

Figure 4 Kernel Density Estimates of Conventional Hospitalizations, 2012–2015

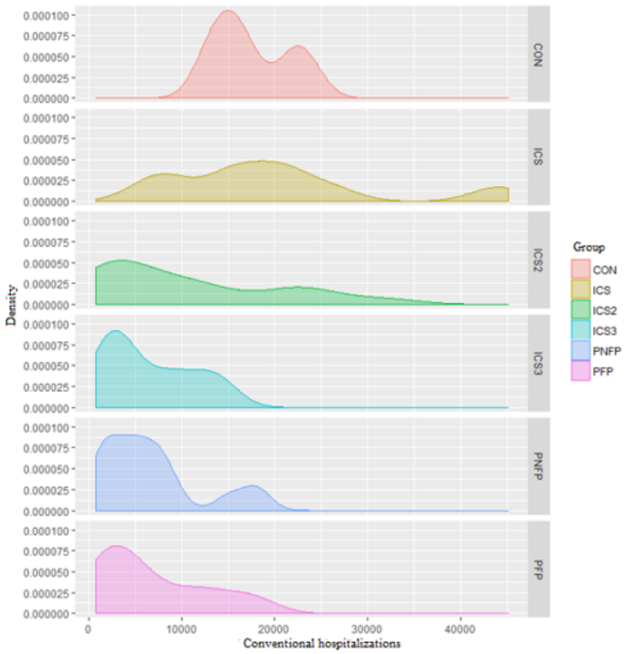


Figure 5 Kernel Density Estimates of Surgical Hospitalizations, 2012–2015

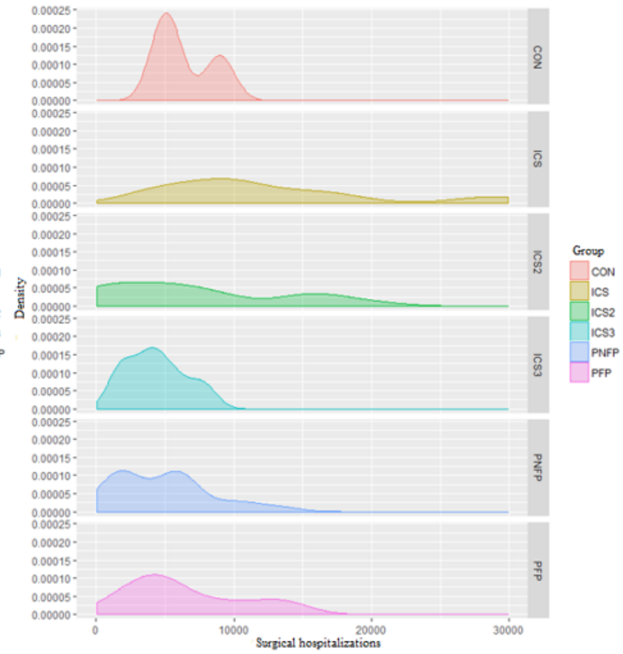


Figure 6 Kernel Density Estimates of MOS Hospitalizations, 2012–2015

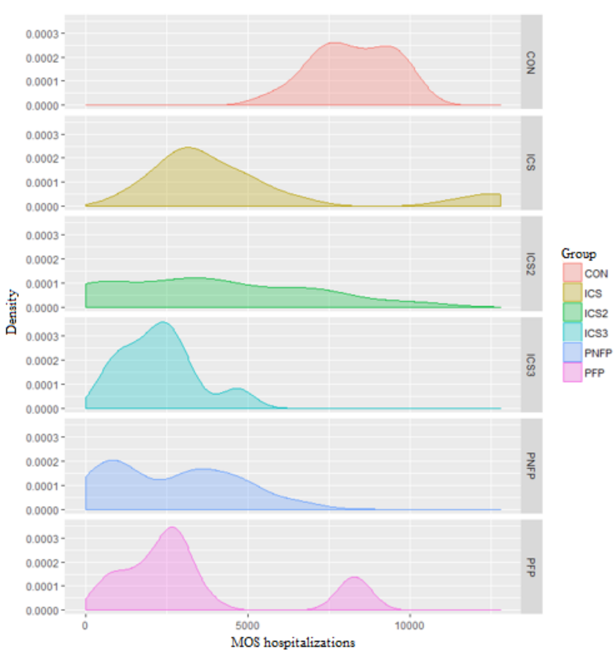


Figure 7 Kernel Density Estimates of the Casemix, 2012–2015

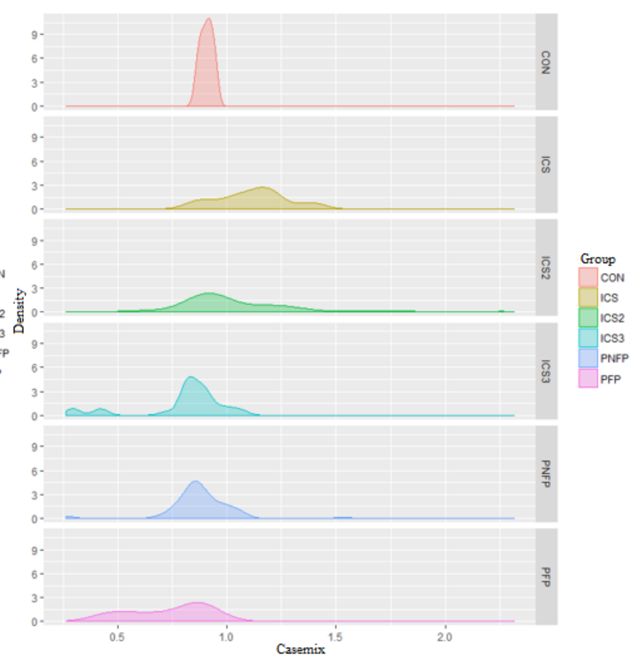


Figure 8 LOESS Estimates by Year and Group, Casemix

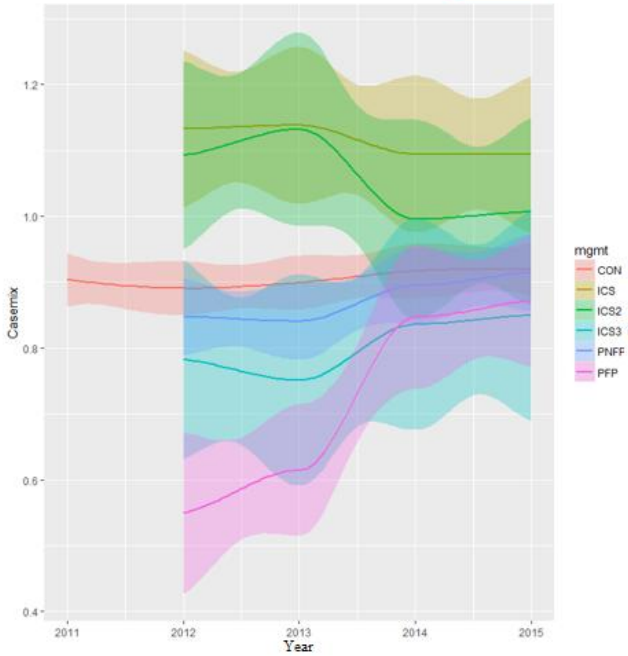


Figure 9 LOESS Estimates by Year and Group, % Cesarean Sections

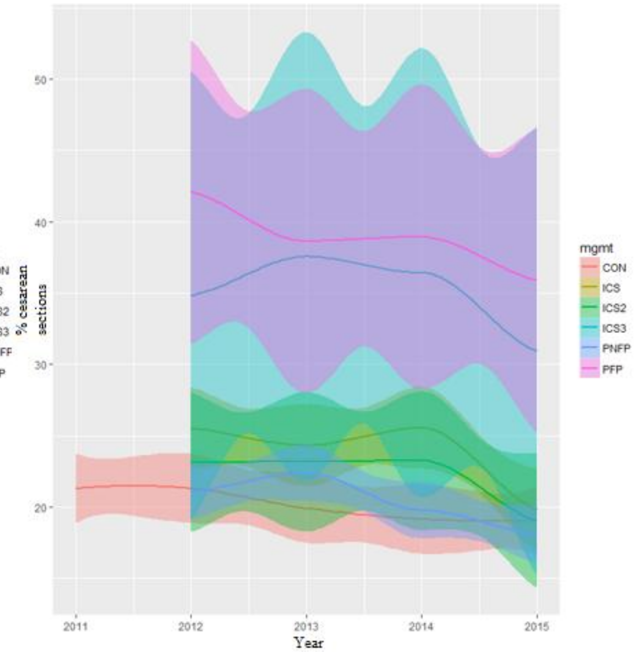


Figure 10 LOESS Estimates by Year and Group, % Mortality at Hospital Discharge

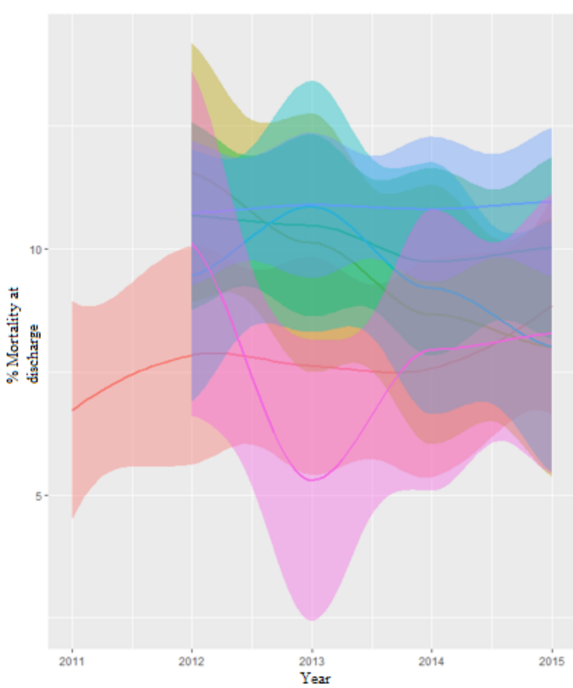


Figure 11 LOESS Estimates by Year and Group, % 30-Day Hospital Readmissions

At first glance, we observe that the activity levels of the three hospitals, both medical and surgical, resemble the levels observed in the hospitals of the ICS1-3 groups, with an outpatient surgery level similar to that observed in some SCS2 and PFP centers. The temporal evolution of the indicators represented in the LOESS graphs shows good adequacy in terms of caesarean sections and mortality at hospital discharge rates, convergent with those of the ICS1-3 and PFP groups. With regard to hospital readmissions, we observe levels similar to those of the other hospital groups.

