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MEASURING THE EFFICIENCY OF AN EU COUNTRY'S DECENTRALISED HEALTH SYSTEM

Running Head: Efficiency in a desentralised Health system.

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The authors declare that they had full access to all of the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis

Summary

Objective: The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Matherial and Methods: In this paper we have used Data Envelopment Analysis (DEA) to analyse the evolution of efficiency in the last ten Autonomous Regions to receive health care competences at the end of 2001. For this study we have taken into account the number of beds and full-time workers as inputs and the calculation of basic care units as outputs to measure the efficiency of the Spanish public sector, private sector and jointly in the years 2002, 2007, 2012 and 2017.

Results: Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%).

Conclusion: In general, it can be observed that the transfer of responsibilities in the health sector has improved efficiency in the NHS.

Strengths and limitations of this study

We are aware that, by using full-time workers as input, those communities with a greater weight of part-time staff may overestimate their efficiency results, which could be a limitation. On the other hand, we have used the basic units of assistance or UBAs as outputs which, although they offer fairly approximate information, may make it difficult to compare with other studies.

JEL classification

C14; I18; H21.

Key words: Efficiency; National Health System; Devolution; DEA; Data Envelopment Analysis; Health Decentralisation.

1. Introduction

Spain is a decentralised country in which the Autonomous Communities have the powers to administer and manage certain public services, including health. However, this has not always been the case. To understand the current situation, it is necessary to go back to 1977, the year in which the Ministry of Health and Social Security was created. Months later, by Royal Decree-Law 36/1978, a Social Security Management Entity was created, the National Health Institute, abbreviated as INSALUD, in charge of providing health care (García González-Posada, J.,1999).

During the process of political and economic change that took place at that time, the Spanish Transition, the approval of the Constitution in 1978 brought changes related to the decentralisation of powers, including in the area of health. Specifically, Article 43 recognises the right to health protection and Article 148.1.21 recognises health as a competence that can be assumed by the Autonomous Communities, leaving only the State with exclusive competence in external health and the general coordination of health (Article 149.1.16).

The constitution of the communities is carried out at different paces, so there are some that assume the functions and services carried out by INSALUD sooner than others, the process of transfer begins in 1981 and ends at the end of 2001. Thus, first, Catalonia (1981), Andalusia (1984), the Basque Country (1984), the Valencian Community (1987), Galicia (1990), the Community of Navarre (1990) and the Canary Islands (1994) received the competencies.

Meanwhile, Aragon, the Principality of Asturias, the Balearic Islands, Cantabria, Castile-La Mancha, Castile and Leon, Extremadura, La Rioja, the Community of Madrid and the Region of Murcia were under State administration through INSALUD, until they received the transfer of competences. After a long process, at the end of 2001, these last ten Autonomous Regions received the transfers and by the following year were already administering and managing health care in their territory. Thus, INSALUD was liquidated and converted into a smaller entity, the Instituto Nacional de Gestión Sanitaria, abbreviated as INGESA (Cantarero, D., 2003), which would continue to administer and manage healthcare in the Autonomous Cities of Ceuta and Melilla.

Therefore, to summarise, our country currently has the National Health System, which brings together the public health networks of the seventeen Autonomous Regions, and INGESA, the state administrator and manager of the Autonomous Cities.

The decentralisation of the health system carried out in Spain is not an isolated event; other countries such as Italy, the United Kingdom, Portugal, the Philippines, etc. have also done so (Alves, J., Peralta, S., & Perelman, J. 2013; Liwanag, H. J., & Wyss, K., 2018). These types of reforms have given rise to a debate in the literature about who plays a better role in managing healthcare: the state or the territories that make it up? In other words, in terms of the welfare and efficiency of the population, what is more favourable: a centralised or decentralised healthcare system?.

Numerous studies (Abimbola, S., Baatiema, L., & Bigdeli, M., 2019; Alves, J., Peralta, S., & Perelman, J.,2013; James, C., Beazley, I., Penn, C., Philips, L., & Dougherty, S.,

2019; Liwanag, H. J., & Wyss, K., 2018) discuss the direct consequences that accompany health decentralisation, as well as its advantages and disadvantages.

Decentralisation is generally considered to improve efficiency in health care and influence health care by bringing governance closer to the population, allowing for feedback (Abimbola, S., Baatiema, L., & Bigdeli, M., 2019). It also fosters competition between territories that try to stand out and proceed in the best possible way, most of the time leading to increased spending, which is often accompanied by improved health outcomes.

However, when decision-makers increase spending, this can result in increased costs due to: duplication of inputs, where two neighbouring regions may share similar services; diseconomies of scale or even moral hazard, as they expect their debts to be covered by the central government (Alves, J., Peralta, S., & Perelman, J., 2013).

Methodology and data

2.1. Variables used

The information on the variables used has been compiled from the Spanish Ministry of Health database (Sanidad, 2004; Salud & Sanitaria, 2009; Estadística de Centros de Atención 2012, 2014; Sanitaria & Dirección General de Salud Pública, 2019). The period of analysis is divided into five-year periods, from 2002, when the last ten autonomous communities received health competencies and began to operate on their own, to 2017.

In order to examine the evolution of efficiency after the transfer of power, the number of beds and the number of full-time workers have been used as inputs to the model. These data have been chosen because the number of beds installed in hospitals has been used as a proxy variable for the capital factor in recent years in numerous studies (Martín & López del Amo, 2007). When distinguishing between the number of public and private beds, the corresponding percentages indicated in the Ministry's database have been applied.

Similarly, the number of full-time workers has been used to represent the labour factor. This includes doctors, nurses, MIR, auxiliary nurses, senior health technicians, other health personnel and non-health personnel. As in the previous case, due to the need to compare the results of the Public Sector versus the Private Sector, after reviewing numerous official State documents (Rivero Corte & Alfaro Latorre, 2008; Andradas Aragonés & Alfaro Latorre, 2016a, 2016b; Sanidad, 2022) over the last twenty years, there has been a trend in the sector indicating that eight out of every ten workers belong to the public hospital network. Therefore, to the total number of full-time employees we have applied a percentage of 80% to obtain the number of public workers, conversely 20% has been applied to find the figures for the Private Sector.

On the output side, the Basic Care Units (BAU), one of the first measures of hospital consumption, were taken into account. To calculate this index, a series of weightings were taken into account with respect to the variables that comprise it: 1 BAU = stays; 0.5 BAU = first consultations; 0.25 BAU = successive consultations and, finally, 0.5 BAU = non-admitted emergencies (López Rois et al., 1996). For the calculation of non-admitted emergencies and number of stays financed by the Public Sector, since the corresponding

percentages for 2002 are not explicit, the following data are taken into account: "Paid by Social Security", "Paid by Companies collaborating with the S.S.", "Paid by other Public Entities", "Paid by Civil Servants' Mutual Societies" and "Others" (Salud & Sanitaria, 2009). It should also be mentioned that, for the calculation of first consultations, in the absence of specific data by autonomous community, the average percentage corresponding to first consultations with respect to total consultations was used in 2012 and 2017. (Estadística de Centros de Atención 2012, 2014; Sanitaria & Dirección General de Salud Pública, 2019).

Data Envelopment Analysis (DEA)

Data Envelopment Analysis, known as DEA, is a non-parametric frontier method used to measure the efficiency of each organisation or organisational unit (DMU, Decision Making Units), which in this case corresponds to the CAACs analysed, by solving a linear programming problem (Kirigia, Emrouznejad, & Sambo, 2002) for each unit under the assumption, in this study, of Constant Returns to Scale (CRS):

$$Eficiencience = Max_{u_r, v_r} \sum_r u_r y_{r j0}$$

$$s.a. \sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0; \ \forall j$$

$$\sum_i v_i x_{i j0} = 1$$

$$u_r, v_i \geq 0 ; \forall_r, \forall_i$$

Where y_rj is the quantity of output r produced by the hospitals of AC j; x_ij the quantity of input i used by the hospitals of AC j; u_r the weight given to output r, (r = 1, ..., t, where t is the number of outputs); v_i the weight given to input i, (where as in the previous case i = 1, ..., m, where m is the number of inputs); j_0 AC under evaluation. Therefore, a CAAC is on the efficiency frontier if and only if, ∑_(_r^)^ ▒u_r y_(r j0) is equal to unity, i.e. it reaches the maximum efficiency levels.

This technique, widely used in the health sector (Martín & López del Amo, 2007), allows measuring several different types of efficiency: technical, allocative congestion and dynamic through the Malmquist index. In addition, it also allows for the observation of possible economies of scale.

In order to carry out the corresponding analysis of technical efficiency in the Public, Private and Joint Sector, a series of inputs and an output have been chosen, which have been discussed in greater detail in the previous subsection.

That said, the programme used to apply this analysis technique was DEAFrontier Software for Excel.

3. Results

3.1. Efficiency in the last ten Autonomous Regions to receive transfers

Table 1. Efficiency of the NHS and the private sector in the last ten Autonomous Communities to receive health care competencies.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8851	0,9114	0,8515	0,7794
Principado de Asturias	0,8985	0,9178	0,8845	0,8031
Illes Balears	0,9219	0,9337	0,9448	0,9150
Cantabria	0,8890	0,9446	0,9000	0,8260
Castilla y León	1,0000	0,9850	0,9331	0,8436
Castilla-La Mancha	0,9051	0,9897	0,9147	0,8487
Extremadura	0,8131	0,9821	0,8924	0,7735
Comunidad de Madrid	0,9335	1,0000	0,9937	1,0000
Región de Murcia	1,0000	1,0000	0,9524	0,9633
La Rioja	0,8442	0,9472	1,0000	0,9766

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Taking unity as the optimum value for efficiency and taking into account both the public and private sectors, it can be seen that, in general, the devolved regions have worsened their efficiency since the transfer of powers, with Castile and Leon, Aragon and the Principality of Asturias standing out. Only the Autonomous Community of Madrid improved, reaching maximum efficiency, and La Rioja, increasing its efficiency by a higher relative percentage. These results can be explained by the behaviour of the private sector which, in most of the regions, has a negative influence on the data as a whole.

Table 2. Efficiency of the last ten Autonomous Communities to receive health care competencies in hospitals belonging to the NHS.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8072	0,8591	0,8702	0,7701
Principado de Asturias	0,8911	0,9388	0,9196	0,8075
Illes Balears	0,6918	0,7511	0,7374	0,9475
Cantabria	0,9094	0,9606	0,9742	0,9638
Castilla y León	1,0000	0,9831	0,9698	0,8676
Castilla-La Mancha	0,7776	0,8441	0,8898	0,8718
Extremadura	0,6879	0,9394	0,8663	0,7719
Comunidad de Madrid	0,8432	0,8720	0,8985	1,0000

Región de Murcia	1,0000	1,0000	1,0000	1,0000
La Rioja	0,7609	0,8709	1,0000	0,9562

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Unlike the previous case, table 2 only shows the efficiency data relating to the NHS. While the Region of Murcia stands out as the most efficient region throughout the period under study, most of the Autonomous Regions analysed, 60% to be precise, improved their efficiency after the transfer of competences prior to 2002. The Balearic Islands (36.95%), La Rioja (25.66%) and the Community of Madrid (18.60%) are the regions that have seen the greatest increase in efficiency in the use of available public resources. Only Castile and Leon, the Principality of Asturias and Aragon have worsened.

Only Catilla y León, the Principality of Asturias and Aragón have seen their efficiency decrease.

Table 3. Efficiency of the last ten Autonomous Communities in receiving health care competencies in hospitals belonging to the Private Sector.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,6155	0,7812	0,4794	0,5968
Principado de Asturias	0,3236	0,4221	0,4044	0,4694
Illes Balears	1,0000	1,0000	1,0000	1,0000
Cantabria	0,2413	0,3519	0,1844	0,2112
Castilla y León	0,3826	0,4801	0,3225	0,3629
Castilla-La Mancha	0,6206	0,9799	0,4801	0,4903
Extremadura	1,0000	1,0000	0,8322	0,6826
Comunidad de Madrid	0,6597	0,8471	0,7354	0,9871
Región de Murcia	0,3150	0,4369	0,2954	0,3573
La Rioja	1,0000	0,5846	1,0000	1,0000

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

The inefficiency in some Autonomous Regions is probably due to the fact that the private sector in these regions was not as developed and depended to a greater extent on INSALUD. The Balearic Islands stand out for having the highest efficiency during the whole period considered, possibly due to their previous experience, as before the transfer of the transfers they already had a significant weight of the private sector in their hospitals. Its case could be compared with that of Catalonia, both of which are similar in terms of the significant weight of the private sector in health care, which had already been reflected for many years. On the other hand, Asturias has practically doubled its efficiency, although it has not yet reached good levels, but the improvement is more than visible.

In general, the results in this case are more diverse: 50% of the ACs worsen, with Extremadura and Castilla-La Mancha being the worst performers (the latter standing out if we consider the 2007 value); two of them remain constant practically throughout the

entire period (Balearic Islands and La Rioja, with the exception of 2007 but then recovering) and the rest improve, with the Principality of Asturias and the Community of Madrid standing out as we have already mentioned, which progresses in such a way that it reaches levels very close to absolute efficiency.

3.2. Relative comparison, efficiency of all Regions

In Table 1 in the Annex I it could be seen that Andalusia and Catalonia can be considered as benchmarks for practically the entire period, taking into account the SNS alone. Firstly, the Region of Murcia, which managed to become a benchmark Autonomous Region with its optimal efficiency values, has improved significantly with respect to the other Autonomous Regions that received the transfers before 2002. Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%). On the other hand, it is important to mention the reduction in the gap between the most efficient and the least efficient ACs over time. In 2002, the lowest value among the Autonomous Communities was 0.5183, belonging to the Balearic Islands, with respect to 1, which implies a difference in efficiency of 0.4817. Over the years, in 2017 this inequality is reduced to 0.7146 in Extremadura and the optimal unit, indicating this time a distance of 0.2854, which translates as a decrease in the differences of almost 40% between the lowest values.

Figure 1

As it could be seen in Table 2 in Annex 2, likewise, we observe that, as a whole, the efficiency of the Autonomous Regions has improved and that after the transfer of competences the differences between the regions have been reduced. This is the case of the Balearic Islands, the Canary Islands and Cantabria. As shown in graph 1, in 2017 compared to 2002, the disparities between these three regions are greatly reduced and converge. Both Castillas also manage to reduce their interregional differences, with Castilla-La Mancha standing out. The Community of Madrid and the Region of Murcia converge at the same time, becoming in 2017 one of the reference ACs due to their high efficiency values.

The blue line shows the reference ACs, i.e. those with optimal efficiency values, while the dashed red line shows the average efficiency for that year, which is useful for easily visualising which ACs are above (or below) the average. It is interesting to perform the analysis from this perspective, since some regions may have improved their efficiency but worsened in comparison with the rest of the regions, because the latter have improved more, and vice versa. Thus, in the case of the Balearic Islands, which improved its efficiency to a great extent (81.44%, as mentioned above), its efficiency improved with respect to other regions that were relatively far behind it, for example, surpassing the Autonomous Community of Valencia, the Principality of Asturias and Galicia. The Community of Madrid improved its efficiency in 2017 with respect to 2002 by 63.77%, which places it at the top of the table, as shown in table 5. On the other hand, although

Castilla y León's efficiency improved by approximately 7%, its relative position compared to the rest of the Autonomous Regions was reduced to the bottom five.

Another case in point is Ceuta and Melilla which, after the creation of INGESA, managed to improve their efficiency by 62.12% - probably due to the fact that they only have to manage the autonomous cities and, as there are not a greater number of territories, they can better focus on the needs of the autonomous cities - but if we make a relative comparison, they are below the rest of the Autonomous Regions.

Table 3 in Annex I shows the combined data for the NHS and the private sector, which leads to the following results: on calculating the efficiency values of the ten Autonomous Regions that received the competences at the end of 2001, with respect to the rest of the regions that already had them, it is found that 70% of them have seen their efficiency worsen. Aragon (-12.53%), the Region of Murcia (-10.70%) and Castile and Leon (-9.75%) stand out. In contrast to table 4, the reference Autonomous Community is Catalonia. On the other hand, the Autonomous Region with the greatest improvement in efficiency is La Rioja (8.63%), followed by the Autonomous Region of Madrid (7.12%), which manages to achieve maximum efficiency. In this case, the Balearic Islands improved by only 3.01%, but this is also partly due to the fact that it starts from higher values, close to 90% efficiency.

This difference in results may be due to the fact that the Private Sector - with the exception of Catalonia and the Balearic Islands as mentioned above - dragged down the positive results achieved by the Public Sector reflected in table 1 Annex I.

Figure 2

The results shown in Figure 2 are very different from the previous graph, showing virtually no reduction in differences between regions over the period analysed.

If we take into account the results shown in table 4 Annex I, with the Autonomous Regions highlighted in blue as benchmarks for their optimum efficiency values, the Basque Country improves its relative position to a large extent, going from being in the bottom positions in 2002 to the top positions in 2017. La Rioja also improves considerably, although less so. On the other hand, Aragon has seen its position drop significantly.

4. Discussion

We are aware that it is difficult in this area to compare the results found with other studies due to the fact that DEA can give different results when the inputs and outputs used are not the same. Moreover, we have used global data from the health sector - in order to be able to draw conclusions, not only in the public sector (NHS), but also in the private sector and jointly, on the effects of decentralisation in the Spanish health sector - while in many other studies a specific selection of hospitals has been carried out (Granado Cabello & Vega Hidalgo, 2014; Pérez-Romero, Ortega-Díaz, Ocaña-Riola, & Martín-Martín, 2017; Sbert & Gómez Vicens, 2013).

As far as the public sector is concerned, our results show that most of the Autonomous Regions that were the last to receive health transfers improved their efficiency levels to their highest values between 2007 and 2012. However, if we consider the comparison of these regions as a whole, the highest figures are found in 2012. We believe that this behaviour is possible due to the positive impact of the incorporation of new management models and changes in the organisational structure of those Autonomous Regions that received the transfer of competences at the end of 2001, coinciding with the authors Granado Cabello and Vega Hidalgo (2014). However, other authors such as Sbert, J. M., and Gómez Vicens, J. M. (2013) do not agree with this explanation, as they believe that, after the transfers, there is a period of adaptation that leads to an increase in costs and resources that are detrimental to productivity levels.

