Universidade de Aveiro
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Departamento de Economia, Gestão e Engenharia Industrial

INÊS SILVESTRE CONDEIXA

QUÃO EFICIENTE É O DESEMPENHO HOSPITALAR PÓS-FUSÕES? O CASO PORTUGUÊS

DO HOSPITAL MERGERS IMPROVE THE PERFORMANCE OF HOSPITAL EFFICIENCY?

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Economia, realizada sob a orientação científica da Doutora Marta Alexandra Ferreira Dias, Professora Auxiliar do Departamento de Economia, Gestão e Engenharia Industrial da Universidade de Aveiro, e da Doutora Marlene Paula Castro Amorim, Professora Auxiliar do Departamento de Economia, Gestão e Engenharia Industrial da Universidade de Aveiro.

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o júri

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palavras-chave fusões; hospitais; eficiência técnica; *data envelopment analysis.*

resumo Atualmente cada vez mais empresas se juntam para aumentar o seu mercado, obter economias de escala, melhorar as estruturas de custos fixos e, consequentemente, aumentar o lucro. Os hospitais não são exceção. No entanto, a reestruturação de um hospital deve considerar a eficiência do desempenho. A criação dos Centros de Hospitalares (HC's) afecta a eficiência dos mesmos, sendo esta a nossa questão fulcral. Para responder a esta questão medimos o impacto das fusões horizontais na eficiência dos hospitais portugueses, utilizando o método *Data Envelopment Analysis* (DEA). Os resultados empíricos do nosso estudo mostram que as fusões não resultam necessariamente num aumento da eficiência técnica. Algumas fusões hospitalares podem alcançar uma dimensão excessiva, criando deseconomias de escala. A análise sugere, assim, que existem diferenças de acordo com áreas geográficas e estruturas hospitalares. Foram notórias diferenças entre as unidades hospitalares de pequena e grande dimensão, que pensamos que pode ser explicadas pelas necessidades de mercado e problema dos "picos de afluência". O desempenho das fusões mais antigas, parece permanecer estável nos anos seguintes.

keywords mergers; hospitals; technical efficiency; data envelopment analysis

abstract

Nowadays, more and more firms come together to gain size, scale, improve their fixed cost and increase profitability. Hospitals are no exception. However, restructuring an hospital cannot leave aside aspects of efficiency in performance. How merger of Hospitals Centres (HC's) affects the technical efficiency is the focus of this research. We measure the impact on efficiency of Portuguese hospitals, after a horizontal merger, using Data Envelopment Analysis (DEA). The empirical results of our research show that the merger did not result in increased technical efficiency. Some hospital mergers become too large and therefore after the mergers might experience diseconomies of scale. The analysis strongly suggests that there are differences according to geographical areas and hospital sizes. We found differences between small and large units that could be explained by the needs and "peak load" problems. The performance of old mergers seems to remain stable in subsequent years.

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Introduction

In Europe, health care expenditure has risen considerably in the past years. The increase in health care spending raises issues of economic sustainability, and for this reason there is a generalised concern with its reduction. Despite its indisputable quality, the huge costs of the Portuguese health care system, has led to judgments about its sustainability. This calls for urgent solutions, which can ease the gap between supply and demand.

One of the main procedures implemented for this aim is to merge hospitals and the creation of "Hospital Centres" (HC), a policy that is still in progress in Portugal. The integration of hospitals allows, at least in theory, for synergies, streamlining resources and creating economies. Campos (2008) refers that one of the most important actions is specifically the concentration of dispersed units in HC that confer a strategy and a group hierarchy, therefore resources and management tools, so far underutilized.

However, the increase in efficiency expected with the mergers is not always clear. Other studies stress that integration of hospitals may even cause the opposite effect: create diseconomies of scale and consequently decrease efficiency. Even though there are several types of mergers, we focus on the horizontal mergers, since they are more likely to happen in hospitals and affect their efficiency. Thus, the aim of this research is to analyse the effects of hospital mergers on efficiency in Portugal. For this purpose the analysis addressee period before and after the creation of the HC's.

Conclusions and results of this analysis are important for policy decisions and for politicians, as well as for the population. It is vital to be able to understand the goals achieved with the hospital merger implementation, its benefits and drawbacks.

Our thesis involved several steps and is presented here in four main chapters. In the first chapter we discuss one of the main subject of our research – mergers. We provide an overview of the state of art to explain the main question focused in our research. In the second chapter we approach the health sector, focusing on the reform system in Portugal. We also refer an economic perspective, reviewing the sustainability issues in the health sector as well as the overall hospital framework. In the third chapter we define the concept of efficiency and the different aspects to be considered. In the fourth chapter we justify the method chosen, we explain the main features of the model and we describe the context and data used in the model. And after the data, we present our results and some possible interpretations of counter intuitive results.

Our results provide additional insights into efficiency in few HC's, and indicate regional differences. We show that economies of scale do not exist for all the hospitals mergers. Our findings also indicate that efficiency scores remain stable in subsequent years.

Finally, we summarize the main results. Furthermore, some revenues for future research are identified, issued from an evaluation of the deficiencies and possible improvements of this work.

Chapter 1 Mergers

The European Commission (Neves 2003) says that mergers happen when different future share activities that allow firms, for example, to develop new products more efficiently or to reduce production or distribution costs. In addition to the improved efficiency, with a merger the market becomes more competitive, giving to customers higher quality services at reasonable prices (Neves 2003). In a simple way, a merger is a combination of two firms into one.