Table 4 Descriptive Statistics (Means) of the Ribera, Torrevieja and Vinalopó Hospitals, 2011–2015

Variable	Ribera	Torrevieja	Vinalopó
Hospitalizations	22600.40	16268.00	13667.80
Surgical Hospitalizations	8969.00	5491.60	4702.40
Medical Hospitalizations	13579.40	10778.60	8965.20
MOS Hospitalizations	9589.20	6913.40	8214.00
Case mix (no AP-GRD)	0.94	0.95	0.96
Contract M€	171.2	110.3	101.6
% Cesarean sections	18.59	21.74	20.13
Means stay (*days*)	4.73	4.73	4.94
Means stay *FCF*	8.70	8.67	9.73
Means stay *AMI*	5.63	7.02	7.10
% Mortality at hospital discharge	7.06	6.83	9.29
% Mortality at hospital discharge *ES*	12.01	8.35	7.53
% 30-day read. for *Diabetes*	10.14	9.71	14.45
% 30-day read. for *COPD*	13.22	12.89	10.13
% 30-day read. for *CHF*	7.18	16.41	10.13
% 30-day read. for *SD*	8.53	8.64	9.27

Table 4 presents the means of the hospital-level aggregate indicators. In the casemix, the results are not shown as a function of the AP-GRD[11] weights because we only have the adjusted weights in the Catalan system for comparison with the SISCAT hospitals, as described in the methods section. The mean weights of the AP-GRD using the MBDS for the three hospitals are 0.97, 1.01, and 1.08, respectively. Note that the assigned weights suggest a conservative estimate of their hypothetical weight in the Catalan system.