That said, it should be stressed that the introduction of these changes does not fully explain the increase in efficiency in the Autonomous Regions studied, as there are other socio-economic factors that may influence efficiency. It is also necessary to question why, as we have seen, some regions do not improve as much as others. Despite the fact that, following decentralisation, the efficiency of the NHS improves in general - in its entirety if we compare all the Autonomous Regions as a whole - those territories that are less efficient may be due to factors such as ageing, geographical dispersion, wealth or the public spending policies of each region, among other variables. In this sense, we agree with Pérez-Romero, Ortega-Díaz, Ocaña-Riola and Martín-Martín (2017).

Despite these differences, it should be stressed that after the transfer of powers in the public health sector there has been a positive impact which has led to a reduction in the gap between the most efficient and least efficient Autonomous Regions in Spain. Over the fifteen years observed, the gap between Autonomous Regions has narrowed by approximately 40%. In view of this improvement, however, we would like to focus on two aspects relating to the private sector and waiting lists.

On the one hand, the data provided by the Ministry show that over the years, following the transfers, public provision has not only become more efficient, but has also increased with respect to private provision, even in regions where the private sector is very efficient. The case of the Community of Madrid stands out, which, despite the strong presence of the private sector, has increasingly increased the supply of public services. On the other hand, there is also the case of La Rioja, a territory in which the Private Sector is very efficient and yet the importance of public activities is increasing. In other words, we find that the evolution of public activity is increasing, except in the case of the Balearic Islands, where its weight is increasing in relation to the private sector. This can also be seen in the decrease in spending on concerts in a large part of the Autonomous Regions, as indicated by IDIS (2019).

Therefore, we can say that the transfers have boosted the public sector even in those Autonomous Regions with a strong presence of private activity, even if this is efficient. We believe that this trend may have a negative impact on citizens in the future because, with a permanent increase in health spending, not only in Spain but in other countries as well - derived from demographic factors, such as ageing, which affects Western Europe in particular, as pointed out by Jakovljevic et al. (2019), or cultural factors such as the desire for greater welfare - the public health system may be limited by the need for a

larger budget and greater flexibility. Authors such as Kosycarz, Nowakowska, & Mikołajczyk, (2019) propose a similar approach to improving public hospitals in Poland through public-private partnerships.

All of this is directly related to the problem of waiting lists. In particular, there are two cases in which the Autonomous Regions with the highest waiting list figures should increase their productivity by improving the management of their public sector, i.e. Extremadura, Castile-La Mancha and Aragon. In the cases of the Region of Murcia or Cantabria, where their public sector is very efficient, they should consider the possibility that their private sector, which is being underutilised, could, according to article 66 of Law 14/1986, of 25 April, General Health (BOE, 2018), link private hospitals to the planning of the public sector, without them losing their ownership, thus alleviating waiting lists, as also argued by IDIS, (2019). Another possibility in this case could be to increase public resources in the face of such good management to reduce waiting lists.

Those ACs with lower levels of efficiency, as explained above, are probably not making efficient use of their resources and could offer greater capacity or, in other words, not have such high waiting times.

5. Conclusions. Limitations and extensions

This article has analysed the effects of decentralisation in Spain, specifically on the last ten Autonomous Regions that received the health care transfers at the end of 2001, with respect to the efficiency levels of the Public, Private and Joint Sectors.

An improvement of 60% can be seen in the communities analysed if we only take into account the NHS, however, if we consider the results of both sectors we observe that the majority of the territories worsen. This is due to the fact that the figures for the private sector have a negative impact on the analysis as a whole. If we take into consideration all the Autonomous Communities that make up the Spanish territory, we can observe an improvement in the Public Sector of the ten communities analysed in terms of their relative position, with the following standing out: Region of Murcia, Community of Madrid and Balearic Islands. However, it should be noted that there are socio-economic factors such as the level of ageing, geographical dispersion, spending policies or the wealth of each region, which could explain why some territories have not improved as much.

On the other hand, in the face of the economic crisis, our results show that 60% of the public sector was not affected, in fact, its efficiency increased. The years 2007 and 2012 stand out as the years in which the highest efficiency values were reached (2012 if all the Autonomous Regions in Spain are taken into account) and one of the reasons for this behaviour is the change in the management model after the transfers. Otherwise, 80% of the private sector saw a decrease in efficiency.

In the light of the above, we can affirm that the transfers have not favoured the privatisation of the system. This can be demonstrated by the fact that even in communities where private provision has a strong presence or is highly efficient - as in the case of the Community of Madrid and La Rioja - public provision has increased despite everything.

On the other hand, with regard to those regions which are not fully efficient, i.e. which could generate more output with their current inputs and thus be more productive, two different cases can be identified. Extremadura, Aragon and Castile-La Mancha, which have waiting lists above the average for the Spanish regions, imply that they should, and need to, improve the management of their public resources (NHS). As for the Region of Murcia and Cantabria, where the public sector is very efficient, the private sector is notable for its under-utilisation of resources, which could be used to reduce the high waiting lists in both regions through public-private partnerships.

Finally, it would be of great interest to extend our study once the Ministry of Health makes the data for the last few years available to the public, in order to compare efficiency between the Autonomous Regions before and after the health crisis. As well as the functioning and behaviour of hospitals during the pandemic.

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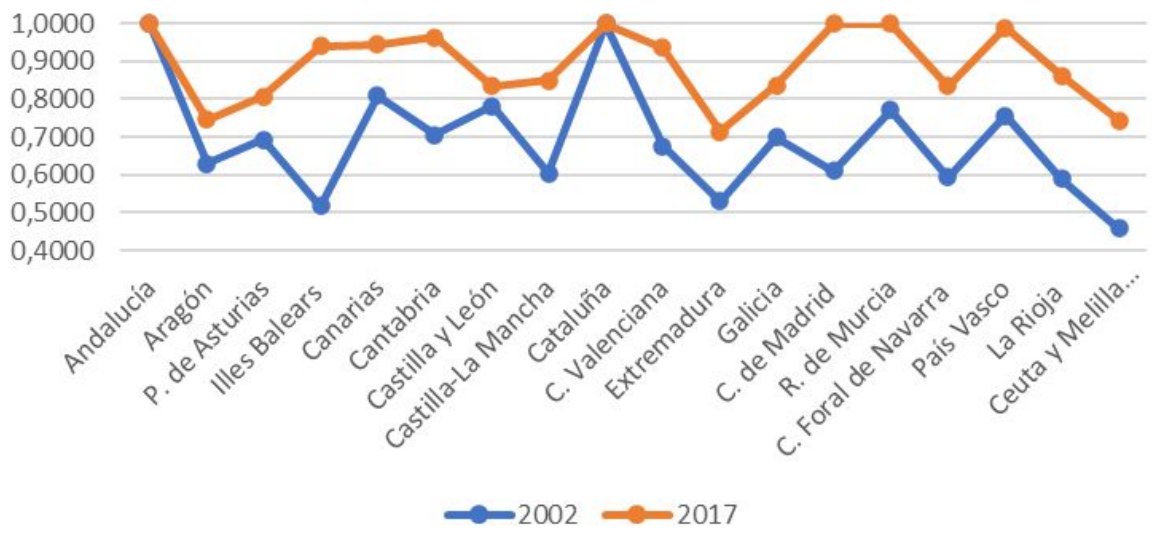
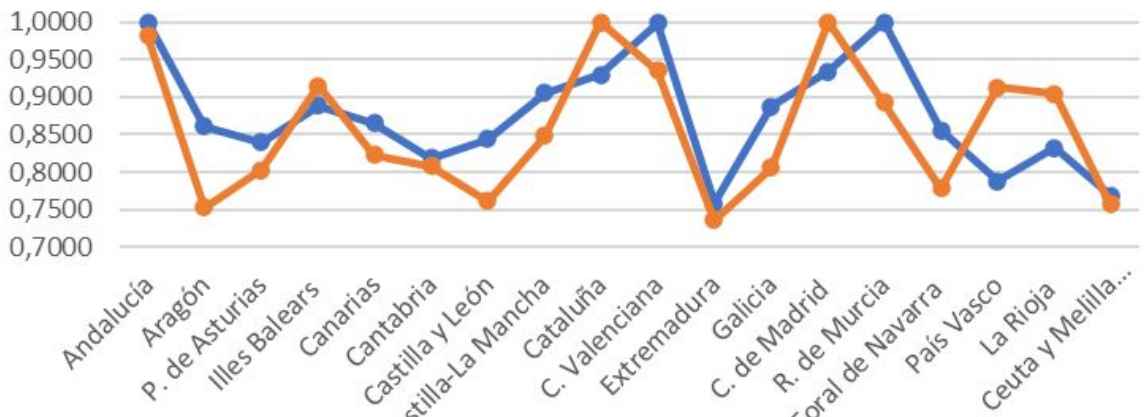
Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Figure 2. Comparison of the efficiency values of the NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

ANNEX I

Table 1. Efficiency of hospitals belonging to the NHS in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
Regions	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9035	0,9346	1,0000
Aragón	0,6290	0,7130	0,8021	0,7451
Principado de Asturias	0,6932	0,7647	0,8459	0,8075
Illes Balears	0,5183	0,7511	0,7374	0,9403
Canarias	0,8088	0,9029	0,9062	0,9446
Cantabria	0,7057	0,8379	0,9679	0,9636
Castilla y León	0,7821	0,7724	0,8845	0,8343
Castilla-La Mancha	0,6040	0,7413	0,8241	0,8494
Cataluña	1,0000	1,0000	1,0000	1,0000
Comunidad Valenciana	0,6754	0,8860	0,8935	0,9365
Extremadura	0,5313	0,7099	0,7453	0,7146
Galicia	0,6987	0,7614	0,8942	0,8370
Comunidad de Madrid	0,6104	0,8720	0,8835	0,9997
Región de Murcia	0,7703	1,0000	1,0000	1,0000
Comunidad Foral de Navarra	0,5942	0,9233	0,8735	0,8346
País Vasco	0,7571	0,7145	0,9750	0,9890
La Rioja	0,5893	0,7528	0,8910	0,8611
Ceuta y Melilla	0,4592	0,5839	0,6867	0,7444

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 2. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS between 2002 and 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Cataluña	Andalucía
Cataluña	R. de Murcia	R. de Murcia	Cataluña
Canarias	C. F. Navarra	País Vasco	R. de Murcia
Castilla y León	Andalucía	Cantabria	C. de Madrid
R. de Murcia	Canarias	Andalucía	País Vasco
País Vasco	C. Valenciana	Canarias	Cantabria
Cantabria	C. de Madrid	Galicia	Canarias
Galicia	Cantabria	C. Valenciana	Illes Balears
P. de Asturias	Castilla y León	La Rioja	C. Valenciana
C. Valenciana	P. de Asturias	Castilla y León	La Rioja
Aragón	Galicia	C. de Madrid	Castilla-La Mancha
C. de Madrid	La Rioja	C. F. Navarra	Galicia

Castilla-La Mancha	Illes Balears	P. de Asturias	C. F. Navarra
C. F. Navarra	Castilla-La Mancha	Castilla-La Mancha	Castilla y León
La Rioja	País Vasco	Aragón	P. de Asturias
Extremadura	Aragón	Extremadura	Aragón
Illes Balears	Extremadura	Illes Balears	Ceuta y Melilla
Ceuta y Melilla	Ceuta y Melilla	Ceuta y Melilla	Extremadura

Source: Own elaboration

Table 3. Efficiency of hospitals belonging to the NHS and the private sector in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
CCAA	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9689	1,0000	0,9815
Aragón	0,8609	0,8470	0,8348	0,7530
Principado de Asturias	0,8399	0,8435	0,8593	0,8031
Illes Balears	0,8883	0,8676	0,9271	0,9150
Canarias	0,8649	0,8632	0,8958	0,8232
Cantabria	0,8187	0,8371	0,8873	0,8082
Castilla y León	0,8445	0,8576	0,8394	0,7621
Castilla-La Mancha	0,9051	0,9196	0,8953	0,8487
Cataluña	0,9297	1,0000	1,0000	1,0000
Comunidad Valenciana	0,9982	1,0000	0,9450	0,9352
Extremadura	0,7588	0,8124	0,8092	0,7367
Galicia	0,8877	0,8976	0,9059	0,8059
Comunidad de Madrid	0,9335	0,9292	0,9798	1,0000
Región de Murcia	1,0000	0,9315	0,9245	0,8930
Comunidad Foral de Navarra	0,8557	0,8032	0,8773	0,7781
País Vasco	0,7880	0,7121	0,9438	0,9125
La Rioja	0,8329	0,8801	0,9930	0,9048
Ceuta y Melilla	0,7690	0,8215	0,8439	0,7570

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 4. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS and Private Sector between 2002 - 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Andalucía	Cataluña
R. de Murcia	C. Valenciana	Cataluña	C. de Madrid
C. Valenciana	Andalucía	La Rioja	Andalucía
C. de Madrid	R. de Murcia	C. de Madrid	C. Valenciana
Cataluña	C. de Madrid	C. Valenciana	Illes Balears
Castilla-La Mancha	Castilla-La Mancha	País Vasco	País Vasco

Illes Balears	Galicia	Illes Balears	La Rioja
Galicia	La Rioja	R. de Murcia	R. de Murcia
Canarias	Illes Balears	Galicia	Castilla-La Mancha
Aragón	Canarias	Canarias	Canarias
C. F. Navarra	Castilla y León	Castilla-La Mancha	Cantabria
Castilla y León	Aragón	Cantabria	Galicia
P. de Asturias	P. de Asturias	C. Foral de Navarra	P. de Asturias
La Rioja	Cantabria	P. de Asturias	C. Foral de Navarra
Cantabria	Ceuta y Melilla	Ceuta y Melilla	Castilla y León
País Vasco	Extremadura	Castilla y León	Ceuta y Melilla
Ceuta y Melilla	C. Foral de Navarra	Aragón	Aragón
Extremadura	País Vasco	Extremadura	Extremadura

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

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HOW DOES DECENTRALISATION SUIT THE SPANISH HEALTHCARE SYSTEM?

Running Head: Efficiency in a desentralised Health system.

Abstract

Objective: The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Matherial and Methods: In this paper we have used Data Envelopment Analysis (DEA) to analyse the evolution of efficiency in the last ten Autonomous Regions to receive health care competences at the end of 2001. For this study we have taken into account the number of beds and full-time workers as inputs and the calculation of basic care units as outputs to measure the efficiency of the Spanish public sector, private sector and jointly in the years 2002, 2007, 2012 and 2017.

Results: Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%).

Conclusion: In general, it can be observed that the transfer of responsibilities in the health sector has improved efficiency in the NHS.

Strengths and limitations of this study

- We are aware that, by using full-time workers as input, those communities with a greater weight of part-time staff may overestimate their efficiency results, which could be a limitation.
- On the other hand, we have used the basic units of assistance or UBAs as outputs which, although they offer fairly approximate information, may make it difficult to compare with other studies.

JEL classification

C14; I18; H21.

Key words: Efficiency; National Health System; Devolution; DEA; Data Envelopment Analysis; Health Decentralisation.

1. Introduction

Spain is a decentralised country in which the Autonomous Communities have the powers to administer and manage certain public services, including health. However, this has not always been the case. To understand the current situation, it is necessary to go back to 1977, the year in which the Ministry of Health and Social Security was created. Months later, by Royal Decree-Law 36/1978, a Social Security Management Entity was created, the National Health Institute, abbreviated as INSALUD, in charge of providing health care [1]..

During the process of political and economic change that took place at that time, the Spanish Transition, the approval of the Constitution in 1978 brought changes related to the decentralisation of powers, including in the area of health. Specifically, Article 43 recognises the right to health protection and Article 148.1.21 recognises health as a competence that can be assumed by the Autonomous Communities, leaving only the State with exclusive competence in external health and the general coordination of health (Article 149.1.16).

The constitution of the communities is carried out at different paces, so there are some that assume the functions and services carried out by INSALUD sooner than others, the process of transfer begins in 1981 and ends at the end of 2001. Thus, first, Catalonia (1981), Andalusia (1984), the Basque Country (1984), the Valencian Community (1987), Galicia (1990), the Community of Navarre (1990) and the Canary Islands (1994) received the competencies.

Meanwhile, Aragon, the Principality of Asturias, the Balearic Islands, Cantabria, Castile-La Mancha, Castile and Leon, Extremadura, La Rioja, the Community of Madrid and the Region of Murcia were under State administration through INSALUD, until they received the transfer of competences. After a long process, at the end of 2001, these last ten Autonomous Regions received the transfers and by the following year were already administering and managing health care in their territory. Thus, INSALUD was liquidated and converted into a smaller entity, the Instituto Nacional de Gestión Sanitaria, abbreviated as INGESA [2], which would continue to administer and manage healthcare in the Autonomous Cities of Ceuta and Melilla.

Therefore, to summarise, our country currently has the National Health System, which brings together the public health networks of the seventeen Autonomous Regions, and INGESA, the state administrator and manager of the Autonomous Cities.

Each Autonomous Community carries out the planning, administration and management of the health services in its territory, following the guidelines set out in the LGS (General Health Act), but with variability in terms of the portfolio of services for its citizens, while respecting the basic levels cited in Law 14/1986, LGS. The autonomous communities' highest health management body is the Regional Ministry of Health, which is responsible for setting up a Health Service (from the point of view of

both the service provider and the service funder), made up of outpatient centres (Primary healthcare centers) and hospitals that provide the services planned in the autonomous community's service portfolio. Each Autonomous Community divides the territory into Health Areas, which are the Basic Geographical and Functional Units of health care, each health area being autonomous and able to establish its own specific health plans and adapt resources to the needs of the population concerned. These health areas, provided for in the LGS, are created to cover approximately 200,000 inhabitants, with at least one Tertiary Hospital Centre and different Health Centres, approximately one for every 20,000 inhabitants.

The universal nature of our public health care system necessarily means that it is not linked to citizens' ability to pay, unlike other types of contributory benefits offered by the Social Security System, which are directly affected by the social contributions made by the system's potential beneficiaries. Consequently, as health care is treated as a non-contributory benefit of the social security system, its main source of financing is the transfers made by the corresponding public administrations (State, Autonomous Communities or Local Corporations), which come mainly from public sector tax revenues.

The decentralisation of the health system carried out in Spain is not an isolated event; other countries such as Italy, the United Kingdom, Portugal, the Philippines, etc. have also done so [3] [4]. These types of reforms have given rise to a debate in the literature about who plays a better role in managing healthcare: the state or the territories that make it up? In other words, in terms of the welfare and efficiency of the population, what is more favourable: a centralised or decentralised healthcare system?.

Numerous studies [5] [3] [6] [4] discuss the direct consequences that accompany health decentralisation, as well as its advantages and disadvantages.

The mere definition of the concept of decentralisation generates different positions and approaches that often complicate rather than facilitate the analysis [7] [8] defines decentralisation as "the transfer of planning, management and collection responsibilities and allocation of resources from the central government and its agencies to territorial units" as well as Delegation as the transfer of decision-making and administrative power - including financial responsibilities - over public functions to autonomous organisations [9] [10]. It is the latter concept that best fits the decentralisation process that has taken place in the Spanish national health system.

Privatisation, on the other hand, would be the policy of having services provided by businesses, community groups, co-operatives, private voluntary associations, individuals, small informal enterprises and other non-governmental organisations. For this author, privatisation ranges from leaving the provision of goods and services entirely to economic competition to "partnerships" between public agencies and private enterprises [11].

Decentralisation is generally considered to improve efficiency in health care and influence health care by bringing governance closer to the population, allowing for feedback [5]. It also fosters competition between territories that try to stand out and proceed in the best possible way, most of the time leading to increased spending, which

is often accompanied by improved health outcomes [12] [3]. In that sense, it should take in account that, although Tiebout [13] argued in his famous article that citizens "vote with their feet" and choose the jurisdiction that offers them the best range of services, it is debatable whether citizen mobility is as typical in Europe as it is in the US [14]. While mobility enhances the benefits of decentralisation, it is not entirely dependent on it. Even in the absence of mobility, the efficient provision of a local public good is determined by the condition that the sum of marginal costs of substitution equals marginal costs, and this condition tends to vary across territories [15].

However, when decision-makers increase spending, this can result in increased costs due to: duplication of inputs, where two neighbouring regions may share similar services; diseconomies of scale or even moral hazard, as they expect their debts to be covered by the central government [3].

The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Methodology and data

2.1. Variables used

We understand *Devolution* as the creation or reinforcement of levels of government lower than the state, to which broader responsibilities than the simply administrative ones are attributed for the development of certain functions, which is the case in Spain [10].

In this paper, performance improvement means improving the efficiency (or productivity) of public services [16]. In measuring performance a distinction can be made between technical efficiency ("doing more with less") and allocative efficiency ("doing the right thing in the right place").

Technical efficiency describes a production process in which maximum output is achieved when inputs are fixed and technology is fixed. Allocative efficiency refers to the allocation of resources (finance, labour or physical capital) and is achieved when the combination of inputs and outputs is cost-minimising and/or profit-maximising [17] [18].

The concept of technical efficiency is similar to the concept of productivity. Productivity is usually defined as the ratio between the quantity of output and the quantity of inputs used. Productivity is much easier to calculate when the production unit analysed uses an input to produce a product. If a production unit uses several inputs to produce several outputs, inputs and outputs must be combined [19] (as we have done with the calculation of the Basic Care Units –BAU).

In contrast to efficiency, which is the relationship between outcomes and inputs, effectiveness is the relationship between defined outcomes and defined inputs and depends on service quality [20].

This paper has proposed the measurement of technical efficiency, understood as productivity.

The information on the variables used has been compiled from the Spanish Ministry of Health database [21] [22] [23] [24]. The period of analysis is divided into five-year periods, from 2002, when the last ten autonomous communities received health competencies and began to operate on their own, to 2017.

In order to examine the evolution of efficiency after the transfer of power, the number of beds and the number of full-time workers have been used as inputs to the model. These data have been chosen because the number of beds installed in hospitals has been used as a proxy variable for the capital factor in recent years in numerous studies [25]. When distinguishing between the number of public and private beds, the corresponding percentages indicated in the Ministry's database have been applied.

Similarly, the number of full-time workers has been used to represent the labour factor. This includes doctors, nurses, MIR, auxiliary nurses, senior health technicians, other health personnel and non-health personnel. As in the previous case, due to the need to compare the results of the Public Sector versus the Private Sector, after reviewing numerous official State documents [26] [27] [28] [29] over the last twenty years, there has been a trend in the sector indicating that eight out of every ten workers belong to the public hospital network. Therefore, to the total number of full-time employees we have applied a percentage of 80% to obtain the number of public workers, conversely 20% has been applied to find the figures for the Private Sector.

On the output side, the Basic Care Units (BAU), one of the first measures of hospital consumption, were taken into account. To calculate this index, a series of weightings were taken into account with respect to the variables that comprise it: 1 BAU = stays; 0.5 BAU = first consultations; 0.25 BAU = successive consultations and, finally, 0.5 BAU = non-admitted emergencies [30]. For the calculation of non-admitted emergencies and number of stays financed by the Public Sector, since the corresponding percentages for 2002 are not explicit, the following data are taken into account: "Paid by Social Security", "Paid by Companies collaborating with the S.S.", "Paid by other Public Entities", "Paid by Civil Servants' Mutual Societies" and "Others" [22]. It should also be mentioned that, for the calculation of first consultations, in the absence of specific data by autonomous community, the average percentage corresponding to first consultations with respect to total consultations was used in 2012 and 2017. [23] [24] .

2.2. Data Envelopment Analysis (DEA)

Data Envelopment Analysis, known as DEA, is a non-parametric frontier method used to measure the efficiency of each organisation or organisational unit (DMU, Decision Making Units), which in this case corresponds to the CAACs analysed, by solving a linear programming problem [31] for each unit under the assumption, in this study, of Constant Returns to Scale (CRS):

$$Eficiencience = Max_{u_r, v_r} \sum_r u_r y_{r\,j0}$$

$$s.a. \sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0;\ \forall j$$

$$\sum_i v_i x_{i\,j0} = 1$$

$$u_r, v_i \geq 0\,; \forall_r, \forall_i$$

Where y_rj is the quantity of output r produced by the hospitals of AC j; x_ij the quantity of input i used by the hospitals of AC j; u_r the weight given to output r, (r = 1, ..., t, where t is the number of outputs); v_i the weight given to input i, (where as in the previous case i = 1, ..., m, where m is the number of inputs); j_0 AC under evaluation. Therefore, a CAAC is on the efficiency frontier if and only if, ∑_(_r^)^ ▒u_r y_(r j0) is equal to unity, i.e. it reaches the maximum efficiency levels.

This technique, widely used in the health sector [25], allows measuring several different types of efficiency: technical, allocative congestion and dynamic through the Malmquist index. In addition, it also allows for the observation of possible economies of scale.

In order to carry out the corresponding analysis of technical efficiency in the Public, Private and Joint Sector, a series of inputs and an output have been chosen, which have been discussed in greater detail in the previous subsection.

That said, the programme used to apply this analysis technique was DEAFrontier Software for Excel.

2.3. Patient and public involvement

No patient involved

3. Results

3.1. Efficiency in the last ten Autonomous Regions to receive transfers

Taking unity as the optimum value for efficiency and taking into account both the public and private sectors, it can be seen in Table 1 that, in general, the devolved regions have worsened their efficiency since the devolution, with Castile and Leon, Aragon and the Principality of Asturias standing out. Only the Autonomous Community of Madrid improved, reaching maximum efficiency, and La Rioja, increasing its efficiency by a higher relative percentage.

Table 1. Efficiency of the NHS and the private sector in the last ten Autonomous Communities to receive health care competencies.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8851	0,9114	0,8515	0,7794
Principado de Asturias	0,8985	0,9178	0,8845	0,8031
Illes Balears	0,9219	0,9337	0,9448	0,9150
Cantabria	0,8890	0,9446	0,9000	0,8260
Castilla y León	1,0000	0,9850	0,9331	0,8436
Castilla-La Mancha	0,9051	0,9897	0,9147	0,8487
Extremadura	0,8131	0,9821	0,8924	0,7735
Comunidad de Madrid	0,9335	1,0000	0,9937	1,0000
Región de Murcia	1,0000	1,0000	0,9524	0,9633
La Rioja	0,8442	0,9472	1,0000	0,9766

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Unlike the previous case, table 2 only shows the efficiency data relating to the NHS. While the Region of Murcia stands out as the most efficient region throughout the period under study, most of the Autonomous Regions analysed, 60% to be precise, improved efficiency rates (they are closer to 1) after the transfer of competences prior to 2002. The Balearic Islands (36.95%), La Rioja (25.66%) and the Community of Madrid (18.60%) are the regions that have seen the greatest increase in efficiency in the use of available public resources. Only Castile and Leon, the Principality of Asturias and Aragon have worsened.

Table 2. Efficiency of the last ten Autonomous Communities to receive health care competencies in hospitals belonging to the NHS.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8072	0,8591	0,8702	0,7701
Principado de Asturias	0,8911	0,9388	0,9196	0,8075
Illes Balears	0,6918	0,7511	0,7374	0,9475
Cantabria	0,9094	0,9606	0,9742	0,9638
Castilla y León	1,0000	0,9831	0,9698	0,8676
Castilla-La Mancha	0,7776	0,8441	0,8898	0,8718
Extremadura	0,6879	0,9394	0,8663	0,7719
Comunidad de Madrid	0,8432	0,8720	0,8985	1,0000
Región de Murcia	1,0000	1,0000	1,0000	1,0000
La Rioja	0,7609	0,8709	1,0000	0,9562

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Only Catilla y León, the Principality of Asturias and Aragón have seen their efficiency decrease (table 3).

Table 3. Efficiency of the last ten Autonomous Communities in receiving health care competencies in hospitals belonging to the Private Sector.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,6155	0,7812	0,4794	0,5968
Principado de Asturias	0,3236	0,4221	0,4044	0,4694
Illes Balears	1,0000	1,0000	1,0000	1,0000
Cantabria	0,2413	0,3519	0,1844	0,2112
Castilla y León	0,3826	0,4801	0,3225	0,3629
Castilla-La Mancha	0,6206	0,9799	0,4801	0,4903
Extremadura	1,0000	1,0000	0,8322	0,6826
Comunidad de Madrid	0,6597	0,8471	0,7354	0,9871
Región de Murcia	0,3150	0,4369	0,2954	0,3573
La Rioja	1,0000	0,5846	1,0000	1,0000

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

In general, the results in this case are more diverse: 50% of the ACs worsen, with Extremadura and Castilla-La Mancha being the worst performers (the latter standing out if we consider the 2007 value); two of them remain constant practically throughout the entire period (Balearic Islands and La Rioja, with the exception of 2007 but then recovering) and the rest improve, with the Principality of Asturias and the Community of Madrid standing out as we have already mentioned, which progresses in such a way that it reaches levels very close to absolute efficiency.

3.2. Relative comparison, efficiency of all Regions

In Annex Table 1 it could be seen that Andalusia and Catalonia can be considered as benchmarks for practically the entire period, taking into account the SNS alone (by obtaining the index 1.000 in the DEA survey). Firstly, the Region of Murcia, which managed to become a benchmark Autonomous Region with its optimal efficiency values, has improved significantly with respect to the other Autonomous Regions that received the transfers before 2002. Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La

Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%). On the other hand, it is important to mention the reduction in the gap between the most efficient and the least efficient ACs over time. In 2002, the lowest value among the Autonomous Communities was 0.5183, belonging to the Balearic Islands, with respect to 1.000, which implies a difference in efficiency of 0.4817. Over the years, in 2017 this inequality is reduced to 0.7146 in Extremadura and the optimal unit, indicating this time a distance of 0.2854, which translates as a decrease in the differences of almost 40% between the lowest values.

Figure 1

As it could be seen in Annex Table 2, likewise, we observe that, as a whole, the efficiency of the Autonomous Regions has improved and that after the transfer of competences the differences in efficiency rates between the regions have been reduced. This is the case of the Balearic Islands, the Canary Islands and Cantabria. As shown in figure 1, in 2017 compared to 2002, the disparities between these three regions are greatly reduced and converge. Both Castillas also manage to reduce their interregional differences, with Castilla-La Mancha standing out. The Community of Madrid and the Region of Murcia converge at the same time, becoming in 2017 one of the reference ACs due to their high efficiency values.

The blue line shows the reference ACs, i.e. those with optimal efficiency values, while the dashed red line shows the average efficiency for that year, which is useful for easily visualising which ACs are above (or below) the average. It is interesting to perform the analysis from this perspective, since some regions may have improved their efficiency but worsened in comparison with the rest of the regions, because the latter have improved more, and vice versa. Thus, in the case of the Balearic Islands, which improved its efficiency to a great extent (81.44%, as mentioned above), its efficiency improved with respect to other regions that were relatively far behind it, for example, surpassing the Autonomous Community of Valencia, the Principality of Asturias and Galicia. The Community of Madrid improved its efficiency in 2017 with respect to 2002 by 63.77%, which places it at the top of the table, as shown in Annex Table 3. On the other hand, although Castilla y León's efficiency improved by approximately 7%, its relative position compared to the rest of the Autonomous Regions was reduced to the bottom five.

Annex Table 4 shows the combined data for the NHS and the private sector, which leads to the following results: on calculating the efficiency values of the ten Autonomous Regions that received the competences at the end of 2001, with respect to the rest of the regions that already had them, it is found that 70% of them have seen their efficiency worsen. Aragon (-12.53%), the Region of Murcia (-10.70%) and Castile and Leon (-9.75%) stand out. In contrast to Annex Table 1, the reference Autonomous Community is Catalonia. On the other hand, the Autonomous Region with the greatest improvement in efficiency is La Rioja (8.63%), followed by the Autonomous Region of Madrid (7.12%), which manages to achieve maximum efficiency. In this case, the

Balearic Islands improved by only 3.01%, but it starts from higher values, close to 90% efficiency (figure 2).

Figure 2

4. Discussion

We are aware that it is difficult in this area to compare the results found with other studies due to the fact that DEA can give different results when the inputs and outputs used are not the same. Moreover, we have used global data from the health sector - in order to be able to draw conclusions, not only in the public sector (NHS), but also in the private sector and jointly, on the effects of decentralisation in the Spanish health sector - while in many other studies a specific selection of hospitals has been carried out [32] [33] [34].

As far as the public sector is concerned, our results show that most of the Autonomous Regions that were the last to receive health transfers improved their efficiency levels to their highest values between 2007 and 2012. However, if we consider the comparison of these regions as a whole, the highest figures are found in 2012. We believe that this behaviour is possible due to the positive impact of the incorporation of new management models and changes in the organisational structure of those Autonomous Regions that received the transfer of competences at the end of 2001, coinciding with the authors Granado Cabello and Vega Hidalgo [32]. However, other authors such as Sbert, J. M., and Gómez Vicens, J. M. [34] do not agree with this explanation, as they believe that, after the transfers, there is a period of adaptation that leads to an increase in costs and resources that are detrimental to productivity levels.

That said, it should be stressed that the introduction of these changes does not fully explain the increase in efficiency in the Autonomous Regions studied, as there are other socio-economic factors that may influence efficiency. It is also necessary to question why, as we have seen, some regions do not improve as much as others. Despite the fact that, following decentralisation, the efficiency of the NHS improves in general - in its entirety if we compare all the Autonomous Regions as a whole - those territories that are less efficient may be due to factors such as ageing, geographical dispersion, wealth or the public spending policies of each region, among other variables. In this sense, we agree with Pérez-Romero, Ortega-Díaz, Ocaña-Riola and Martín-Martín [33].

Despite these differences, it should be stressed that after the transfer of competences in the public health sector there has been a positive impact which has led to a reduction in the gap between the most efficient and least efficient Autonomous Regions in Spain. Over the fifteen years observed, the gap between Autonomous Regions has narrowed by approximately 40%. In view of this improvement, however, we would like to focus on two aspects relating to the private sector and waiting lists.

On the one hand, the data provided by the Ministry show that over the years, following the transfers, public provision has not only become more efficient, but has also increased with respect to private provision, even in regions where the private sector is

very efficient. The case of the Community of Madrid stands out, which, despite the strong presence of the private sector, has increasingly increased the supply of public services. On the other hand, there is also the case of La Rioja, a territory in which the Private Sector is very efficient and yet the importance of public activities is increasing. In other words, we find that the evolution of public activity is increasing, except in the case of the Balearic Islands, where its weight is increasing in relation to the private sector. This can also be seen in the decrease in spending on concerts in a large part of the Autonomous Regions, as indicated by IDIS [35].

Therefore, we can say that the transfers have boosted the public sector even in those Autonomous Regions with a strong presence of private activity, even if this is efficient. We believe that this trend may have a negative impact on citizens in the future because, with a permanent increase in health spending, not only in Spain but in other countries as well - derived from demographic factors, such as ageing, which affects Western Europe in particular, as pointed out by Jakovljevic et al. [36], or cultural factors such as the desire for greater welfare - the public health system may be limited by the need for a larger budget and greater flexibility. Authors such as Kosycarz, Nowakowska, & Mikołajczyk, [37] propose a similar approach to improving public hospitals in Poland through public-private partnerships.

Moreover, These results can be explained by the behaviour of which, in most of the regions, the private sector has a negative influence on the data as a whole (it dragged down the positive results achieved by the Public Sector), because efficiency levels are lower than before devolution, contrary to the results of public hospitals alone. This inefficiency in some Autonomous Regions is probably due to the fact that the private sector in these regions was not market developed and depended to a greater extent on INSALUD (National Institute for Health -the public manager under the Ministry of Health of the Central Government, prior to the devolution-). The Balearic Islands stand out for having the highest efficiency during the whole period considered, possibly due to their previous experience, as before the transfer of the competences, Balearic Islands already had a significant weight of the private sector in the healthcare system. Its case could be compared with that of Catalonia, both of which are similar in terms of the significant weight of the private sector in health care, which had already been reflected for many years [38].

In that sense, Kruse et al [39], in a study of 5 European countries, present evidence that public hospitals have at least the same level of efficiency or more than private hospitals. Likewise, in a comparative study by Comendeiro-Maaløe et al [40] of the performance of a private hospital in Spain and a private hospital licensed as a regional health service, the private hospital generally did not perform better than the public hospitals, although it did excel in some areas. However, according to Lucifora [41], managers of public hospitals often perform worse than managers of private hospitals. In the same sense, Perez-Romero et al [33].

All of this is directly related to the problem of waiting lists. In particular, there are two cases in which the Autonomous Regions with the highest waiting list figures should increase their productivity by improving the management of their public sector, i.e. Extremadura, Castile-La Mancha and Aragon. In the cases of the Region of Murcia or

Cantabria, where their public sector is very efficient, they should consider the possibility that their private sector, which is being underutilised, could, according to article 66 of Law 14/1986, of 25 April, General Health [42], link private hospitals to the planning of the public sector, without them losing their ownership, thus alleviating waiting lists, as also argued by IDIS [35]. Another possibility in this case could be to increase public resources in the face of such good management to reduce waiting lists.