3. Methods

3.1 *Casemix calculation*

To reduce the omitted variable bias when estimating differences in indicators resulting from hospital management, an indicator of the complexity of hospitalized patients must be included in the model. An omitted variable bias occurs when an econometric model fails to include one or more variables that are

[11] [11] The Diagnosis-Related Group (DRG) classification system catalogs episodes of hospitalization in homogeneous groups, based on the consumption of resources and on clinical similarity. The DRG classification used in Spain for the analysis of the hospital sample is the All Patient DRG (AP-DRG), designed to encode clinical variables using the international classification of diseases ICD-9-MC.

relevant to the analysis (Clarke 2005). The bias is created when the model tries to compensate for the omitted variable, overestimating or underestimating the association or effects of the other factors on the variable of interest.

With regard to the group of comparison hospitals,[12] SISCAT *n = 66 (2012–2015)*, we extracted the indicator for hospital *i* in year *t* in the Catalan system using the following equation:

Equation 1 Casemix Calculation

$$Case\ Mix_{i,t} = \frac{\dfrac{\sum_1^n (discharges_{i,t} \cdot\ weight\ DRG_{i,t})}{Nº\ altas_{i,t}}}{\dfrac{\sum_1^n (discharges\ SISCAT_t \cdot\ weight\ DRG\ SISCAT_t)}{No. discharges\ SISCAT_t}},$$

where Casemix assumes positive real values, and the mean is 1. Values higher than 1 indicate a mean complexity of patients admitted higher than that of the system, and values lower than 1 are lower than the mean complexity. Because we do not have these data for the Valencian Community context, we estimated the hypothetical complexity of the three hospitals by analyzing them as though they were in Catalonia. For this purpose, we created a panel data model with fixed effects for the SISCAT using the following equation:

Equation 2 Casemix Estimation Model

$$Case\ Mix_{i,t} = \alpha + \beta_1 X_{1,i,t} + \beta_2 X_{2,i,t} + \beta_3 Z_{1,i,t} + \beta_4 Z_{2,i,t} + \beta_5 W_{1,i,t} + \gamma_t + \varepsilon_{i,t},$$

where X_1 is the number of conventional hospitalizations, X_2 is the number of major outpatient surgery hospitalizations, Z_1 is the mean hospital stay, Z_2 is the mortality at hospital discharge, and γ denotes the fixed temporal effects, coded as binary variable for each year. Then, using the estimated model, we made predictions by year and hospital, based on observables. We obtained an F statistic of 52.06 *($p < 0.001$)* and R^2 value of 75.75%, with a standard residual error of 0.065. The estimated mean values for the three hospitals over the five years are: 0.94 for Ribera, 0.90 for Torrevieja, and 0.88 for Vinalopó. This indicates that the average patient hospitalized in the three Valencian hospitals is marginally less complex than the Catalan average patient. The analysis of the Charlson comorbidity index for hospital discharges from 2011 to 2015 for the three concession hospitals shows that the casemix results, estimated to enable the comparison with the Catalan system, corroborate this index.

3.2 Network Analysis

The network analysis explores the flows of patients, both incoming and outgoing, from the protected population area, to determine whether there are patients not included in the MBDS on which hospitals may be operating.

To analyze the flow of patients between **CON** hospitals (Ribera, Torrevieja and Vinalopó) and the rest of the Valencian health system, we assess the weights by hospital cost (GRD-AP 2014.1) of the protected population treated in other hospital centers and of the patients treated in the **CON** hospital centers from external areas for the 2012–2015 period. The data are provided by the Ribera Salud Group.

3.3 Panel data

[12] Data available at: http://observatorisalut.gencat.cat/ca/central_de_resultats/.

As a primary analysis, we create a linear regression model with panel data and fixed effects: intuitively, this method compares similar hospitals in terms of activity, complexity, year, and geography toward minimizing the omitted variable bias. The variable of interest in this case is the hospital group identified as a factor of six levels, corresponding to the previously identified management models. For these models, the observations of the concession hospitals of 2011 are rejected owing to the lack of homogeneous indicators for the comparator group during this year. The empirical specification is the following:

Equation 3 Linear regression model with panel data and fixed effects

$$Y_{i,t} = \alpha + \beta_1 M_{i,t} + \beta_2 A_{i,t} + \beta_3 C_{i,t} + \epsilon + \tau_t + \varepsilon_{it}.$$

Equation 3 represents the empirical specification of the regression models used for the described indicators, where $Y_{i,t}$ s the clinical or economic indicator of hospital *i* in year *t*, α is the constant term of the model, β_1 is the coefficient of the hospital group M, β_2 is the coefficient of surgical hospital activity *A*, β_3 is the coefficient of the casemix *C*, ϵ are fixed non-observable geographical effects over time, τ_t is the fixed effect of year *y*, and ε_{it} is the error term. This empirical specification aims at eliminating the omitted variable bias of the model as much as possible by controlling for activity, complexity, and temporal and geographical trends (Chamberlain 1984; Croissant and Millo 2008). The coefficient β_1 should approximate the difference between hospital management groups, controlled for activity (conventional or surgical), patient complexity, and geographical and temporal fixed effects. The goodness-of-fit of the regression models are assessed using the adjusted R^2 and the F-test, Student's t-test is used to assess the statistical significance of model coefficients, and the confidence intervals are calculated using the Eicker–Huber–White method (Hoechle 2007). We use no random-effects model because the study unit is aggregated at the hospital and year levels, and the independent variables of the model (volume of activity and casemix) are correlated (Bell and Jones 2015).

The objective of this analysis is to validate the null hypothesis that there are no significant and systematic differences between the hospital management groups (M) and the clinical and economic indicators of interest.

3.4 Synthetic control approximation

To improve the comparison of the concession hospitals with the groups of SISCAT hospitals, we applied the synthetic control method (Abadie, Diamond, and Hainmueller 2010), for the following reason: instead of comparing the results with the average of the group of SISCAT hospitals (n = 66), we construct a linear combination of the SISCAT hospitals, using weights (*W*) to minimize the distance, in terms of the observable characteristics. Then, we compare the results of the control group for each of the concession hospitals. For this purpose, we used data from hospitals for 2012 and 2013, and compared the results in 2014 and 2015 with the resulting control group.

Its application[13] in based on the fact that *W* is a dimension vector (J × 1) of positive weights for each hospital of the control group, with a total value of 1. Here, each value of W represents the weighted average of the available hospitals in the control group and, therefore, is a synthetic control. The variable of interest is observed during T periods in each hospital, 2012–2015 for our case.

Defining K as a linear combination of pre-intervention indicators, such that $Y_i^K = \sum_{s=1}^{T_0} k_s Y_{is}$, and considering M as a vector of such linear combinations defined using vectors K, namely, $X_1 = (Z_1', Y_j^{K_1}, \dots, Y_j^{K_M})'$, we have a matrix (*k* × *J*) of pre-intervention characteristics for the hospital, with *k* = *r*

[13] For a more detailed explanation, please see (Abadie and Gardeazabal 2003).

+ *M*. Similarly, $X_0 = (Z_1', Y_j^{K_1}, \ldots, Y_j^{K_M})'$ is a matrix (*k x J*) of pre-intervention characteristics for the comparator group. The vector W^* is chosen to minimize the distance, $|X_1 - X_0 W|$, such that all weights *w* are positive and sum to 1. To measure the discrepancy between X_1 and X_0, we use $|X_1 - X_0 W|v = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$, where *V* is a positive, semi-defined symmetric matrix (*k x k*).

4. Results

Table 5 outlines the bidirectional flow of patients of each hospital, analyzed with regard to the Valencian healthcare system. The results show that, in all hospitals and years, including adjusting for AP-GRD 2014.1 weights, the flow of patients to the three hospitals exceeds the flow of patients referred to other hospitals in the Valencian community.

The average weights for patients in the outpatient surgery unit (OSU) referred to the Ribera, Torrevieja, and Vinalopó hospitals from 2012 to 15 were approximately 0.45, 0.46, and 0.45, respectively. With regard to hospitalizations, the average weights are 1.018, 0.98, and 1.73, respectively, for the same hospitals. In the case of protected area patients seen in other hospitals of the community, the weights of the OSU cases are 0.58, 0.62, and 0.55, and the weights of hospitalizations are 1.20, 1.51, and 1.28, respectively.

The mean influx of patients in the Valencian Community weighted by complexity, treated in the Ribera, Torrevieja, and Vinalopó hospitals during the study period, are approximately 1076, 2077, and 1889, respectively. These figures imply that, in average annual terms, the three concession hospitals treat approximately 5,000 adjusted cases more than those that are referred to other hospitals for any reason.

4.1 Network analysis

Table 5 External and Internal Flow of Patients (Rib., Tor., and Vin). 2012–2015

		CV-**CON** Derivations				**CON**-CV Derivations			
		Unadjusted		Adjusted		Unadjusted		Adjusted	
Hospital	Year	OSU	Hosp.	OSU	Hosp.	OSU	Hosp.	OSU	Hosp.
Ribera	2012	994	2572	447	2912	407	1881	217	2159
	2013	1146	2882	513	2950	511	1794	267	2107
	2014	1122	3106	503	2978	486	1873	283	2266
	2015	1278	3115	570	2979	457	1514	315	1933
Torrevieja	2012	1043	2816	477	2808	119	938	74	1213
	2013	368	3259	172	3088	154	728	77	1158
	2014	444	3041	205	2945	133	659	90	1037
	2015	609	3031	279	3050	91	630	64	1002
Vinalopó	2012	1299	1952	583	2699	173	1241	67	1454
	2013	1193	1633	530	2748	229	991	97	1195
	2014	1286	1413	577	2869	204	1051	143	1541
	2015	1515	1560	667	2854	156	1042	109	1362

Note that healthcare planning is the sole responsibility of the Valencian Health Department (Conselleria de Sanidad Valenciana – CSV), which decides what services each hospital provides. Therefore, a network structure also exists within the Valencian healthcare system, regulating patient flows, and centralizing services such as burn or organ transplantation units in the three hospitals.

4.2 Panel data models

The results from the panel data models by hospital group, according to ownership or management, are shown below. These models enable us to identify the relationship between the management models and the indicators analyzed below. The tables outline the β_1 coefficients of the regression models, which are interpreted as the attributable difference in the indicator between the concession hospitals (Ribera, Torrevieja, and Vinalopó (**CON**)) and the different hospital management groups of the Catalan system (**ICS1-3**, **PNFP**, and **PFP**). Positive coefficients mean that the concession hospitals have higher values of the dependent variables (% cesarean sections, % mortality at hospital discharge) than those of the Catalan system comparator. The analysis controls for complexity and includes fixed regional and temporal effects, which showed no variability by region for each hospital or year. Thus, the values of the coefficients do not depend on complexity, regional differences, or temporal trends.