Those ACs with lower levels of efficiency, as explained above, are probably not making efficient use of their resources and could offer greater capacity or, in other words, not have such high waiting times.

A case in point is Ceuta and Melilla which, after the creation of INGESA (Management Institute under the Ministry of Health of the Spanish Central Government), managed to improve their efficiency by 62.12% - probably due to the fact that they only have to manage the autonomous cities and, as there are not a greater number of territories, they can better focus on the needs of the autonomous cities - but if we make a relative comparison, they are below the rest of the Autonomous Regions. In this sense of a low level of efficiency of INGESA hospitals, there is evidence of saturation, lack of resources in relation to the population to be attended and waiting times, as stated in the study by Artundo Purroy [43].

Concerning the methodology used in this study, various approaches have been taken in the national and international literature to identify explanatory factors for technical efficiency and productivity [44]. Most studies compare efficiency figures between groups of units and explain them by linear regression. For example, in Iran, variability in efficiency in public hospitals was analysed by applying a multi-group DEA (Rezaee and Karimdadi, 2015) and correlation coefficients are frequently used in Spain to explore the relationship between efficiency and other factors [45] [46] [47] [48].

Perez-Romero et al [49] combine multilevel regression models to explain the efficiency of hospitals in the Spanish public network, this being one of the main methodological innovations provided by this study of Analysis of technical efficiency in the hospitals of the Spanish National Health System.

Linked to the above, a traditional linear regression model useful for estimating the relationship between a dependent variable and multiple independent variables. It is based on correlations and is therefore useful for estimating the variance of an independent variable explained by dependent variables. It is not causal and cannot provide researchers with information about a specific individual. It is parametric and cannot be generalised to results at the extremes of the distribution. Is prone to bias due to omitted variables, multicollinearity and autoregression, although there are tests and extensions to increase robustness [50].

On the other side, a non-parametric benchmarking method for analysing the efficiency of product production at a given input level. Provides a highly individualised benchmark for each individual in the group. Benchmarks are based only on existing input and output data for "equivalents" or other individuals in the same population. May include multiple dependent variables or outcomes simultaneously. Can be combined with other methods to reduce limitations and improve own results. Can be used with a

model-fitting approach to determine which input or dependent variable to focus on to achieve the greatest expected benefit for each individual. Sensitive to omitted variables and measurement error. There are methods to address these issues, but they are not as reliable as other methods. They are limited to the individual or population analysed, so the results cannot be generalised to other populations without subsequent analyses using other methods [50].

Another methodological issue to consider is the difference between DEA and SFA. Data Envelopment Analysis (DEA) is the most commonly used method in mathematical programming to estimate production frontiers. Stochastic frontier analysis (SFA) is the most representative method used in econometrics to estimate production frontiers [51] . DEA is recognised as a powerful tool for efficiency analysis and benchmarking, and its estimates are used in a wide range of industries and activities, including healthcare [52] [53]. The main difference between DEA and SFA is that DEA is usually used to examine the relative efficiency of individual studies. SFA is used to examine absolute efficiency and the relationship between the determinants of input and output (cost) efficiency. Therefore, SFA is often used to assess the efficiency of for-profit organisations. The DEA method measures the efficiency of public subjects by using the observed best performance compared to all subjects [54].

We are aware that this study presents the methodological limitations of DEA, derived from its deterministic character, which has been confronted with the testing of various models [47].

5. Conclusions. Limitations and extensions

This article has analysed the effects of decentralisation in Spain, specifically on the last ten Autonomous Regions that received the health care transfers at the end of 2001, with respect to the efficiency levels of the Public, Private and Joint Sectors.

An improvement of 60% can be seen in the communities analysed if we only take into account the NHS, however, if we consider the results of both sectors we observe that the majority of the territories worsen.

If we take into consideration all the Autonomous Communities that make up the Spanish territory, we can observe an improvement in the Public Sector of the ten communities analysed in terms of their relative position, with the following standing out: Region of Murcia, Community of Madrid and Balearic Islands. However, it should be noted that there are socio-economic factors such as the level of ageing, geographical dispersion, spending policies or the wealth of each region, which could explain why some territories have not improved as much.

On the other hand, in the face of the economic crisis, our results show that 60% of the public sector was not affected, in fact, its efficiency increased. The years 2007 and 2012 stand out as the years in which the highest efficiency values were reached (2012 if all the Autonomous Regions in Spain are taken into account) and one of the reasons for this behaviour is the change in the management model after the transfers. Otherwise, 80% of the private sector saw a decrease in efficiency.

In the light of the above, we can affirm that the transfers have not favoured the privatisation of the system. This can be demonstrated by the fact that even in communities where private provision has a strong presence or is highly efficient - as in the case of the Community of Madrid and La Rioja - public provision has increased despite everything.

On the other hand, with regard to those regions which are not fully efficient, i.e. which could generate more output with their current inputs and thus be more productive, two different cases can be identified. Extremadura, Aragon and Castile-La Mancha, which have waiting lists above the average for the Spanish regions, imply that they should, and need to, improve the management of their public resources (NHS). As for the Region of Murcia and Cantabria, where the public sector is very efficient, the private sector is notable for its under-utilisation of resources, which could be used to reduce the high waiting lists in both regions through public-private partnerships.

DEA measures multiple inputs and outputs and eliminates the need to construct production functions to estimate efficiency. This makes the use of DEA methods in efficiency research more comprehensive and more practical.

One limitation of this study is that it does not include health outcomes in the analysis, which we will try to develop in future papers.

Finally, it would be of great interest to extend our study once the Ministry of Health makes the data for the last few years available to the public, in order to compare efficiency between the Autonomous Regions before and after the health crisis. As well as the functioning and behaviour of hospitals during the pandemic.

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The authors declare that they had full access to all of the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis

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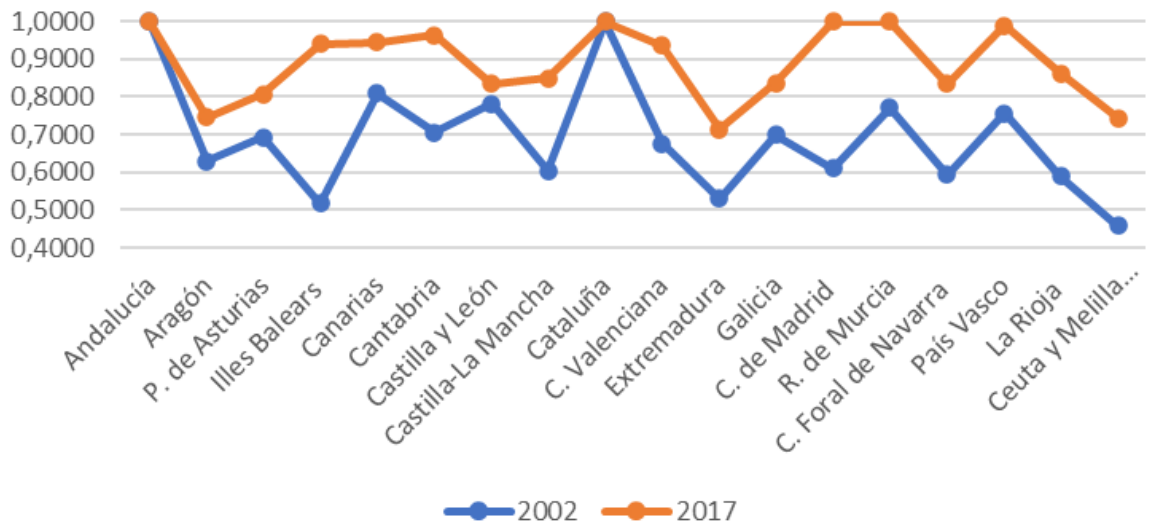
Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.

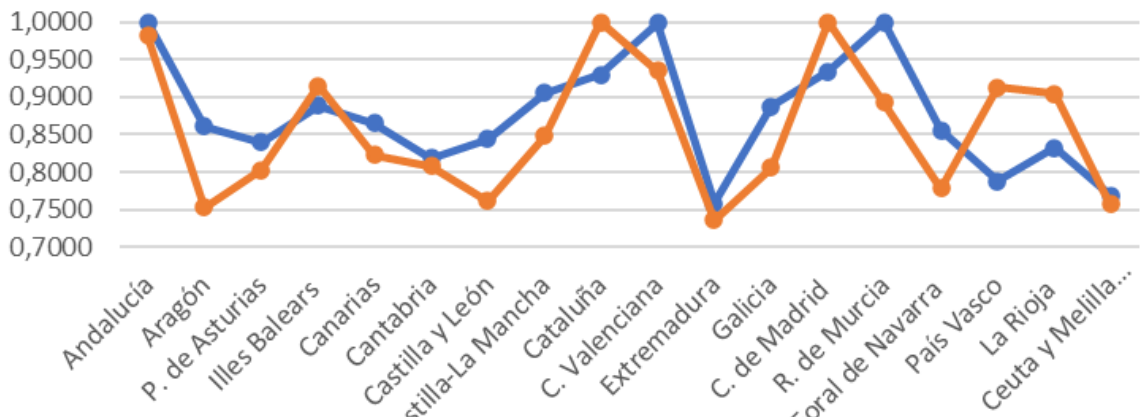
Figure 2. Comparison of the efficiency values of the NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.

Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Figure 2. Comparison of the efficiency values of the Spanish NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

ANNEX

Table 1. Efficiency of hospitals belonging to the NHS in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
Regions	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9035	0,9346	1,0000
Aragón	0,6290	0,7130	0,8021	0,7451
Principado de Asturias	0,6932	0,7647	0,8459	0,8075
Illes Balears	0,5183	0,7511	0,7374	0,9403
Canarias	0,8088	0,9029	0,9062	0,9446
Cantabria	0,7057	0,8379	0,9679	0,9636
Castilla y León	0,7821	0,7724	0,8845	0,8343
Castilla-La Mancha	0,6040	0,7413	0,8241	0,8494
Cataluña	1,0000	1,0000	1,0000	1,0000
Comunidad Valenciana	0,6754	0,8860	0,8935	0,9365
Extremadura	0,5313	0,7099	0,7453	0,7146
Galicia	0,6987	0,7614	0,8942	0,8370
Comunidad de Madrid	0,6104	0,8720	0,8835	0,9997
Región de Murcia	0,7703	1,0000	1,0000	1,0000
Comunidad Foral de Navarra	0,5942	0,9233	0,8735	0,8346
País Vasco	0,7571	0,7145	0,9750	0,9890
La Rioja	0,5893	0,7528	0,8910	0,8611
Ceuta y Melilla	0,4592	0,5839	0,6867	0,7444

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 2. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS between 2002 and 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Cataluña	Andalucía
Cataluña	R. de Murcia	R. de Murcia	Cataluña
Canarias	C. F. Navarra	País Vasco	R. de Murcia
Castilla y León	Andalucía	Cantabria	C. de Madrid
R. de Murcia	Canarias	Andalucía	País Vasco
País Vasco	C. Valenciana	Canarias	Cantabria
Cantabria	C. de Madrid	Galicia	Canarias
Galicia	Cantabria	C. Valenciana	Illes Balears
P. de Asturias	Castilla y León	La Rioja	C. Valenciana
C. Valenciana	P. de Asturias	Castilla y León	La Rioja
Aragón	Galicia	C. de Madrid	Castilla-La Mancha
C. de Madrid	La Rioja	C. F. Navarra	Galicia

Castilla-La Mancha	Illes Balears	P. de Asturias	C. F. Navarra
C. F. Navarra	Castilla-La Mancha	Castilla-La Mancha	Castilla y León
La Rioja	País Vasco	Aragón	P. de Asturias
Extremadura	Aragón	Extremadura	Aragón
Illes Balears	Extremadura	Illes Balears	Ceuta y Melilla
Ceuta y Melilla	Ceuta y Melilla	Ceuta y Melilla	Extremadura

Source: Own elaboration

Table 3. Efficiency of hospitals belonging to the NHS and the private sector in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
CCAA	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9689	1,0000	0,9815
Aragón	0,8609	0,8470	0,8348	0,7530
Principado de Asturias	0,8399	0,8435	0,8593	0,8031
Illes Balears	0,8883	0,8676	0,9271	0,9150
Canarias	0,8649	0,8632	0,8958	0,8232
Cantabria	0,8187	0,8371	0,8873	0,8082
Castilla y León	0,8445	0,8576	0,8394	0,7621
Castilla-La Mancha	0,9051	0,9196	0,8953	0,8487
Cataluña	0,9297	1,0000	1,0000	1,0000
Comunidad Valenciana	0,9982	1,0000	0,9450	0,9352
Extremadura	0,7588	0,8124	0,8092	0,7367
Galicia	0,8877	0,8976	0,9059	0,8059
Comunidad de Madrid	0,9335	0,9292	0,9798	1,0000
Región de Murcia	1,0000	0,9315	0,9245	0,8930
Comunidad Foral de Navarra	0,8557	0,8032	0,8773	0,7781
País Vasco	0,7880	0,7121	0,9438	0,9125
La Rioja	0,8329	0,8801	0,9930	0,9048
Ceuta y Melilla	0,7690	0,8215	0,8439	0,7570

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 4. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS and Private Sector between 2002 - 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Andalucía	Cataluña
R. de Murcia	C. Valenciana	Cataluña	C. de Madrid
C. Valenciana	Andalucía	La Rioja	Andalucía
C. de Madrid	R. de Murcia	C. de Madrid	C. Valenciana
Cataluña	C. de Madrid	C. Valenciana	Illes Balears
Castilla-La Mancha	Castilla-La Mancha	País Vasco	País Vasco

Illes Balears	Galicia	Illes Balears	La Rioja
Galicia	La Rioja	R. de Murcia	R. de Murcia
Canarias	Illes Balears	Galicia	Castilla-La Mancha
Aragón	Canarias	Canarias	Canarias
C. F. Navarra	Castilla y León	Castilla-La Mancha	Cantabria
Castilla y León	Aragón	Cantabria	Galicia
P. de Asturias	P. de Asturias	C. Foral de Navarra	P. de Asturias
La Rioja	Cantabria	P. de Asturias	C. Foral de Navarra
Cantabria	Ceuta y Melilla	Ceuta y Melilla	Castilla y León
País Vasco	Extremadura	Castilla y León	Ceuta y Melilla
Ceuta y Melilla	C. Foral de Navarra	Aragón	Aragón
Extremadura	País Vasco	Extremadura	Extremadura

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	N/A
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5*
Bias	9	Describe any efforts to address potential sources of bias	12
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*N/A*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*N/A*
		Cross-sectional study—Report numbers of outcome events or summary measures	*N/A*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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EVALUATING THE DECENTRALISATION OF THE SPANISH HEALTH CARE SYSTEM: A DEA APPROACH

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EVALUATING THE DECENTRALISATION OF THE SPANISH HEALTH CARE SYSTEM: A DEA APPROACH

Running Head: Efficiency in a desentralised Health system.

Abstract

Objectives: The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Design: In this paper we have used Data Envelopment Analysis (DEA) to analyse the evolution of efficiency in the last ten Autonomous Regions to receive health care competences at the end of 2001.

Participants: For this study we have taken into account the number of beds and full-time workers as inputs and the calculation of basic care units as outputs to measure the efficiency of the Spanish public sector, private sector and jointly in the years 2002, 2007, 2012 and 2017 for the last Autonomous Regions receiving health care competences.

Results: Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%).

Conclusion: In general, it can be observed that the transfer of responsibilities in the health sector has improved efficiency in the NHS.

Strengths and limitations of this study

- The use of DEA methods in efficiency research shows comprehensive and practical results.
- One limitation of this study is not to include health outcomes in the analysis.
- Using full-time workers as input, regions with a greater weight of part-time staff may overestimate their efficiency results.
- The use of UBAs as outputs may make it difficult to compare with other studies.
- There are methodological limitations of DEA, derived from its deterministic character.

JEL classification

C14; I18; H21.

Key words: Efficiency; National Health System; Devolution; DEA; Data Envelopment Analysis; Health Decentralisation.

1. Introduction

Spain is a decentralised country in which the Autonomous Communities have the powers to administer and manage certain public services, including health. However, this has not always been the case. To understand the current situation, it is necessary to go back to 1977, the year in which the Ministry of Health and Social Security was created. Months later, by Royal Decree-Law 36/1978, a Social Security Management Entity was created, the National Health Institute, abbreviated as INSALUD, in charge of providing health care [1].

During the process of political and economic change that took place at that time, the Spanish Transition, the approval of the Constitution in 1978 brought changes related to the decentralisation of powers, including in the area of health. Specifically, Article 43 recognises the right to health protection and Article 148.1.21 recognises health as a competence that can be assumed by the Autonomous Communities, leaving only the State with exclusive competence in external health and the general coordination of health (Article 149.1.16).

The constitution of the communities is carried out at different paces, so there are some that assume the functions and services carried out by INSALUD sooner than others, the process of transfer begins in 1981 and ends at the end of 2001. Thus, first, Catalonia (1981), Andalusia (1984), the Basque Country (1984), the Valencian Community (1987), Galicia (1990), the Community of Navarre (1990) and the Canary Islands (1994) received the competencies.

Meanwhile, Aragon, the Principality of Asturias, the Balearic Islands, Cantabria, Castile-La Mancha, Castile and Leon, Extremadura, La Rioja, the Community of Madrid and the Region of Murcia were under State administration through INSALUD, until they received the transfer of competences. After a long process, at the end of 2001, these last ten Autonomous Regions received the transfers and by the following year were already administering and managing health care in their territory. Thus, INSALUD was liquidated and converted into a smaller entity, the Instituto Nacional de Gestión Sanitaria, abbreviated as INGESA [2], which would continue to administer and manage healthcare in the Autonomous Cities of Ceuta and Melilla.

Therefore, to summarise, our country currently has the National Health System, which brings together the public health networks of the seventeen Autonomous Regions, and INGESA, the state administrator and manager of the Autonomous Cities.

Each Autonomous Community carries out the planning, administration and management of the health services in its territory, following the guidelines set out in the LGS (General

Health Act), but with variability in terms of the portfolio of services for its citizens, while respecting the basic levels cited in Law 14/1986, LGS. The autonomous communities' highest health management body is the Regional Ministry of Health, which is responsible for setting up a Health Service (from the point of view of both the service provider and the service funder), made up of outpatient centres (Primary healthcare centers) and hospitals that provide the services planned in the autonomous community's service portfolio. Each Autonomous Community divides the territory into Health Areas, which are the Basic Geographical and Functional Units of health care, each health area being autonomous and able to establish its own specific health plans and adapt resources to the needs of the population concerned. These health areas, provided for in the LGS, are created to cover approximately 200,000 inhabitants, with at least one Tertiary Hospital Centre and different Health Centres, approximately one for every 20,000 inhabitants.

The universal nature of our public health care system necessarily means that it is not linked to citizens' ability to pay, unlike other types of contributory benefits offered by the Social Security System, which are directly affected by the social contributions made by the system's potential beneficiaries. Consequently, as health care is treated as a non-contributory benefit of the social security system, its main source of financing is the transfers made by the corresponding public administrations (State, Autonomous Communities or Local Corporations), which come mainly from public sector tax revenues.

The decentralisation of the health system carried out in Spain is not an isolated event; other countries such as Italy, the United Kingdom, Portugal, the Philippines, etc. have also done so [3] [4]. These types of reforms have given rise to a debate in the literature about who plays a better role in managing healthcare: the state or the territories that make it up? In other words, in terms of the welfare and efficiency of the population, what is more favourable: a centralised or decentralised healthcare system?.

Numerous studies [5] [3] [6] [4] discuss the direct consequences that accompany health decentralisation, as well as its advantages and disadvantages.

The mere definition of the concept of decentralisation generates different positions and approaches that often complicate rather than facilitate the analysis [7] [8] defines decentralisation as "the transfer of planning, management and collection responsibilities and allocation of resources from the central government and its agencies to territorial units" as well as Delegation as the transfer of decision-making and administrative power - including financial responsibilities - over public functions to autonomous organisations [9] [10]. It is the latter concept that best fits the decentralisation process that has taken place in the Spanish national health system.

Privatisation, on the other hand, would be the policy of having services provided by businesses, community groups, co-operatives, private voluntary associations, individuals, small informal enterprises and other non-governmental organisations. For this author, privatisation ranges from leaving the provision of goods and services entirely to economic competition to "partnerships" between public agencies and private enterprises [11].

Decentralisation is generally considered to improve efficiency in health care and influence health care by bringing governance closer to the population, allowing for

feedback [5]. It also fosters competition between territories that try to stand out and proceed in the best possible way, most of the time leading to increased spending, which is often accompanied by improved health outcomes [12] [3]. In that sense, it should take in account that, although Tiebout [13] argued in his famous article that citizens "vote with their feet" and choose the jurisdiction that offers them the best range of services, it is debatable whether citizen mobility is as typical in Europe as it is in the US [14]. While mobility enhances the benefits of decentralisation, it is not entirely dependent on it. Even in the absence of mobility, the efficient provision of a local public good is determined by the condition that the sum of marginal costs of substitution equals marginal costs, and this condition tends to vary across territories [15].

However, when decision-makers increase spending, this can result in increased costs due to: duplication of inputs, where two neighbouring regions may share similar services; diseconomies of scale or even moral hazard, as they expect their debts to be covered by the central government [3].

The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Methodology and data

2.1. Variables used

We understand *Devolution* as the creation or reinforcement of levels of government lower than the state, to which broader responsibilities than the simply administrative ones are attributed for the development of certain functions, which is the case in Spain [10].

In this paper, performance improvement means improving the efficiency (or productivity) of public services [16]. In measuring performance a distinction can be made between technical efficiency ("doing more with less") and allocative efficiency ("doing the right thing in the right place").

Technical efficiency describes a production process in which maximum output is achieved when inputs are fixed and technology is fixed. Allocative efficiency refers to the allocation of resources (finance, labour or physical capital) and is achieved when the combination of inputs and outputs is cost-minimising and/or profit-maximising [17] [18].

The concept of technical efficiency is similar to the concept of productivity. Productivity is usually defined as the ratio between the quantity of output and the quantity of inputs used. Productivity is much easier to calculate when the production unit analysed uses an input to produce a product. If a production unit uses several inputs to produce several outputs, inputs and outputs must be combined [19] (as we have done with the calculation of the Basic Care Units –BAU).

In contrast to efficiency, which is the relationship between outcomes and inputs, effectiveness is the relationship between defined outcomes and defined inputs and depends on service quality [20].

This paper has proposed the measurement of technical efficiency, understood as productivity.

The information on the variables used has been compiled from the Spanish Ministry of Health database [21] [22] [23] [24]. The period of analysis is divided into five-year periods, from 2002, when the last ten autonomous communities received health competencies and began to operate on their own, to 2017.

In order to examine the evolution of efficiency after the transfer of power, the number of beds and the number of full-time workers have been used as inputs to the model. These data have been chosen because the number of beds installed in hospitals has been used as a proxy variable for the capital factor in recent years in numerous studies [25]. When distinguishing between the number of public and private beds, the corresponding percentages indicated in the Ministry's database have been applied.

Similarly, the number of full-time workers has been used to represent the labour factor. This includes doctors, nurses, MIR, auxiliary nurses, senior health technicians, other health personnel and non-health personnel. As in the previous case, due to the need to compare the results of the Public Sector versus the Private Sector, after reviewing numerous official State documents [26] [27] [28] [29] over the last twenty years, there has been a trend in the sector indicating that eight out of every ten workers belong to the public hospital network. Therefore, to the total number of full-time employees we have applied a percentage of 80% to obtain the number of public workers, conversely 20% has been applied to find the figures for the Private Sector.

On the output side, the Basic Care Units (BAU), one of the first measures of hospital consumption, were taken into account. To calculate this index, a series of weightings were taken into account with respect to the variables that comprise it: 1 BAU = stays; 0.5 BAU = first consultations; 0.25 BAU = successive consultations and, finally, 0.5 BAU = non-admitted emergencies [30]. For the calculation of non-admitted emergencies and number of stays financed by the Public Sector, since the corresponding percentages for 2002 are not explicit, the following data are taken into account: "Paid by Social Security", "Paid by Companies collaborating with the S.S.", "Paid by other Public Entities", "Paid by Civil Servants' Mutual Societies" and "Others" [22]. It should also be mentioned that, for the calculation of first consultations, in the absence of specific data by autonomous community, the average percentage corresponding to first consultations with respect to total consultations was used in 2012 and 2017. [23] [24] .

2.2. Data Envelopment Analysis (DEA)

Data Envelopment Analysis, known as DEA, is a non-parametric frontier method used to measure the efficiency of each organisation or organisational unit (DMU, Decision Making Units), which in this case corresponds to the CAACs analysed, by solving a linear programming problem [31] for each unit under the assumption, in this study, of Constant Returns to Scale (CRS):

$$Eficiencience = Max_{u_r, v_r} \sum_r u_r y_{r j0}$$

$$s.a. \sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0; \forall j$$

$$\sum_i v_i x_{i j0} = 1$$

$$u_r, v_i \geq 0; \forall_r, \forall_i$$

Where y_rj is the quantity of output r produced by the hospitals of AC j; x_ij the quantity of input i used by the hospitals of AC j; u_r the weight given to output r, (r = 1, ..., t, where t is the number of outputs); v_i the weight given to input i, (where as in the previous case i = 1, ..., m, where m is the number of inputs); j_0 AC under evaluation. Therefore, a CAAC is on the efficiency frontier if and only if, ∑_(_r^)^ ▒u_r y_(r j0) is equal to unity, i.e. it reaches the maximum efficiency levels.

This technique, widely used in the health sector [25], allows measuring several different types of efficiency: technical, allocative congestion and dynamic through the Malmquist index. In addition, it also allows for the observation of possible economies of scale.

In order to carry out the corresponding analysis of technical efficiency in the Public, Private and Joint Sector, a series of inputs and an output have been chosen, which have been discussed in greater detail in the previous subsection.

That said, the programme used to apply this analysis technique was DEAFrontier Software for Excel.

2.3. Patient and public involvement

No patient involved

3. Results

3.1. Efficiency in the last ten Autonomous Regions to receive transfers

Taking unity as the optimum value for efficiency and taking into account both the public and private sectors, it can be seen in Table 1 that, in general, the devolved regions have worsened their efficiency since the devolution, with Castile and Leon, Aragon and the Principality of Asturias standing out. Only the Autonomous Community of Madrid improved, reaching maximum efficiency, and La Rioja, increasing its efficiency by a higher relative percentage.

Table 1. Efficiency of the NHS and the private sector in the last ten Autonomous Communities to receive health care competencies.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8851	0,9114	0,8515	0,7794
Principado de Asturias	0,8985	0,9178	0,8845	0,8031
Illes Balears	0,9219	0,9337	0,9448	0,9150
Cantabria	0,8890	0,9446	0,9000	0,8260
Castilla y León	1,0000	0,9850	0,9331	0,8436
Castilla-La Mancha	0,9051	0,9897	0,9147	0,8487
Extremadura	0,8131	0,9821	0,8924	0,7735
Comunidad de Madrid	0,9335	1,0000	0,9937	1,0000
Región de Murcia	1,0000	1,0000	0,9524	0,9633
La Rioja	0,8442	0,9472	1,0000	0,9766

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Unlike the previous case, table 2 only shows the efficiency data relating to the NHS. While the Region of Murcia stands out as the most efficient region throughout the period under study, most of the Autonomous Regions analysed, 60% to be precise, improved efficiency rates (they are closer to 1) after the transfer of competences prior to 2002. The Balearic Islands (36.95%), La Rioja (25.66%) and the Community of Madrid (18.60%) are the regions that have seen the greatest increase in efficiency in the use of available public resources. Only Castile and Leon, the Principality of Asturias and Aragon have worsened.

Table 2. Efficiency of the last ten Autonomous Communities to receive health care competencies in hospitals belonging to the NHS.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8072	0,8591	0,8702	0,7701
Principado de Asturias	0,8911	0,9388	0,9196	0,8075
Illes Balears	0,6918	0,7511	0,7374	0,9475
Cantabria	0,9094	0,9606	0,9742	0,9638
Castilla y León	1,0000	0,9831	0,9698	0,8676
Castilla-La Mancha	0,7776	0,8441	0,8898	0,8718
Extremadura	0,6879	0,9394	0,8663	0,7719
Comunidad de Madrid	0,8432	0,8720	0,8985	1,0000
Región de Murcia	1,0000	1,0000	1,0000	1,0000

La Rioja	0,7609	0,8709	1,0000	0,9562

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Only Catilla y León, the Principality of Asturias and Aragón have seen their efficiency decrease (table 3).

Table 3. Efficiency of the last ten Autonomous Communities in receiving health care competencies in hospitals belonging to the Private Sector.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,6155	0,7812	0,4794	0,5968
Principado de Asturias	0,3236	0,4221	0,4044	0,4694
Illes Balears	1,0000	1,0000	1,0000	1,0000
Cantabria	0,2413	0,3519	0,1844	0,2112
Castilla y León	0,3826	0,4801	0,3225	0,3629
Castilla-La Mancha	0,6206	0,9799	0,4801	0,4903
Extremadura	1,0000	1,0000	0,8322	0,6826
Comunidad de Madrid	0,6597	0,8471	0,7354	0,9871
Región de Murcia	0,3150	0,4369	0,2954	0,3573
La Rioja	1,0000	0,5846	1,0000	1,0000

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

In general, the results in this case are more diverse: 50% of the ACs worsen, with Extremadura and Castilla-La Mancha being the worst performers (the latter standing out if we consider the 2007 value); two of them remain constant practically throughout the entire period (Balearic Islands and La Rioja, with the exception of 2007 but then recovering) and the rest improve, with the Principality of Asturias and the Community of Madrid standing out as we have already mentioned, which progresses in such a way that it reaches levels very close to absolute efficiency.

3.2. Relative comparison, efficiency of all Regions

In Annex Table 1 it could be seen that Andalusia and Catalonia can be considered as benchmarks for practically the entire period, taking into account the SNS alone (by obtaining the index 1.000 in the DEA survey). Firstly, the Region of Murcia, which managed to become a benchmark Autonomous Region with its optimal efficiency values, has improved significantly with respect to the other Autonomous Regions that received

the transfers before 2002. Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%). On the other hand, it is important to mention the reduction in the gap between the most efficient and the least efficient ACs over time. In 2002, the lowest value among the Autonomous Communities was 0.5183, belonging to the Balearic Islands, with respect to 1.000, which implies a difference in efficiency of 0.4817. Over the years, in 2017 this inequality is reduced to 0.7146 in Extremadura and the optimal unit, indicating this time a distance of 0.2854, which translates as a decrease in the differences of almost 40% between the lowest values.

Figure 1

As it could be seen in Annex Table 2, likewise, we observe that, as a whole, the efficiency of the Autonomous Regions has improved and that after the transfer of competences the differences in efficiency rates between the regions have been reduced. This is the case of the Balearic Islands, the Canary Islands and Cantabria. As shown in figure 1, in 2017 compared to 2002, the disparities between these three regions are greatly reduced and converge. Both Castillas also manage to reduce their interregional differences, with Castilla-La Mancha standing out. The Community of Madrid and the Region of Murcia converge at the same time, becoming in 2017 one of the reference ACs due to their high efficiency values.

The blue line shows the reference ACs, i.e. those with optimal efficiency values, while the dashed red line shows the average efficiency for that year, which is useful for easily visualising which ACs are above (or below) the average. It is interesting to perform the analysis from this perspective, since some regions may have improved their efficiency but worsened in comparison with the rest of the regions, because the latter have improved more, and vice versa. Thus, in the case of the Balearic Islands, which improved its efficiency to a great extent (81.44%, as mentioned above), its efficiency improved with respect to other regions that were relatively far behind it, for example, surpassing the Autonomous Community of Valencia, the Principality of Asturias and Galicia. The Community of Madrid improved its efficiency in 2017 with respect to 2002 by 63.77%, which places it at the top of the table, as shown in Annex Table 3. On the other hand, although Castilla y León's efficiency improved by approximately 7%, its relative position compared to the rest of the Autonomous Regions was reduced to the bottom five.

Annex Table 4 shows the combined data for the NHS and the private sector, which leads to the following results: on calculating the efficiency values of the ten Autonomous Regions that received the competences at the end of 2001, with respect to the rest of the regions that already had them, it is found that 70% of them have seen their efficiency worsen. Aragon (-12.53%), the Region of Murcia (-10.70%) and Castile and Leon (-9.75%) stand out. In contrast to Annex Table 1, the reference Autonomous Community

is Catalonia. On the other hand, the Autonomous Region with the greatest improvement in efficiency is La Rioja (8.63%), followed by the Autonomous Region of Madrid (7.12%), which manages to achieve maximum efficiency. In this case, the Balearic Islands improved by only 3.01%, but it starts from higher values, close to 90% efficiency (figure 2).

Figure 2

4. Discussion

We are aware that it is difficult in this area to compare the results found with other studies due to the fact that DEA can give different results when the inputs and outputs used are not the same. Moreover, we have used global data from the health sector - in order to be able to draw conclusions, not only in the public sector (NHS), but also in the private sector and jointly, on the effects of decentralisation in the Spanish health sector - while in many other studies a specific selection of hospitals has been carried out [32] [33] [34].

As far as the public sector is concerned, our results show that most of the Autonomous Regions that were the last to receive health transfers improved their efficiency levels to their highest values between 2007 and 2012. However, if we consider the comparison of these regions as a whole, the highest figures are found in 2012. We believe that this behaviour is possible due to the positive impact of the incorporation of new management models and changes in the organisational structure of those Autonomous Regions that received the transfer of competences at the end of 2001, coinciding with the authors Granado Cabello and Vega Hidalgo [32]. However, other authors such as Sbert, J. M., and Gómez Vicens, J. M. [34] do not agree with this explanation, as they believe that, after the transfers, there is a period of adaptation that leads to an increase in costs and resources that are detrimental to productivity levels.

That said, it should be stressed that the introduction of these changes does not fully explain the increase in efficiency in the Autonomous Regions studied, as there are other socio-economic factors that may influence efficiency. It is also necessary to question why, as we have seen, some regions do not improve as much as others. Despite the fact that, following decentralisation, the efficiency of the NHS improves in general - in its entirety if we compare all the Autonomous Regions as a whole - those territories that are less efficient may be due to factors such as ageing, geographical dispersion, wealth or the public spending policies of each region, among other variables. In this sense, we agree with Pérez-Romero, Ortega-Díaz, Ocaña-Riola and Martín-Martín [33].

Despite these differences, it should be stressed that after the transfer of competences in the public health sector there has been a positive impact which has led to a reduction in the gap between the most efficient and least efficient Autonomous Regions in Spain. Over the fifteen years observed, the gap between Autonomous Regions has narrowed by approximately 40%. In view of this improvement, however, we would like to focus on two aspects relating to the private sector and waiting lists.

On the one hand, the data provided by the Ministry show that over the years, following the transfers, public provision has not only become more efficient, but has also increased with respect to private provision, even in regions where the private sector is very efficient. The case of the Community of Madrid stands out, which, despite the strong presence of the private sector, has increasingly increased the supply of public services. On the other hand, there is also the case of La Rioja, a territory in which the Private Sector is very efficient and yet the importance of public activities is increasing. In other words, we find that the evolution of public activity is increasing, except in the case of the Balearic Islands, where its weight is increasing in relation to the private sector. This can also be seen in the decrease in spending on concerts in a large part of the Autonomous Regions, as indicated by IDIS [35].

Therefore, we can say that the transfers have boosted the public sector even in those Autonomous Regions with a strong presence of private activity, even if this is efficient. We believe that this trend may have a negative impact on citizens in the future because, with a permanent increase in health spending, not only in Spain but in other countries as well - derived from demographic factors, such as ageing, which affects Western Europe in particular, as pointed out by Jakovljevic et al. [36], or cultural factors such as the desire for greater welfare - the public health system may be limited by the need for a larger budget and greater flexibility. Authors such as Kosycarz, Nowakowska, & Mikołajczyk, [37] propose a similar approach to improving public hospitals in Poland through public-private partnerships.

Moreover, These results can be explained by the behaviour of which, in most of the regions, the private sector has a negative influence on the data as a whole (it dragged down the positive results achieved by the Public Sector), because efficiency levels are lower than before devolution, contrary to the results of public hospitals alone. This inefficiency in some Autonomous Regions is probably due to the fact that the private sector in these regions was not market developed and depended to a greater extent on INSALUD (National Institute for Health -the public manager under the Ministry of Health of the Central Government, prior to the devolution-). The Balearic Islands stand out for having the highest efficiency during the whole period considered, possibly due to their previous experience, as before the transfer of the competences, Balearic Islands already had a significant weight of the private sector in the healthcare system. Its case could be compared with that of Catalonia, both of which are similar in terms of the significant weight of the private sector in health care, which had already been reflected for many years [38].