Table 6 Regression, Adequacy, and Safety Models (2012–2015, including Fixed Effects)

	Dependent Variable:		
	% Cesarean sections	% Mortality at hospital discharge	% Mortality at hospital discharge (*ES*)
	(1)	(2)	(3)
ICS1-CON Difference	9.946***	0.883	-0.748
	(3.628)	(1.493)	(1.118)
SCS2-CON Difference	6.586*	1.023	-0.148
	(3.927)	(1.586)	(1.188)
SCS3-CON Difference	15.829***	-0.086	-0.578
	(3.560)	(1.467)	(1.119)
PNFP-CON Difference	5.340	1.398	0.262
	(3.899)	(1.605)	(1.195)
PFP-CON Difference	20.335***	-1.737	-2.907**
	(4.196)	(1.723)	(1.290)
Mean indicator	24.45	9.93	8.52
	(0.73)	(0.23)	(0.17)
Observations	198	236	251
R^2	0.587	0.319	0.348
Adjusted R^2	0.541	0.256	0.291
Estimated Residual Error	6.983 (df = 177)	3.059 (df = 215)	2.344 (df = 230)
F Statistic	12.604*** (df = 20; 177)	5.036*** (df = 20; 215)	6.137*** (df = 20; 230)
Note:			*In this and the following tables:* *p<0.10 **p<0.05 ***p<0.01

Table 6 outlines the results from the selected adequacy and safety indicators. The results showed that, when controlling for complexity and regional and temporal fixed effects, the three **CON** hospitals have cesarean section rates significantly different from those of the Catalan groups, except the Catalan group **PNFP** (private not-for-profit hospitals). However, all other categories have higher cesarean section rates than the **CON** group. The SISCAT private for-profit (**PFP**) hospitals are 20 percentage points higher, the hospitals of the **SCS3** group are 15 percentage points higher, and those of the **ICS1** group are approximately 10 percentage points higher. The **SCS2** hospitals have a difference of 6.5 %, albeit only significant at the 10% level. Note that, owing to data limitations, the control for complexity (at the hospital level) prevents us from adjusting for obstetrician risk of deliveries at the individual level and, therefore, for differences in care complexity. This is a key factor, especially for the **ICS1** and **SCS2** groups. The goodness-of-fit of the model is relatively high (adjusted R^2 = 0.541), which indicates that the model captures more than 50% of the variance in the indicator. With regard to mortality at hospital discharge and mortality for selected diseases (*SD*), we found no significant differences between the hospital groups. We only find a significantly lower rate in the **PFP** hospital centers of the SISCAT, compared with the other hospital groups, in column (3) of Table 6. This difference may be due to the flow of patients in the SISCAT network, in which the most complex cases treated at **PFP** centers are usually transferred to **ICS1** and **SCS2** hospitals. Therefore, hospital discharges are often encoded as a transfer, and not as an *exitus*. However, we can conclude that, at the group level, **CON** hospitals have highly correct adequacy, measured as the cesarean rate. With regard to safety, we conclude that **CON** hospitals are at least as safe as Catalan hospitals.

Table 7 Regression and Efficiency Models (2012–2015, including Fixed Effects)

	Dependent Variable:		
	Mean stay	FCF Mean Stay	AMI Mean Stay
	(1)	(2)	(3)
ICS1-CON Difference	-1.100	2.369	-0.212
	(2.912)	(2.509)	(1.055)
SCS2-CON Difference	-0.475	2.820	0.323
	(3.081)	(2.644)	(1.114)
SCS3-CON Difference	0.488	3.474	-0.104
	(2.931)	(2.565)	(1.058)
PNFP-CON Difference	1.098	3.803	0.372
	(3.098)	(2.662)	(1.120)
PFP-CON Difference	-0.408	6.398**	0.792
	(3.374)	(2.878)	(1.218)
Mean Indicator	6.07	10.04	7.34
	(0.40)	(0.32)	(0.13)
Observations	136	123	134
R^2	0.285	0.183	0.136
Adjusted R^2	0.182	0.051	0.010
Estimated Residual Error	4.259 (df = 118)	3.531 (df = 105)	1.537 (df = 116)
F Statistic	2.763*** (df = 17; 118)	1.383 (df = 17; 105)	1.076 (df = 17; 116)

The efficiency models are measured as mean hospital stay. Here, the results show no significant differences between hospitals from the **CON** group and other hospitals in terms of general mean hospital stay and the mean stay owing to a fracture of the neck of the femur or acute myocardial infarction. We found a mean hospital stay due to fractured neck of the femur in **PFP** hospital centers approximately only 6.4 days longer than that in the other hospital groups. Thus, we conclude that **CON** hospital centers show similar performance to that of Catalan hospitals in terms of mean hospital stay. The goodness-of-fit of the models is relatively low compared with the results outlined in Table 6.

Table 8 Regression and Effectiveness Models (2012–2015, including Fixed Effects)

	Dependent variable:			
	% Read. 30 days SD	Read. 30 days *Diabetes*	Read. 30 days *CHF*	Read. 30 days *COPD*
	(1)	(2)	(3)	(4)
ICS1-CON Difference	-1.534	4.674**	1.326	-2.145
	(1.448)	(2.206)	(1.898)	(2.051)
SCS2-CON Difference	-2.335	2.445	0.515	-1.459
	(1.526)	(2.359)	(2.011)	(2.187)
SCS3-CON Difference	-0.628	2.381	2.845	1.250
	(1.385)	(2.166)	(1.822)	(1.970)
PNFP-CON Difference	-2.068	3.806	1.760	-0.533
	(1.518)	(2.387)	(2.026)	(2.213)
PFP-CON Difference	-3.175*	7.674**	1.423	-2.286
	(1.751)	(3.392)	(2.286)	(2.571)
Mean Indicator	9.79	6.89	13.57	15.91
	(0.20)	(0.32)	(0.26)	(0.29)
Observations	239	186	227	226
R^2	0.274	0.290	0.225	0.233
Adjusted R^2	0.208	0.204	0.150	0.158
Estimated Residual Error	2.830 (df = 218)	3.868 (df = 165)	3.703 (df = 206)	3.967 (df = 205)
F Statistic	4.122*** (df = 20; 218)	3.375*** (df = 20; 165)	2.991*** (df = 20; 206)	3.110*** (df = 20; 205)