In that sense, Kruse et al [39], in a study of 5 European countries, present evidence that public hospitals have at least the same level of efficiency or more than private hospitals. Likewise, in a comparative study by Comendeiro-Maaløe et al [40] of the performance of a private hospital in Spain and a private hospital licensed as a regional health service, the private hospital generally did not perform better than the public hospitals, although it did excel in some areas. However, according to Lucifora [41], managers of public hospitals often perform worse than managers of private hospitals. In the same sense, Perez-Romero et al [33].

All of this is directly related to the problem of waiting lists. In particular, there are two cases in which the Autonomous Regions with the highest waiting list figures should increase their productivity by improving the management of their public sector, i.e. Extremadura, Castile-La Mancha and Aragon. In the cases of the Region of Murcia or Cantabria, where their public sector is very efficient, they should consider the possibility that their private sector, which is being underutilised, could, according to article 66 of Law 14/1986, of 25 April, General Health [42], link private hospitals to the planning of the public sector, without them losing their ownership, thus alleviating waiting lists, as also argued by IDIS [35]. Another possibility in this case could be to increase public resources in the face of such good management to reduce waiting lists.

Those ACs with lower levels of efficiency, as explained above, are probably not making efficient use of their resources and could offer greater capacity or, in other words, not have such high waiting times.

A case in point is Ceuta and Melilla which, after the creation of INGESA (Management Institute under the Ministry of Health of the Spanish Central Government), managed to improve their efficiency by 62.12% - probably due to the fact that they only have to manage the autonomous cities and, as there are not a greater number of territories, they can better focus on the needs of the autonomous cities - but if we make a relative comparison, they are below the rest of the Autonomous Regions. In this sense of a low level of efficiency of INGESA hospitals, there is evidence of saturation, lack of resources in relation to the population to be attended and waiting times, as stated in the study by Artundo Purroy [43].

Concerning the methodology used in this study, various approaches have been taken in the national and international literature to identify explanatory factors for technical efficiency and productivity [44]. Most studies compare efficiency figures between groups of units and explain them by linear regression. For example, in Iran, variability in efficiency in public hospitals was analysed by applying a multi-group DEA (Rezaee and Karimdadi, 2015) and correlation coefficients are frequently used in Spain to explore the relationship between efficiency and other factors [45] [46] [47] [48].

Perez-Romero et al [49] combine multilevel regression models to explain the efficiency of hospitals in the Spanish public network, this being one of the main methodological innovations provided by this study of Analysis of technical efficiency in the hospitals of the Spanish National Health System.

Linked to the above, a traditional linear regression model useful for estimating the relationship between a dependent variable and multiple independent variables. It is based on correlations and is therefore useful for estimating the variance of an independent variable explained by dependent variables. It is not causal and cannot provide researchers with information about a specific individual. It is parametric and cannot be generalised to results at the extremes of the distribution. Is prone to bias due to omitted variables, multicollinearity and autoregression, although there are tests and extensions to increase robustness [50].

On the other side, a non-parametric benchmarking method for analysing the efficiency of product production at a given input level. Provides a highly individualised benchmark for

each individual in the group. Benchmarks are based only on existing input and output data for "equivalents" or other individuals in the same population. May include multiple dependent variables or outcomes simultaneously. Can be combined with other methods to reduce limitations and improve own results. Can be used with a model-fitting approach to determine which input or dependent variable to focus on to achieve the greatest expected benefit for each individual. Sensitive to omitted variables and measurement error. There are methods to address these issues, but they are not as reliable as other methods. They are limited to the individual or population analysed, so the results cannot be generalised to other populations without subsequent analyses using other methods [50].

Another methodological issue to consider is the difference between DEA and SFA. Data Envelopment Analysis (DEA) is the most commonly used method in mathematical programming to estimate production frontiers. Stochastic frontier analysis (SFA) is the most representative method used in econometrics to estimate production frontiers [51]. DEA is recognised as a powerful tool for efficiency analysis and benchmarking, and its estimates are used in a wide range of industries and activities, including healthcare [52] [53]. The main difference between DEA and SFA is that DEA is usually used to examine the relative efficiency of individual studies. SFA is used to examine absolute efficiency and the relationship between the determinants of input and output (cost) efficiency. Therefore, SFA is often used to assess the efficiency of for-profit organisations. The DEA method measures the efficiency of public subjects by using the observed best performance compared to all subjects [54].

We are aware that this study presents the methodological limitations of DEA, derived from its deterministic character, which has been confronted with the testing of various models [47]. The limitations of the DEA methodology are that it does not measure error, it does not measure the relative differences between efficient suppliers, the use of many input and output variables is often considered flawed and that homogeneity in the units used is required [55] [56].

5. Conclusions. Limitations and extensions

This article has analysed the effects of decentralisation in Spain, specifically on the last ten Autonomous Regions that received the health care transfers at the end of 2001, with respect to the efficiency levels of the Public, Private and Joint Sectors.

An improvement of 60% can be seen in the communities analysed if we only take into account the NHS, however, if we consider the results of both sectors we observe that the majority of the territories worsen.

If we take into consideration all the Autonomous Communities that make up the Spanish territory, we can observe an improvement in the Public Sector of the ten communities analysed in terms of their relative position, with the following standing out: Region of Murcia, Community of Madrid and Balearic Islands. However, it should be noted that there are socio-economic factors such as the level of ageing, geographical dispersion, spending policies or the wealth of each region, which could explain why some territories have not improved as much.

On the other hand, in the face of the economic crisis, our results show that 60% of the public sector was not affected, in fact, its efficiency increased. The years 2007 and 2012 stand out as the years in which the highest efficiency values were reached (2012 if all the Autonomous Regions in Spain are taken into account) and one of the reasons for this behaviour is the change in the management model after the transfers. Otherwise, 80% of the private sector saw a decrease in efficiency.

In the light of the above, we can affirm that the transfers have not favoured the privatisation of the system. This can be demonstrated by the fact that even in communities where private provision has a strong presence or is highly efficient - as in the case of the Community of Madrid and La Rioja - public provision has increased despite everything.

On the other hand, with regard to those regions which are not fully efficient, i.e. which could generate more output with their current inputs and thus be more productive, two different cases can be identified. Extremadura, Aragon and Castile-La Mancha, which have waiting lists above the average for the Spanish regions, imply that they should, and need to, improve the management of their public resources (NHS). As for the Region of Murcia and Cantabria, where the public sector is very efficient, the private sector is notable for its under-utilisation of resources, which could be used to reduce the high waiting lists in both regions through public-private partnerships.

DEA measures multiple inputs and outputs and eliminates the need to construct production functions to estimate efficiency. This makes the use of DEA methods in efficiency research more comprehensive and more practical.

One limitation of this study is that it does not include health outcomes in the analysis, which we will try to develop in future papers.

Finally, it would be of great interest to extend our study once the Ministry of Health makes the data for the last few years available to the public, in order to compare efficiency between the Autonomous Regions before and after the health crisis. As well as the functioning and behaviour of hospitals during the pandemic.

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design of the study, performed part of the literature review and helped to draft the manuscript; Moises Rodriguez-Manero performed part of the literature review and helped to draft the manuscript

The authors declare that they had full access to all of the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis

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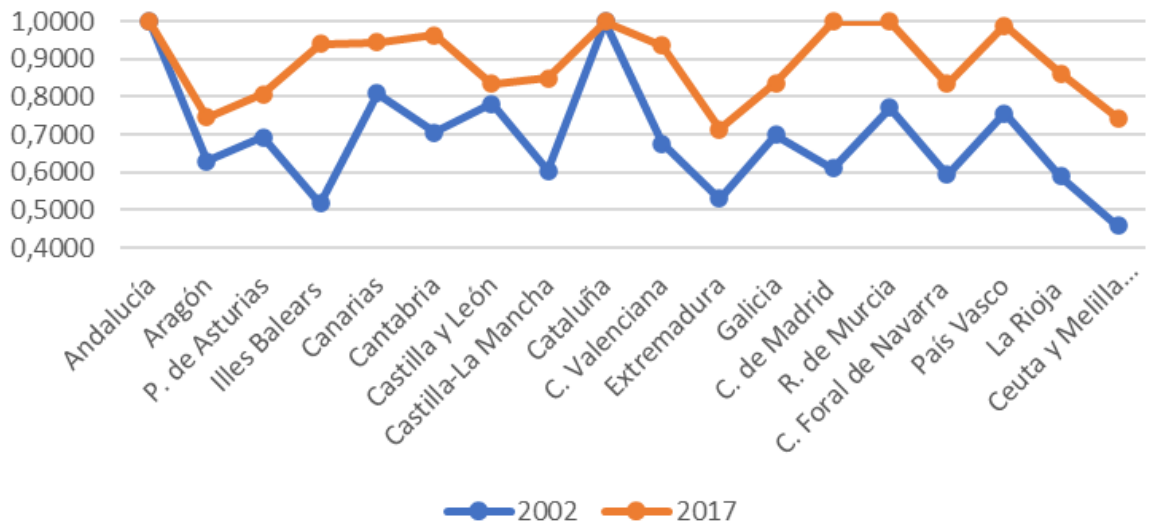
Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.

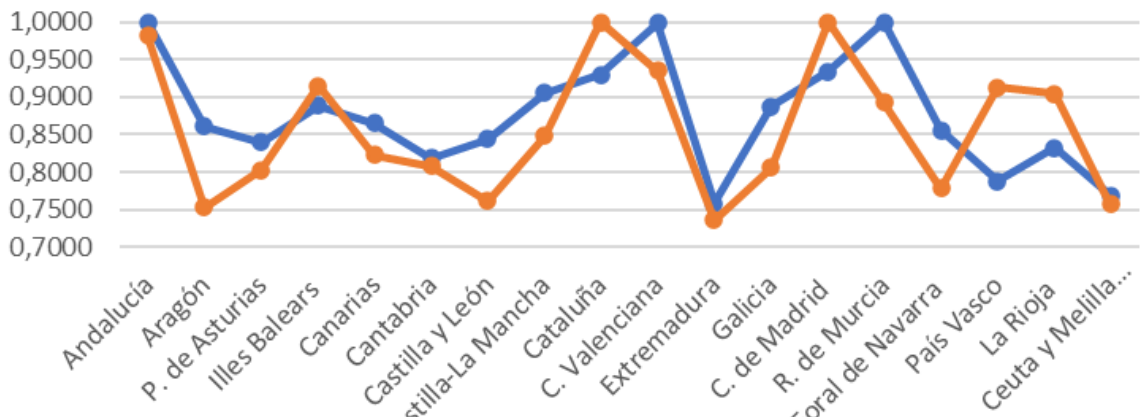
Figure 2. Comparison of the efficiency values of the NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.

Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Figure 2. Comparison of the efficiency values of the Spanish NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

ANNEX

Table 1. Efficiency of hospitals belonging to the NHS in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
Regions	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9035	0,9346	1,0000
Aragón	0,6290	0,7130	0,8021	0,7451
Principado de Asturias	0,6932	0,7647	0,8459	0,8075
Illes Balears	0,5183	0,7511	0,7374	0,9403
Canarias	0,8088	0,9029	0,9062	0,9446
Cantabria	0,7057	0,8379	0,9679	0,9636
Castilla y León	0,7821	0,7724	0,8845	0,8343
Castilla-La Mancha	0,6040	0,7413	0,8241	0,8494
Cataluña	1,0000	1,0000	1,0000	1,0000
Comunidad Valenciana	0,6754	0,8860	0,8935	0,9365
Extremadura	0,5313	0,7099	0,7453	0,7146
Galicia	0,6987	0,7614	0,8942	0,8370
Comunidad de Madrid	0,6104	0,8720	0,8835	0,9997
Región de Murcia	0,7703	1,0000	1,0000	1,0000
Comunidad Foral de Navarra	0,5942	0,9233	0,8735	0,8346
País Vasco	0,7571	0,7145	0,9750	0,9890
La Rioja	0,5893	0,7528	0,8910	0,8611
Ceuta y Melilla	0,4592	0,5839	0,6867	0,7444

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 2. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS between 2002 and 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Cataluña	Andalucía
Cataluña	R. de Murcia	R. de Murcia	Cataluña
Canarias	C. F. Navarra	País Vasco	R. de Murcia
Castilla y León	Andalucía	Cantabria	C. de Madrid
R. de Murcia	Canarias	Andalucía	País Vasco
País Vasco	C. Valenciana	Canarias	Cantabria
Cantabria	C. de Madrid	Galicia	Canarias
Galicia	Cantabria	C. Valenciana	Illes Balears
P. de Asturias	Castilla y León	La Rioja	C. Valenciana
C. Valenciana	P. de Asturias	Castilla y León	La Rioja
Aragón	Galicia	C. de Madrid	Castilla-La Mancha
C. de Madrid	La Rioja	C. F. Navarra	Galicia

Castilla-La Mancha	Illes Balears	P. de Asturias	C. F. Navarra
C. F. Navarra	Castilla-La Mancha	Castilla-La Mancha	Castilla y León
La Rioja	País Vasco	Aragón	P. de Asturias
Extremadura	Aragón	Extremadura	Aragón
Illes Balears	Extremadura	Illes Balears	Ceuta y Melilla
Ceuta y Melilla	Ceuta y Melilla	Ceuta y Melilla	Extremadura

Source: Own elaboration

Table 3. Efficiency of hospitals belonging to the NHS and the private sector in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
CCAA	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9689	1,0000	0,9815
Aragón	0,8609	0,8470	0,8348	0,7530
Principado de Asturias	0,8399	0,8435	0,8593	0,8031
Illes Balears	0,8883	0,8676	0,9271	0,9150
Canarias	0,8649	0,8632	0,8958	0,8232
Cantabria	0,8187	0,8371	0,8873	0,8082
Castilla y León	0,8445	0,8576	0,8394	0,7621
Castilla-La Mancha	0,9051	0,9196	0,8953	0,8487
Cataluña	0,9297	1,0000	1,0000	1,0000
Comunidad Valenciana	0,9982	1,0000	0,9450	0,9352
Extremadura	0,7588	0,8124	0,8092	0,7367
Galicia	0,8877	0,8976	0,9059	0,8059
Comunidad de Madrid	0,9335	0,9292	0,9798	1,0000
Región de Murcia	1,0000	0,9315	0,9245	0,8930
Comunidad Foral de Navarra	0,8557	0,8032	0,8773	0,7781
País Vasco	0,7880	0,7121	0,9438	0,9125
La Rioja	0,8329	0,8801	0,9930	0,9048
Ceuta y Melilla	0,7690	0,8215	0,8439	0,7570

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 4. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS and Private Sector between 2002 - 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Andalucía	Cataluña
R. de Murcia	C. Valenciana	Cataluña	C. de Madrid
C. Valenciana	Andalucía	La Rioja	Andalucía
C. de Madrid	R. de Murcia	C. de Madrid	C. Valenciana
Cataluña	C. de Madrid	C. Valenciana	Illes Balears
Castilla-La Mancha	Castilla-La Mancha	País Vasco	País Vasco

Illes Balears	Galicia	Illes Balears	La Rioja
Galicia	La Rioja	R. de Murcia	R. de Murcia
Canarias	Illes Balears	Galicia	Castilla-La Mancha
Aragón	Canarias	Canarias	Canarias
C. F. Navarra	Castilla y León	Castilla-La Mancha	Cantabria
Castilla y León	Aragón	Cantabria	Galicia
P. de Asturias	P. de Asturias	C. Foral de Navarra	P. de Asturias
La Rioja	Cantabria	P. de Asturias	C. Foral de Navarra
Cantabria	Ceuta y Melilla	Ceuta y Melilla	Castilla y León
País Vasco	Extremadura	Castilla y León	Ceuta y Melilla
Ceuta y Melilla	C. Foral de Navarra	Aragón	Aragón
Extremadura	País Vasco	Extremadura	Extremadura

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	N/A
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5*
Bias	9	Describe any efforts to address potential sources of bias	12
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*N/A*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*N/A*
		Cross-sectional study—Report numbers of outcome events or summary measures	*N/A*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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EVALUATING THE DECENTRALISATION OF THE SPANISH HEALTH CARE SYSTEM: A DATA ENVELOPMENT ANALYSIS APPROACH

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EVALUATING THE DECENTRALISATION OF THE SPANISH HEALTH CARE SYSTEM: A DATA ENVELOPMENT ANALYSIS APPROACH

Running Head: Efficiency in a desentralised Health system.

Abstract

Objectives: The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Design: In this paper we have used Data Envelopment Analysis (DEA) to analyse the evolution of efficiency in the last ten Autonomous Regions to receive health care competences at the end of 2001.

Participants: For this study we have taken into account the number of beds and full-time workers as inputs and the calculation of basic care units as outputs to measure the efficiency of the Spanish public sector, private sector and jointly in the years 2002, 2007, 2012 and 2017 for the last Autonomous Regions receiving health care competences.

Results: Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%).

Conclusion: In general, it can be observed that the transfer of responsibilities in the health sector has improved efficiency in the NHS.

Strengths and limitations of this study

- The use of DEA methods in efficiency research shows comprehensive and practical results.
- One limitation of this study is not to include health outcomes in the analysis.
- Using full-time workers as input, regions with a greater weight of part-time staff may overestimate their efficiency results.
- The use of UBAs as outputs may make it difficult to compare with other studies.
- There are methodological limitations of DEA, derived from its deterministic character.

JEL classification

C14; I18; H21.

Key words: Efficiency; National Health System; Devolution; DEA; Data Envelopment Analysis; Health Decentralisation.

1. Introduction

Spain is a decentralised country in which the Autonomous Communities have the powers to administer and manage certain public services, including health. However, this has not always been the case. To understand the current situation, it is necessary to go back to 1977, the year in which the Ministry of Health and Social Security was created. Months later, by Royal Decree-Law 36/1978, a Social Security Management Entity was created, the National Health Institute, abbreviated as INSALUD, in charge of providing health care [1].

During the process of political and economic change that took place at that time, the Spanish Transition, the approval of the Constitution in 1978 brought changes related to the decentralisation of powers, including in the area of health. Specifically, Article 43 recognises the right to health protection and Article 148.1.21 recognises health as a competence that can be assumed by the Autonomous Communities, leaving only the State with exclusive competence in external health and the general coordination of health (Article 149.1.16).

The constitution of the communities is carried out at different paces, so there are some that assume the functions and services carried out by INSALUD sooner than others, the process of transfer begins in 1981 and ends at the end of 2001. Thus, first, Catalonia (1981), Andalusia (1984), the Basque Country (1984), the Valencian Community (1987), Galicia (1990), the Community of Navarre (1990) and the Canary Islands (1994) received the competencies.

Meanwhile, Aragon, the Principality of Asturias, the Balearic Islands, Cantabria, Castile-La Mancha, Castile and Leon, Extremadura, La Rioja, the Community of Madrid and the Region of Murcia were under State administration through INSALUD, until they received the transfer of competences. After a long process, at the end of 2001, these last ten Autonomous Regions received the transfers and by the following year were already administering and managing health care in their territory. Thus, INSALUD was liquidated and converted into a smaller entity, the Instituto Nacional de Gestión Sanitaria, abbreviated as INGESA [2], which would continue to administer and manage healthcare in the Autonomous Cities of Ceuta and Melilla.

Therefore, to summarise, our country currently has the National Health System, which brings together the public health networks of the seventeen Autonomous Regions, and INGESA, the state administrator and manager of the Autonomous Cities.

Each Autonomous Community carries out the planning, administration and management of the health services in its territory, following the guidelines set out in the LGS (General Health Act), but with variability in terms of the portfolio of services for its citizens, while respecting the basic levels cited in Law 14/1986, LGS. The autonomous communities' highest health management body is the Regional Ministry of Health, which is responsible for setting up a Health Service (from the point of view of both the service provider and the service funder), made up of outpatient centres (Primary healthcare centers) and hospitals that provide the services planned in the autonomous community's service portfolio. Each Autonomous Community divides the territory into Health Areas, which are the Basic Geographical and Functional Units of health care, each health area being autonomous and able to establish its own specific health plans and adapt resources to the needs of the population concerned. These health areas, provided for in the LGS, are created to cover approximately 200,000 inhabitants, with at least one Tertiary Hospital Centre and different Health Centres, approximately one for every 20,000 inhabitants.

The universal nature of our public health care system necessarily means that it is not linked to citizens' ability to pay, unlike other types of contributory benefits offered by the Social Security System, which are directly affected by the social contributions made by the system's potential beneficiaries. Consequently, as health care is treated as a non-contributory benefit of the social security system, its main source of financing is the transfers made by the corresponding public administrations (State, Autonomous Communities or Local Corporations), which come mainly from public sector tax revenues.

The decentralisation of the health system carried out in Spain is not an isolated event; other countries such as Italy, the United Kingdom, Portugal, the Philippines, etc. have also done so [3] [4]. These types of reforms have given rise to a debate in the literature about who plays a better role in managing healthcare: the state or the territories that make it up? In other words, in terms of the welfare and efficiency of the population, what is more favourable: a centralised or decentralised healthcare system?.

Numerous studies [5] [3] [6] [4] discuss the direct consequences that accompany health decentralisation, as well as its advantages and disadvantages.

The mere definition of the concept of decentralisation generates different positions and approaches that often complicate rather than facilitate the analysis [7] [8] defines decentralisation as "the transfer of planning, management and collection responsibilities and allocation of resources from the central government and its agencies to territorial units" as well as Delegation as the transfer of decision-making and administrative power - including financial responsibilities - over public functions to autonomous organisations [9] [10]. It is the latter concept that best fits the decentralisation process that has taken place in the Spanish national health system.

Privatisation, on the other hand, would be the policy of having services provided by businesses, community groups, co-operatives, private voluntary associations, individuals, small informal enterprises and other non-governmental organisations. For this author, privatisation ranges from leaving the provision of goods and services

entirely to economic competition to "partnerships" between public agencies and private enterprises [11].

Decentralisation is generally considered to improve efficiency in health care and influence health care by bringing governance closer to the population, allowing for feedback [5]. It also fosters competition between territories that try to stand out and proceed in the best possible way, most of the time leading to increased spending, which is often accompanied by improved health outcomes [12] [3]. In that sense, it should take in account that, although Tiebout [13] argued in his famous article that citizens "vote with their feet" and choose the jurisdiction that offers them the best range of services, it is debatable whether citizen mobility is as typical in Europe as it is in the US [14]. While mobility enhances the benefits of decentralisation, it is not entirely dependent on it. Even in the absence of mobility, the efficient provision of a local public good is determined by the condition that the sum of marginal costs of substitution equals marginal costs, and this condition tends to vary across territories [15].

However, when decision-makers increase spending, this can result in increased costs due to: duplication of inputs, where two neighbouring regions may share similar services; diseconomies of scale or even moral hazard, as they expect their debts to be covered by the central government [3].

The aim of the study was to answer whether the central government has been more efficient than the regional governments or vice versa. Likewise, through the analysis of the data, the aim was to shed light on whether decentralisation has had a positive impact on the efficiency of the hospital sector or not.

Methodology and data

2.1. Variables used

We understand *Devolution* as the creation or reinforcement of levels of government lower than the state, to which broader responsibilities than the simply administrative ones are attributed for the development of certain functions, which is the case in Spain [10].

In this paper, performance improvement means improving the efficiency (or productivity) of public services [16]. In measuring performance a distinction can be made between technical efficiency ("doing more with less") and allocative efficiency ("doing the right thing in the right place").

Technical efficiency describes a production process in which maximum output is achieved when inputs are fixed and technology is fixed. Allocative efficiency refers to the allocation of resources (finance, labour or physical capital) and is achieved when the combination of inputs and outputs is cost-minimising and/or profit-maximising [17] [18].

The concept of technical efficiency is similar to the concept of productivity. Productivity is usually defined as the ratio between the quantity of output and the quantity of inputs used. Productivity is much easier to calculate when the production

unit analysed uses an input to produce a product. If a production unit uses several inputs to produce several outputs, inputs and outputs must be combined [19] (as we have done with the calculation of the Basic Care Units –BAU).

In contrast to efficiency, which is the relationship between outcomes and inputs, effectiveness is the relationship between defined outcomes and defined inputs and depends on service quality [20].

This paper has proposed the measurement of technical efficiency, understood as productivity.

The information on the variables used has been compiled from the Spanish Ministry of Health database [21] [22] [23] [24]. The period of analysis is divided into five-year periods, from 2002, when the last ten autonomous communities received health competencies and began to operate on their own, to 2017.

In order to examine the evolution of efficiency after the transfer of power, the number of beds and the number of full-time workers have been used as inputs to the model. These data have been chosen because the number of beds installed in hospitals has been used as a proxy variable for the capital factor in recent years in numerous studies [25]. When distinguishing between the number of public and private beds, the corresponding percentages indicated in the Ministry's database have been applied.

Similarly, the number of full-time workers has been used to represent the labour factor. This includes doctors, nurses, MIR, auxiliary nurses, senior health technicians, other health personnel and non-health personnel. As in the previous case, due to the need to compare the results of the Public Sector versus the Private Sector, after reviewing numerous official State documents [26] [27] [28] [29] over the last twenty years, there has been a trend in the sector indicating that eight out of every ten workers belong to the public hospital network. Therefore, to the total number of full-time employees we have applied a percentage of 80% to obtain the number of public workers, conversely 20% has been applied to find the figures for the Private Sector.

On the output side, the Basic Care Units (BAU), one of the first measures of hospital consumption, were taken into account. To calculate this index, a series of weightings were taken into account with respect to the variables that comprise it: 1 BAU = stays; 0.5 BAU = first consultations; 0.25 BAU = successive consultations and, finally, 0.5 BAU = non-admitted emergencies [30]. For the calculation of non-admitted emergencies and number of stays financed by the Public Sector, since the corresponding percentages for 2002 are not explicit, the following data are taken into account: "Paid by Social Security", "Paid by Companies collaborating with the S.S.", "Paid by other Public Entities", "Paid by Civil Servants' Mutual Societies" and "Others" [22]. It should also be mentioned that, for the calculation of first consultations, in the absence of specific data by autonomous community, the average percentage corresponding to first consultations with respect to total consultations was used in 2012 and 2017. [23] [24] .

2.2. Data Envelopment Analysis (DEA)

Data Envelopment Analysis, known as DEA, is a non-parametric frontier method used to measure the efficiency of each organisation or organisational unit (DMU, Decision Making Units), which in this case corresponds to the CAACs analysed, by solving a linear programming problem [31] for each unit under the assumption, in this study, of Constant Returns to Scale (CRS):

$$Eficiencience = Max_{u_r, v_r} \sum_r u_r y_{r\,j0}$$

$$s.a. \sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0;\ \forall j$$

$$\sum_i v_i x_{i\,j0} = 1$$

$$u_r, v_i \geq 0\,; \forall_r, \forall_i$$

Where y_rj is the quantity of output r produced by the hospitals of AC j; x_ij the quantity of input i used by the hospitals of AC j; u_r the weight given to output r, (r = 1, ..., t, where t is the number of outputs); v_i the weight given to input i, (where as in the previous case i = 1, ..., m, where m is the number of inputs); j_0 AC under evaluation. Therefore, a CAAC is on the efficiency frontier if and only if, ∑_(_r^)^ ▒u_r y_(r j0) is equal to unity, i.e. it reaches the maximum efficiency levels.

This technique, widely used in the health sector [25], allows measuring several different types of efficiency: technical, allocative congestion and dynamic through the Malmquist index. In addition, it also allows for the observation of possible economies of scale.

In order to carry out the corresponding analysis of technical efficiency in the Public, Private and Joint Sector, a series of inputs and an output have been chosen, which have been discussed in greater detail in the previous subsection.

That said, the programme used to apply this analysis technique was DEAFrontier Software for Excel.

2.3. Patient and public involvement

No patient involved

3. Results

3.1. Efficiency in the last ten Autonomous Regions to receive transfers

Taking unity as the optimum value for efficiency and taking into account both the public and private sectors, it can be seen in Table 1 that, in general, the devolved regions have worsened their efficiency since the devolution, with Castile and Leon, Aragon and the Principality of Asturias standing out. Only the Autonomous Community of Madrid improved, reaching maximum efficiency, and La Rioja, increasing its efficiency by a higher relative percentage.

Table 1. Efficiency of the NHS and the private sector in the last ten Autonomous Communities to receive health care competencies.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8851	0,9114	0,8515	0,7794
Principado de Asturias	0,8985	0,9178	0,8845	0,8031
Illes Balears	0,9219	0,9337	0,9448	0,9150
Cantabria	0,8890	0,9446	0,9000	0,8260
Castilla y León	1,0000	0,9850	0,9331	0,8436
Castilla-La Mancha	0,9051	0,9897	0,9147	0,8487
Extremadura	0,8131	0,9821	0,8924	0,7735
Comunidad de Madrid	0,9335	1,0000	0,9937	1,0000
Región de Murcia	1,0000	1,0000	0,9524	0,9633
La Rioja	0,8442	0,9472	1,0000	0,9766

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Unlike the previous case, table 2 only shows the efficiency data relating to the NHS. While the Region of Murcia stands out as the most efficient region throughout the period under study, most of the Autonomous Regions analysed, 60% to be precise, improved efficiency rates (they are closer to 1) after the transfer of competences prior to 2002. The Balearic Islands (36.95%), La Rioja (25.66%) and the Community of Madrid (18.60%) are the regions that have seen the greatest increase in efficiency in the use of available public resources. Only Castile and Leon, the Principality of Asturias and Aragon have worsened.

Table 2. Efficiency of the last ten Autonomous Communities to receive health care competencies in hospitals belonging to the NHS.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,8072	0,8591	0,8702	0,7701

Principado de Asturias	0,8911	0,9388	0,9196	0,8075
Illes Balears	0,6918	0,7511	0,7374	0,9475
Cantabria	0,9094	0,9606	0,9742	0,9638
Castilla y León	1,0000	0,9831	0,9698	0,8676
Castilla-La Mancha	0,7776	0,8441	0,8898	0,8718
Extremadura	0,6879	0,9394	0,8663	0,7719
Comunidad de Madrid	0,8432	0,8720	0,8985	1,0000
Región de Murcia	1,0000	1,0000	1,0000	1,0000
La Rioja	0,7609	0,8709	1,0000	0,9562

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Only Catilla y León, the Principality of Asturias and Aragón have seen their efficiency decrease (table 3).

Table 3. Efficiency of the last ten Autonomous Communities in receiving health care competencies in hospitals belonging to the Private Sector.

	Efficiency			
Regions (NHS + Private)	**2002**	**2007**	**2012**	**2017**
Aragón	0,6155	0,7812	0,4794	0,5968
Principado de Asturias	0,3236	0,4221	0,4044	0,4694
Illes Balears	1,0000	1,0000	1,0000	1,0000
Cantabria	0,2413	0,3519	0,1844	0,2112
Castilla y León	0,3826	0,4801	0,3225	0,3629
Castilla-La Mancha	0,6206	0,9799	0,4801	0,4903
Extremadura	1,0000	1,0000	0,8322	0,6826
Comunidad de Madrid	0,6597	0,8471	0,7354	0,9871
Región de Murcia	0,3150	0,4369	0,2954	0,3573
La Rioja	1,0000	0,5846	1,0000	1,0000

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

In general, the results in this case are more diverse: 50% of the ACs worsen, with Extremadura and Castilla-La Mancha being the worst performers (the latter standing out if we consider the 2007 value); two of them remain constant practically throughout the entire period (Balearic Islands and La Rioja, with the exception of 2007 but then recovering) and the rest improve, with the Principality of Asturias and the Community of Madrid standing out as we have already mentioned, which progresses in such a way that it reaches levels very close to absolute efficiency.

3.2. Relative comparison, efficiency of all Regions

In Annex Table 1 it could be seen that Andalusia and Catalonia can be considered as benchmarks for practically the entire period, taking into account the SNS alone (by obtaining the index 1.000 in the DEA survey). Firstly, the Region of Murcia, which managed to become a benchmark Autonomous Region with its optimal efficiency values, has improved significantly with respect to the other Autonomous Regions that received the transfers before 2002. Of the Autonomous Regions that received the transfers at the end of 2001, the following stand out for their higher efficiency growth: the Balearic Islands (81.44% improvement), the Madrid Autonomous Region, which practically reached absolute efficiency levels (having increased by 63.77%), and La Rioja which, together with the Balearic Islands which started from very low values, improved notably (46.13%). On the other hand, it is important to mention the reduction in the gap between the most efficient and the least efficient ACs over time. In 2002, the lowest value among the Autonomous Communities was 0.5183, belonging to the Balearic Islands, with respect to 1.000, which implies a difference in efficiency of 0.4817. Over the years, in 2017 this inequality is reduced to 0.7146 in Extremadura and the optimal unit, indicating this time a distance of 0.2854, which translates as a decrease in the differences of almost 40% between the lowest values.

Figure 1

As it could be seen in Annex Table 2, likewise, we observe that, as a whole, the efficiency of the Autonomous Regions has improved and that after the transfer of competences the differences in efficiency rates between the regions have been reduced. This is the case of the Balearic Islands, the Canary Islands and Cantabria. As shown in figure 1, in 2017 compared to 2002, the disparities between these three regions are greatly reduced and converge. Both Castillas also manage to reduce their interregional differences, with Castilla-La Mancha standing out. The Community of Madrid and the Region of Murcia converge at the same time, becoming in 2017 one of the reference ACs due to their high efficiency values.

The blue line shows the reference ACs, i.e. those with optimal efficiency values, while the dashed red line shows the average efficiency for that year, which is useful for easily visualising which ACs are above (or below) the average. It is interesting to perform the analysis from this perspective, since some regions may have improved their efficiency but worsened in comparison with the rest of the regions, because the latter have improved more, and vice versa. Thus, in the case of the Balearic Islands, which improved its efficiency to a great extent (81.44%, as mentioned above), its efficiency improved with respect to other regions that were relatively far behind it, for example, surpassing the Autonomous Community of Valencia, the Principality of Asturias and Galicia. The Community of Madrid improved its efficiency in 2017 with respect to 2002 by 63.77%, which places it at the top of the table, as shown in Annex Table 3. On the other hand, although Castilla y León's efficiency improved by approximately 7%, its

relative position compared to the rest of the Autonomous Regions was reduced to the bottom five.

Annex Table 4 shows the combined data for the NHS and the private sector, which leads to the following results: on calculating the efficiency values of the ten Autonomous Regions that received the competences at the end of 2001, with respect to the rest of the regions that already had them, it is found that 70% of them have seen their efficiency worsen. Aragon (-12.53%), the Region of Murcia (-10.70%) and Castile and Leon (-9.75%) stand out. In contrast to Annex Table 1, the reference Autonomous Community is Catalonia. On the other hand, the Autonomous Region with the greatest improvement in efficiency is La Rioja (8.63%), followed by the Autonomous Region of Madrid (7.12%), which manages to achieve maximum efficiency. In this case, the Balearic Islands improved by only 3.01%, but it starts from higher values, close to 90% efficiency (figure 2).

Figure 2

4. Discussion

We are aware that it is difficult in this area to compare the results found with other studies due to the fact that DEA can give different results when the inputs and outputs used are not the same. Moreover, we have used global data from the health sector - in order to be able to draw conclusions, not only in the public sector (NHS), but also in the private sector and jointly, on the effects of decentralisation in the Spanish health sector - while in many other studies a specific selection of hospitals has been carried out [32] [33] [34].

As far as the public sector is concerned, our results show that most of the Autonomous Regions that were the last to receive health transfers improved their efficiency levels to their highest values between 2007 and 2012. However, if we consider the comparison of these regions as a whole, the highest figures are found in 2012. We believe that this behaviour is possible due to the positive impact of the incorporation of new management models and changes in the organisational structure of those Autonomous Regions that received the transfer of competences at the end of 2001, coinciding with the authors Granado Cabello and Vega Hidalgo [32]. However, other authors such as Sbert, J. M., and Gómez Vicens, J. M. [34] do not agree with this explanation, as they believe that, after the transfers, there is a period of adaptation that leads to an increase in costs and resources that are detrimental to productivity levels.

That said, it should be stressed that the introduction of these changes does not fully explain the increase in efficiency in the Autonomous Regions studied, as there are other socio-economic factors that may influence efficiency. It is also necessary to question why, as we have seen, some regions do not improve as much as others. Despite the fact that, following decentralisation, the efficiency of the NHS improves in general - in its entirety if we compare all the Autonomous Regions as a whole - those territories that

are less efficient may be due to factors such as ageing, geographical dispersion, wealth or the public spending policies of each region, among other variables. In this sense, we agree with Pérez-Romero, Ortega-Díaz, Ocaña-Riola and Martín-Martín [33].

Despite these differences, it should be stressed that after the transfer of competences in the public health sector there has been a positive impact which has led to a reduction in the gap between the most efficient and least efficient Autonomous Regions in Spain. Over the fifteen years observed, the gap between Autonomous Regions has narrowed by approximately 40%. In view of this improvement, however, we would like to focus on two aspects relating to the private sector and waiting lists.