With regard to the effectiveness of the procedures, measured as the 30-day readmission rates, we find significant differences in three cases only. With regard to the 30-day readmission rates for selected diseases, *SD*, we again find a difference in the **PFP** group only, which had a rate 3.17% lower than that of the other groups. Considering the results in Table 6 with regard to mortality at hospital discharge for *SD*, we conclude that the most serious patients treated in PFP hospitals of the SISCAT are transferred to other hospital centers, which significantly decreases both mortality and the 30-day readmission rates. With regard to the 30-day readmission rates for diabetes episodes, we find that both **ICS1** and **PFP** hospitals have significantly higher rates than **CON**, **SCS2-3**, and **PNFP** hospitals. We find no significant difference in congestive heart failure (CHF) or chronic obstructive pulmonary disease (COPD). In general, we conclude that **CON** hospitals are similar to Catalan hospital groups in terms of treatment effectiveness.

Table 9 Regression and Economic Indicator Models (2012–2015, including Fixed Effects)

	Dependent Variable:				
	Contract (*M€*)	Debt	Liquidity	Profitability	Solvency
	(1)	(2)	(3)	(4)	(5)
ICS1-CON Dif.	18.009*			-3.765*	
	(9.932)			(1.959)	
SCS2-CON Dif.	13.052	-8.151	-29.830	-2.772	3.927
	(10.576)	(12.125)	(28.830)	(2.091)	(46.489)
SCS3-CON Dif.	9.232	-4.779	-43.536	-3.211	-29.963
	(10.133)	(11.278)	(26.816)	(1.990)	(43.241)
PNFP-CON Dif.	8.343	2.169	-6.875	-2.319	-12.855
	(10.716)	(12.316)	(29.286)	(2.116)	(47.224)
PFP-CON Dif.	-8.800	6.798	-40.819	-0.632	-29.706
	(10.957)	(12.534)	(29.803)	(2.212)	(48.059)
Mean Indicator	66.38	69.52	123.92	0.98	163.07
	(4.79)	(2.09)	(4.46)	(0.20)	(6.80)
Observations	256	221	221	253	221
R^2	0.916	0.253	0.285	0.183	0.227
Adjusted R^2	0.909	0.186	0.222	0.116	0.158
Estimated Residual Error	23.373 (df = 236)	24.274 (df = 202)	57.719 (df = 202)	4.558 (df = 233)	93.074 (df = 202)
F Statistic	134.873*** (df = 19; 236)	3.796*** (df = 18; 202)	4.479*** (df = 18; 202)	2.747*** (df = 19; 233)	3.299*** (df = 18; 202)

The economic outcomes, presented in Table 9, show no significant differences in public contract sum (expressed as millions of euros) in any group, except **ICS1**, with average spending of 18 million euros higher than the other groups ($p < 0.1$), after adjusting for all variables described in the methods section. Therefore, in general, we cannot conclude that the financing of the **CON** hospital centers is different from that of the Catalan groups, adjusted for complexity and activity volume. No significant differences in liquidity and profitability are found between hospital management groups.

4.3 Synthetic Control

Synthetic control is a method of creating a control unit to assess the impact of the study object, in our case, a concession hospital. Its usefulness lies in combining untreated units (i.e., “synthetic” control), in our case, a set of non-concession hospitals, that may provide a closer approximation to the characteristics of the study units (i.e., concession hospitals). This allows us to estimate the impact of the treatment (i.e., being a concession hospital) more directly, avoiding the biases of having control units that are not similar enough to the treatment units (i.e., concession hospitals).

We analyzed the temporal evolution of the indicators, the public contract sum, and the general mortality at hospital discharge in order to apply the synthetic control.

Thus, we use a synthetic hospital as similar as possible to the hospital analyzed in terms of observable characteristics, conventional, medical, surgical, MOS, and mixed-case hospitalizations for the entire study period as a comparator at the individual level for the study indicator in 2012 and 2013. Therefore, the results should be interpreted by comparing the evolution of the indicators of a theoretically identical hospital. The advantage of this comparison method lies in the automatic and systematic selection of comparators, which can be interpreted as a selection depending on the relevance for each case.

5. Health policy implications

5.1. Ribera Hospital

Figures 12 and 13 show the graphs resulting from the synthetic control, indicating a favorable evolution of the indicators of the public contract amount from 2013, lower than the control, and a favorable evolution of the mortality at hospital discharge compared with the synthetic control. The composition of the synthetic comparator is specific to the hospital center and to the indicator. Table 10 outlines the weights of each Catalan hospital on the construction of the synthetic hospital of Ribera.

Figure 12 Synthetic Control, Ribera Hospital, 2012–2015, Public Contract Sum

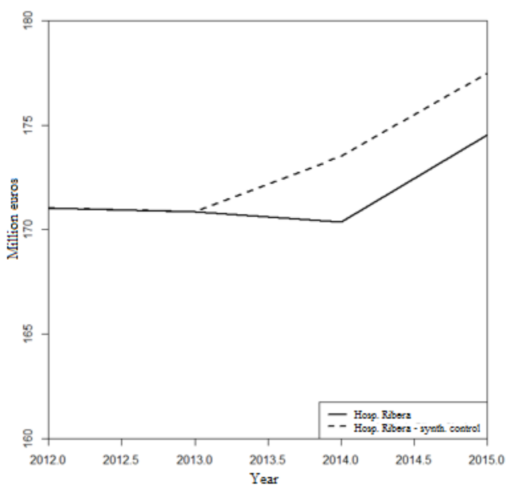


Figure 13 Synthetic Control, Ribera Hospital, 2012–2015, Mortality at Hospital Discharge

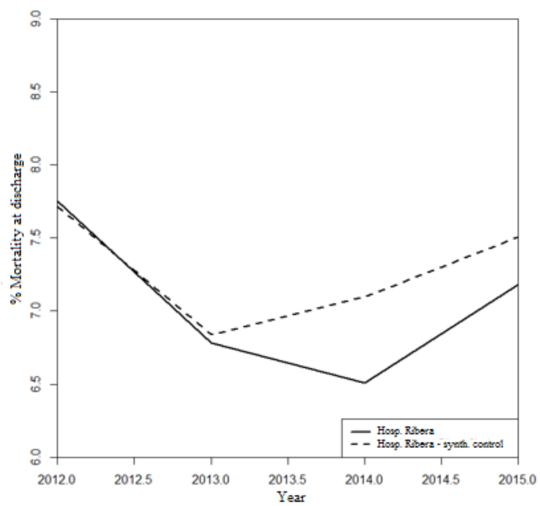


Table 10 Weights of the Catalan Synthetic Hospital Comparator Ribera

Hospital	Contract Sum % *W (weights)*	Hospital	Mortality at Hospital Discharge % *W (weights)*
Sabadell Hospital	61.5%	Sacred Heart University H.	56.9%
Mollet Hospital	26%	Holy Cross and Saint Paul University H.	22.5%
Hebron Valley University H.	7.9%	Hebron Valley University H.	20.6%
Sacred Heart University H.	2.9%	-	-
Holy Spirit Hospital	1.6%	-	-

The results suggest no negative evolution of the Ribera Hospital, both in public financing and in patient care safety, with regard to the most similar synthetic case in the Catalan system. In fact, the mortality at hospital discharge of Ribera hospital decreased by 0.589 percentage points in 2014. The results are in line with those obtained from panel data models. The trend in financing also stands out. Despite the increase in the public contract sum of Ribera Hospital, the synthetic comparator also shows a parallel increase in financing, albeit earlier. Overall, all hospitals tended to increase their budgets at the beginning of the economic cycle, particularly from 2014 to 2015.

5.2 Torrevieja Hospital

The analysis of Torrevieja Hospital shows that, first, the evolution of the synthetic control until 2013 is somewhat different. Therefore, the results should be interpreted cautiously. Nevertheless, the differences in the public contract sum and in the percent of mortality at hospital discharge are small, suggesting that the evolution of Torrevieja Hospital is similar to that of the synthetic group of Catalan hospitals.

Figure 14 Synthetic Control, Torrevieja Hospital, 2012–2015, Public Contract Sum

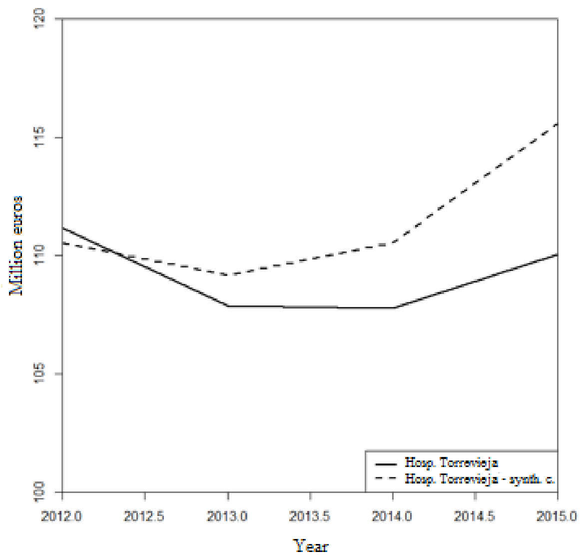


Figure 15 Synthetic Control, Torrevieja Hospital, 2012–2015, Mortality at Hospital Discharge

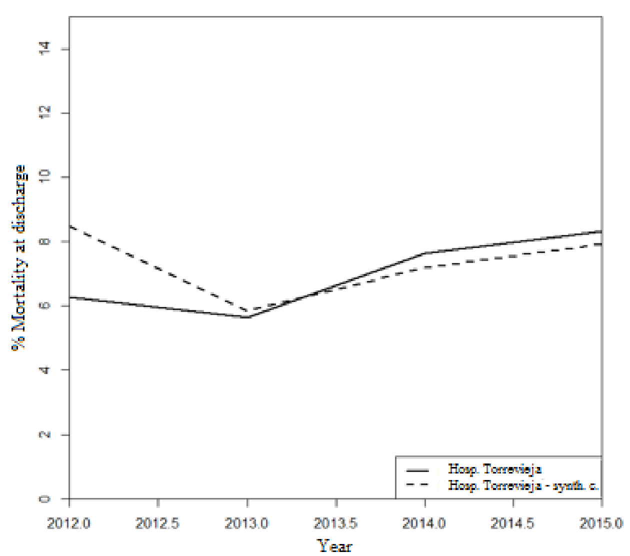


Table 11 Weights of the Comparator Synthetic Catalan Hospital Torrevieja

Hospital	Contract Sum % W *(weights)*	Hospital	Mortality at hospital discharge % W *(weights)*
Calella and Blanes Regional Hospitals	53.1%	Sacred Heart University H.	53.3%
Althaia H. (Manresa)	16%	Holy Cross and Saint Paul University H.	27.4%
Hebron Valley University H.	11.7%	Sabadell H.	16.5%
L'Hospitalet de Llobregat H. - MB H.	6.2%	L'Hospitalet de Llobregat H. - MB H.	2.3%
Holy Spirit Hospital	1.7%	-	-

The public contract sum of Torrevieja Hospital evolves similarly to that of Ribera Hospital, recovering from a downward trend in 2012–13, and recovering in terms of financing, albeit at lower levels than those of the comparator hospital. After 2013, no differences in mortality at hospital discharge were observed between the hospitals.