On the one hand, the data provided by the Ministry show that over the years, following the transfers, public provision has not only become more efficient, but has also increased with respect to private provision, even in regions where the private sector is very efficient. The case of the Community of Madrid stands out, which, despite the strong presence of the private sector, has increasingly increased the supply of public services. On the other hand, there is also the case of La Rioja, a territory in which the Private Sector is very efficient and yet the importance of public activities is increasing. In other words, we find that the evolution of public activity is increasing, except in the case of the Balearic Islands, where its weight is increasing in relation to the private sector. This can also be seen in the decrease in spending on concerts in a large part of the Autonomous Regions, as indicated by IDIS [35].

Therefore, we can say that the transfers have boosted the public sector even in those Autonomous Regions with a strong presence of private activity, even if this is efficient. We believe that this trend may have a negative impact on citizens in the future because, with a permanent increase in health spending, not only in Spain but in other countries as well - derived from demographic factors, such as ageing, which affects Western Europe in particular, as pointed out by Jakovljevic et al. [36], or cultural factors such as the desire for greater welfare - the public health system may be limited by the need for a larger budget and greater flexibility. Authors such as Kosycarz, Nowakowska, & Mikołajczyk, [37] propose a similar approach to improving public hospitals in Poland through public-private partnerships.

Moreover, These results can be explained by the behaviour of which, in most of the regions, the private sector has a negative influence on the data as a whole (it dragged down the positive results achieved by the Public Sector), because efficiency levels are lower than before devolution, contrary to the results of public hospitals alone. This inefficiency in some Autonomous Regions is probably due to the fact that the private sector in these regions was not market developed and depended to a greater extent on INSALUD (National Institute for Health -the public manager under the Ministry of Health of the Central Government, prior to the devolution-). The Balearic Islands stand out for having the highest efficiency during the whole period considered, possibly due to their previous experience, as before the transfer of the competences, Balearic Islands already had a significant weight of the private sector in the healthcare system. Its case could be compared with that of Catalonia, both of which are similar in terms of the significant weight of the private sector in health care, which had already been reflected for many years [38].

In that sense, Kruse et al [39], in a study of 5 European countries, present evidence that public hospitals have at least the same level of efficiency or more than private hospitals. Likewise, in a comparative study by Comendeiro-Maaløe et al [40] of the performance of a private hospital in Spain and a private hospital licensed as a regional health service, the private hospital generally did not perform better than the public hospitals, although it did excel in some areas. However, according to Lucifora [41], managers of public hospitals often perform worse than managers of private hospitals. In the same sense, Perez-Romero et al [33].

All of this is directly related to the problem of waiting lists. In particular, there are two cases in which the Autonomous Regions with the highest waiting list figures should increase their productivity by improving the management of their public sector, i.e. Extremadura, Castile-La Mancha and Aragon. In the cases of the Region of Murcia or Cantabria, where their public sector is very efficient, they should consider the possibility that their private sector, which is being underutilised, could, according to article 66 of Law 14/1986, of 25 April, General Health [42], link private hospitals to the planning of the public sector, without them losing their ownership, thus alleviating waiting lists, as also argued by IDIS [35]. Another possibility in this case could be to increase public resources in the face of such good management to reduce waiting lists.

Those ACs with lower levels of efficiency, as explained above, are probably not making efficient use of their resources and could offer greater capacity or, in other words, not have such high waiting times.

A case in point is Ceuta and Melilla which, after the creation of INGESA (Management Institute under the Ministry of Health of the Spanish Central Government), managed to improve their efficiency by 62.12% - probably due to the fact that they only have to manage the autonomous cities and, as there are not a greater number of territories, they can better focus on the needs of the autonomous cities - but if we make a relative comparison, they are below the rest of the Autonomous Regions. In this sense of a low level of efficiency of INGESA hospitals, there is evidence of saturation, lack of resources in relation to the population to be attended and waiting times, as stated in the study by Artundo Purroy [43].

Concerning the methodology used in this study, various approaches have been taken in the national and international literature to identify explanatory factors for technical efficiency and productivity [44]. Most studies compare efficiency figures between groups of units and explain them by linear regression. For example, in Iran, variability in efficiency in public hospitals was analysed by applying a multi-group DEA (Rezaee and Karimdadi, 2015) and correlation coefficients are frequently used in Spain to explore the relationship between efficiency and other factors [45] [46] [47] [48].

Perez-Romero et al [49] combine multilevel regression models to explain the efficiency of hospitals in the Spanish public network, this being one of the main methodological innovations provided by this study of Analysis of technical efficiency in the hospitals of the Spanish National Health System.

Linked to the above, a traditional linear regression model useful for estimating the relationship between a dependent variable and multiple independent variables. It is

based on correlations and is therefore useful for estimating the variance of an independent variable explained by dependent variables. It is not causal and cannot provide researchers with information about a specific individual. It is parametric and cannot be generalised to results at the extremes of the distribution. Is prone to bias due to omitted variables, multicollinearity and autoregression, although there are tests and extensions to increase robustness [50].

On the other side, a non-parametric benchmarking method for analysing the efficiency of product production at a given input level. Provides a highly individualised benchmark for each individual in the group. Benchmarks are based only on existing input and output data for "equivalents" or other individuals in the same population. May include multiple dependent variables or outcomes simultaneously. Can be combined with other methods to reduce limitations and improve own results. Can be used with a model-fitting approach to determine which input or dependent variable to focus on to achieve the greatest expected benefit for each individual. Sensitive to omitted variables and measurement error. There are methods to address these issues, but they are not as reliable as other methods. They are limited to the individual or population analysed, so the results cannot be generalised to other populations without subsequent analyses using other methods [50].

Another methodological issue to consider is the difference between DEA and SFA. Data Envelopment Analysis (DEA) is the most commonly used method in mathematical programming to estimate production frontiers. Stochastic frontier analysis (SFA) is the most representative method used in econometrics to estimate production frontiers [51]. DEA is recognised as a powerful tool for efficiency analysis and benchmarking, and its estimates are used in a wide range of industries and activities, including healthcare [52] [53]. The main difference between DEA and SFA is that DEA is usually used to examine the relative efficiency of individual studies. SFA is used to examine absolute efficiency and the relationship between the determinants of input and output (cost) efficiency. Therefore, SFA is often used to assess the efficiency of for-profit organisations. The DEA method measures the efficiency of public subjects by using the observed best performance compared to all subjects [54].

We are aware that this study presents the methodological limitations of DEA, derived from its deterministic character, which has been confronted with the testing of various models [47]. The limitations of the DEA methodology are that it does not measure error, it does not measure the relative differences between efficient suppliers, the use of many input and output variables is often considered flawed and that homogeneity in the units used is required [55] [56].

5. Conclusions. Limitations and extensions

This article has analysed the effects of decentralisation in Spain, specifically on the last ten Autonomous Regions that received the health care transfers at the end of 2001, with respect to the efficiency levels of the Public, Private and Joint Sectors.

An improvement of 60% can be seen in the communities analysed if we only take into account the NHS, however, if we consider the results of both sectors we observe that the majority of the territories worsen.

If we take into consideration all the Autonomous Communities that make up the Spanish territory, we can observe an improvement in the Public Sector of the ten communities analysed in terms of their relative position, with the following standing out: Region of Murcia, Community of Madrid and Balearic Islands. However, it should be noted that there are socio-economic factors such as the level of ageing, geographical dispersion, spending policies or the wealth of each region, which could explain why some territories have not improved as much.

On the other hand, in the face of the economic crisis, our results show that 60% of the public sector was not affected, in fact, its efficiency increased. The years 2007 and 2012 stand out as the years in which the highest efficiency values were reached (2012 if all the Autonomous Regions in Spain are taken into account) and one of the reasons for this behaviour is the change in the management model after the transfers. Otherwise, 80% of the private sector saw a decrease in efficiency.

In the light of the above, we can affirm that the transfers have not favoured the privatisation of the system. This can be demonstrated by the fact that even in communities where private provision has a strong presence or is highly efficient - as in the case of the Community of Madrid and La Rioja - public provision has increased despite everything.

On the other hand, with regard to those regions which are not fully efficient, i.e. which could generate more output with their current inputs and thus be more productive, two different cases can be identified. Extremadura, Aragon and Castile-La Mancha, which have waiting lists above the average for the Spanish regions, imply that they should, and need to, improve the management of their public resources (NHS). As for the Region of Murcia and Cantabria, where the public sector is very efficient, the private sector is notable for its under-utilisation of resources, which could be used to reduce the high waiting lists in both regions through public-private partnerships.

DEA measures multiple inputs and outputs and eliminates the need to construct production functions to estimate efficiency. This makes the use of DEA methods in efficiency research more comprehensive and more practical.

One limitation of this study is that it does not include health outcomes in the analysis, which we will try to develop in future papers.

Finally, it would be of great interest to extend our study once the Ministry of Health makes the data for the last few years available to the public, in order to compare efficiency between the Autonomous Regions before and after the health crisis. As well as the functioning and behaviour of hospitals during the pandemic.

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The authors declare that they had full access to all of the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis

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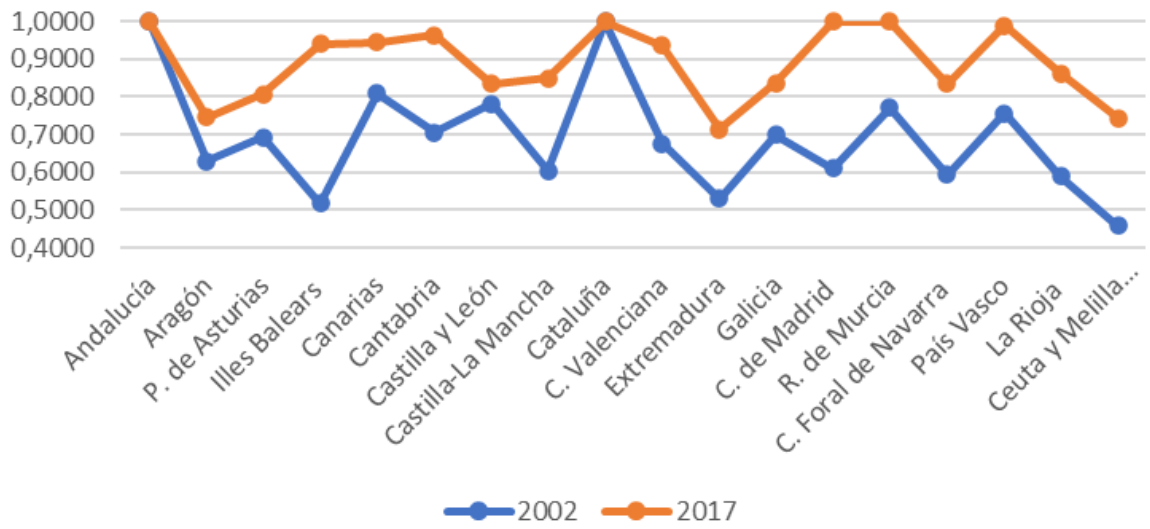
Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.

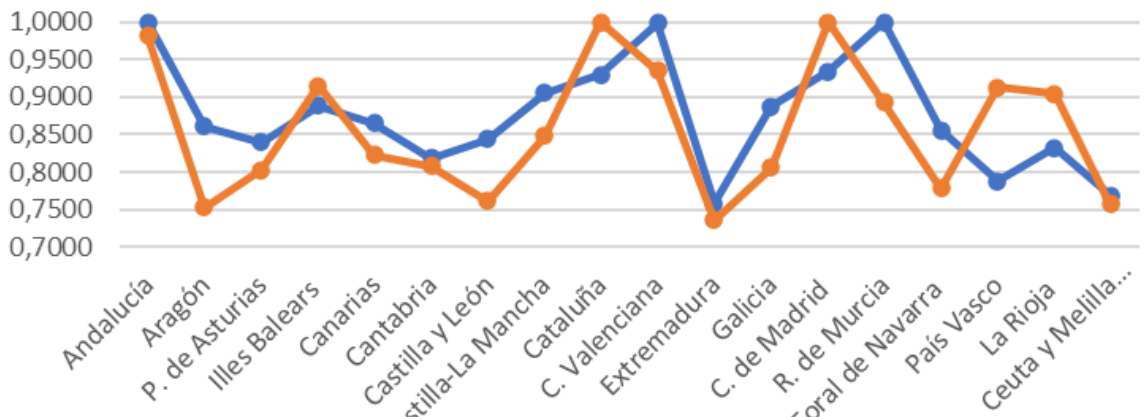
Figure 2. Comparison of the efficiency values of the NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.

Figure 1. Comparison of the efficiency values of the National Health System of all Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Figure 2. Comparison of the efficiency values of the Spanish NHS and the private sector of all the Autonomous Regions (including Ceuta and Melilla) in 2002 and 2017.



Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

ANNEX

Table 1. Efficiency of hospitals belonging to the NHS in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
Regions	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9035	0,9346	1,0000
Aragón	0,6290	0,7130	0,8021	0,7451
Principado de Asturias	0,6932	0,7647	0,8459	0,8075
Illes Balears	0,5183	0,7511	0,7374	0,9403
Canarias	0,8088	0,9029	0,9062	0,9446
Cantabria	0,7057	0,8379	0,9679	0,9636
Castilla y León	0,7821	0,7724	0,8845	0,8343
Castilla-La Mancha	0,6040	0,7413	0,8241	0,8494
Cataluña	1,0000	1,0000	1,0000	1,0000
Comunidad Valenciana	0,6754	0,8860	0,8935	0,9365
Extremadura	0,5313	0,7099	0,7453	0,7146
Galicia	0,6987	0,7614	0,8942	0,8370
Comunidad de Madrid	0,6104	0,8720	0,8835	0,9997
Región de Murcia	0,7703	1,0000	1,0000	1,0000
Comunidad Foral de Navarra	0,5942	0,9233	0,8735	0,8346
País Vasco	0,7571	0,7145	0,9750	0,9890
La Rioja	0,5893	0,7528	0,8910	0,8611
Ceuta y Melilla	0,4592	0,5839	0,6867	0,7444

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 2. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS between 2002 and 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Cataluña	Andalucía
Cataluña	R. de Murcia	R. de Murcia	Cataluña
Canarias	C. F. Navarra	País Vasco	R. de Murcia
Castilla y León	Andalucía	Cantabria	C. de Madrid
R. de Murcia	Canarias	Andalucía	País Vasco
País Vasco	C. Valenciana	Canarias	Cantabria
Cantabria	C. de Madrid	Galicia	Canarias
Galicia	Cantabria	C. Valenciana	Illes Balears
P. de Asturias	Castilla y León	La Rioja	C. Valenciana
C. Valenciana	P. de Asturias	Castilla y León	La Rioja
Aragón	Galicia	C. de Madrid	Castilla-La Mancha
C. de Madrid	La Rioja	C. F. Navarra	Galicia

Castilla-La Mancha	Illes Balears	P. de Asturias	C. F. Navarra
C. F. Navarra	Castilla-La Mancha	Castilla-La Mancha	Castilla y León
La Rioja	País Vasco	Aragón	P. de Asturias
Extremadura	Aragón	Extremadura	Aragón
Illes Balears	Extremadura	Illes Balears	Ceuta y Melilla
Ceuta y Melilla	Ceuta y Melilla	Ceuta y Melilla	Extremadura

Source: Own elaboration

Table 3. Efficiency of hospitals belonging to the NHS and the private sector in the last ten Autonomous Communities to receive healthcare competencies compared to the rest that already had them (except Ceuta and Melilla).

	Efficiency			
CCAA	**2002**	**2007**	**2012**	**2017**
Andalucía	1,0000	0,9689	1,0000	0,9815
Aragón	0,8609	0,8470	0,8348	0,7530
Principado de Asturias	0,8399	0,8435	0,8593	0,8031
Illes Balears	0,8883	0,8676	0,9271	0,9150
Canarias	0,8649	0,8632	0,8958	0,8232
Cantabria	0,8187	0,8371	0,8873	0,8082
Castilla y León	0,8445	0,8576	0,8394	0,7621
Castilla-La Mancha	0,9051	0,9196	0,8953	0,8487
Cataluña	0,9297	1,0000	1,0000	1,0000
Comunidad Valenciana	0,9982	1,0000	0,9450	0,9352
Extremadura	0,7588	0,8124	0,8092	0,7367
Galicia	0,8877	0,8976	0,9059	0,8059
Comunidad de Madrid	0,9335	0,9292	0,9798	1,0000
Región de Murcia	1,0000	0,9315	0,9245	0,8930
Comunidad Foral de Navarra	0,8557	0,8032	0,8773	0,7781
País Vasco	0,7880	0,7121	0,9438	0,9125
La Rioja	0,8329	0,8801	0,9930	0,9048
Ceuta y Melilla	0,7690	0,8215	0,8439	0,7570

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

Table 4. Relative comparison between the Autonomous Regions according to levels of efficiency of the NHS and Private Sector between 2002 - 2017.

2002	**2007**	**2012**	**2017**
Andalucía	Cataluña	Andalucía	Cataluña
R. de Murcia	C. Valenciana	Cataluña	C. de Madrid
C. Valenciana	Andalucía	La Rioja	Andalucía
C. de Madrid	R. de Murcia	C. de Madrid	C. Valenciana
Cataluña	C. de Madrid	C. Valenciana	Illes Balears
Castilla-La Mancha	Castilla-La Mancha	País Vasco	País Vasco

Illes Balears	Galicia	Illes Balears	La Rioja
Galicia	La Rioja	R. de Murcia	R. de Murcia
Canarias	Illes Balears	Galicia	Castilla-La Mancha
Aragón	Canarias	Canarias	Canarias
C. F. Navarra	Castilla y León	Castilla-La Mancha	Cantabria
Castilla y León	Aragón	Cantabria	Galicia
P. de Asturias	P. de Asturias	C. Foral de Navarra	P. de Asturias
La Rioja	Cantabria	P. de Asturias	C. Foral de Navarra
Cantabria	Ceuta y Melilla	Ceuta y Melilla	Castilla y León
País Vasco	Extremadura	Castilla y León	Ceuta y Melilla
Ceuta y Melilla	C. Foral de Navarra	Aragón	Aragón
Extremadura	País Vasco	Extremadura	Extremadura

Source: Own elaboration based on data obtained from the Spanish Ministry of Health.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	N/A
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5*
Bias	9	Describe any efforts to address potential sources of bias	12
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*N/A*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*N/A*
		Cross-sectional study—Report numbers of outcome events or summary measures	*N/A*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.