5. 3. Vinalopó Hospital

The analysis of the Vinalopó Hospital shows a similar trend, with no significant differences in results compared with the synthetic group.

Figure 16 Synthetic Control, Vinalopó Hospital, 2012-2015, Public Contract sum

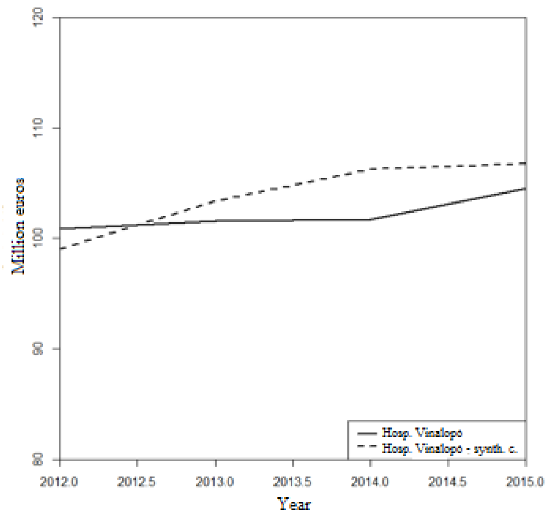


Figure 17 Synthetic Control, Vinalopó Hospital, 2012-2015, Mortality at Hospital Discharge

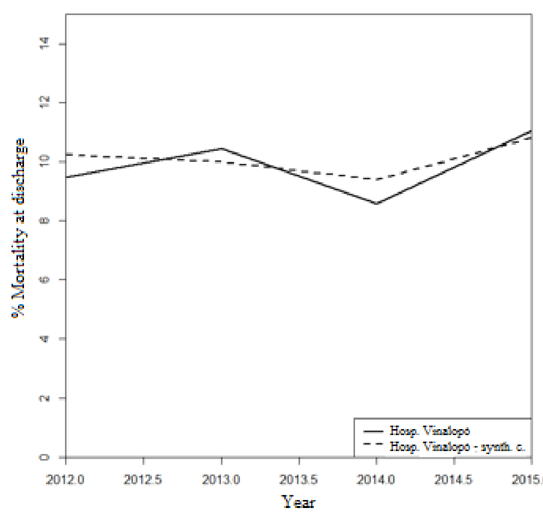


Table 12 Weights of the Catalan Synthetic Hospital Comparator Vinalopó

Hospital	Contract Sum % W *(weights)*	Hospital	Mortality at hospital discharge % W *(weights)*
Sacred Heart University H.	72.4%	Holy Spirit H.	59.5%
Holy Cross and Saint Paul University H.	27.6%	Sabadell H.	32.5%
		L'Hospitalet de Llobregat H. - MB H.	8%

In terms of financing, similarly to the other hospitals analyzed, the increasing trend since 2012 was no higher than that of the synthetic comparator. In terms of mortality at hospital discharge, the results showed that, similarly to Torrevieja Hospital, Vinalopó Hospital followed a trend almost identical to that of the comparator.

6. Final comments and limitations

The findings show no significant differences in either clinical or economic indicators between SISCAT hospitals and the available data, both at the level of the hospital management group and at the level of the disease registry of each study hospital. Nevertheless, the evidence indicates decreased procedure adequacy (cesarean sections) and increased numbers of major outpatient surgeries compared with the comparators. Owing to the flow of patients between the health departments of the Valencian Community and the lack of indicators of complexity at the individual patient level for the comparator group, we made conservative assumptions on the complexity of patients treated at the hospitals, which could overestimate the differences.

The comparison among the different Catalan hospital management groups showed systematic differences from the group of private for-profit hospitals, which had a worse cesarean rate (20 percentage points higher), longer mean stay due to fracture of the femur neck (approximately six days), and 7.67% more 30-day readmissions for diabetes episodes. In addition, for the private for-profit Catalan hospitals, the rates of mortality at hospital discharge for selected diseases and for 30-day readmissions for the same diseases were systematically lower than those of the other hospital groups, including the Valencian hospitals (2.91% and 3.17%, respectively). A potential explanation for these estimates is the configuration of the Catalan hospital system, in which the most serious cases are not treated in these hospitals. Instead, they are referred to other hospital centers with higher levels of specialization, particularly the ICS1 and the SCS2 hospitals. Accordingly, the hypothesis that this is the case for concession hospitals can be ruled out. Taken together, the Ribera, Torrevieja and Vinalopó hospitals had virtually identical results to those of the SCS2, SCS3, and PNFP hospital groups, except in the case of cesarean sections, where the former hospitals showed better results.

At the individual level, the results from the synthetic control suggest that the evolution of the public financing of the different types of activity, adjusted for complexity, is in no case better than the evolution of the Catalan synthetic comparators. In terms of mortality at hospital discharge, we also found no dynamics contrary to the findings at the group level. In terms of the derivational dynamics between the Valencian Community and the study hospitals, the higher complexity of patients referred to Vinalopó Hospital should be noted.

In summary, the Valencian concession hospitals show at least similar health and economic indicators to those of the SCS2-3 and PNFP Catalan groups.

However, the lack of reference data for the Valencian system is the main limitation of our analysis, especially with regard to the weight and typology of the patients in the system, thus preventing an intra-community comparison. Nevertheless, our findings suggest there are no differences in the indicators of results between the concession hospitals and the Catalan hospitals, either in clinical or economic terms.

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