There are several types of mergers, considering different criterions. While the requirements for legal mergers vary across countries, the merger generally takes one of two forms: merger by incorporation, or merger by constitution of a new company. However, some mergers may reduce competition in market, normally by creating a single and principal actor, which is likely to harm consumers through higher prices, lower choice and/or decreasing innovation. According to Farrell *et al.* (2009) (p.371) ,"with banking mergers, prices of many deposit and loan products might be affected; in airline mergers, network effects might imply that a merger could affect even those antitrust markets where the merging entities did not compete directly".

Multiple dimensions of competition must be examined (e.g. product output, product quality, product variety, innovation) in order to understand the effects of mergers. We have to give some time to actually infer which real effects emerge. However, if the period considered is too long, it can lead also to some misinterpretation between mergers and other changes, namely in policy or in the behaviour of economic agents. (Farrell *et al.* 2009).

According to Elgers and Clark (1980) there are three main types of mergers: vertical mergers, horizontal mergers and conglomerate mergers. A vertical merger is a merger in which the firm expands forward in the direction of the customer and backwards towards the source of raw material. Any merger with the buyer or with the supplier that uses its own product or intermediate material for the final production may be called a vertical merger. The basic and principal purpose on these mergers is to reduce the production costs and dependency level, creating an improvement in the supply chain. A horizontal merger is when two firms competing in the same market merge or join together. One of the purposes of horizontal mergers is to gain economies of scale, achieving maximum capacity with lower production costs. Finally, the conglomerate merger happens when two firms merge when they are engaged in unconnected areas. The principal aim of conglomerate mergers is to use financial resources and expand debt capacity. These

mergers are clarified in the literature as those that exhibit different type of products and processes, i.e. a diverse business portfolio.

On the hospital framework, mergers are usually horizontal, as will be discussed in the next section. Nevertheless there are also vertical mergers in health care due to the primary, secondary and tertiary services, such as the case of the creation of Local Health Units. Our research is focused on the effects of the creation of HC's on efficiency, therefore addressing the effects of horizontal mergers.

1.1. Hospital Mergers

Hospital mergers have been defined as "a combination of previously independent hospitals formed by either the dissolution of one hospital and its absorption by another, or creation of a new hospital from the dissolution of all participating hospitals" (Harris *et al.* 2000, p.801).

In general, mergers offer a way to achieve cost savings (Ferrier & Valdmanis 2004) and several reasons can be pointed out to justify why hospital mergers improve productivity and efficiency. One can find in the literature strong beliefs that hospital mergers increase productivity, technical efficiency and scale, reducing costs, whereas the level of quality remains constant (Ferrier & Valdmanis 2004).

Due to the "peak load"[1] problem, a large number of patients my lead to higher occupancy rates, increasing revenue and marginal productivity. Adding to this, administrative costs tend to decrease due to the merger of several services (e.g.: the merger may allow the hospital to have more negotiating power with suppliers, for example for laundry services). So, one of the main purposes of horizontal mergers is to gain economies of scale, achieving maximum use of resources with low production costs, and there are several studies that support this statement.

Ashenfelter *et al.* (2011) in their research found evidence that hospital mergers can easily be anticompetitive. Wilson and Garmon (2011) conclude that the increase in relative prices on merged hospitals is larger than an non-merged hospitals and, once more, mergers appear to be anticompetitive. Despite the lack of data robustness, Adams and Noether (2011) show that econometric results are inconsistent with other market factors (as demand or geographical area) which indicates that the merging hospitals were not "close measure". As well, Farrell *et al.* (2009) say that increases in prices are not uncommon following mergers in recent decades. Dafny (2005) also concludes that price increases following a merger, with the greatest increase occurring among non merged

[1] The demand for the services exhibits substancial variations from hour to hour, day to day, or season to season.

hospitals nearest the merging hospitals. Other authors as Blackstone and Fuhr (1993) emphasize that the power of large buyers would be reduced considerably if mergers were allowed to increase concentration.

Hospital mergers appeared in the 20th century in UK and the concept has been adopted in several European countries. Since then many researches attempt to infer their implications for efficiency. Kristensen *et al.* (2010) studied several hospitals on Denmark and concluded that some of the mergers do not seem to lower costs. On this country some hospital mergers became too large and therefore experienced diseconomies of scale. Kjekshus and Hagen (2007) studied the restructuring of hospitals in Norway and they conclude that large mergers with drastic restructuring improve their efficiency. However this is not always the case in all mergers. Kittelsen and Magnussen (2003) found that Norwegian hospitals merger present economies of scope for surgical and outpatient dimensions. For Greek hospitals, Aletras (1999) found that these exhibit economies of scale resulting from the merger process.

Several research papers can be found on USA. Harrison (2011) argues that some American hospital mergers present real economies of scale and quite relevant cost reductions. However, his study also shows that, eventually in the course of time the cost savings from merger tend to decrease and the number of hospitals experiencing significant positive cost savings fall.

Harris *et al.* (2000) conclude that hospital mergers modify in fact the level of hospital efficiency. Despite being statistically insignificant, the coefficient efficiency ratio of the increases with the presence of hospital mergers. Therefore, the authors conclude that hospital mergers decreased the amount of inputs used, which point out as the major objective of these mergers.

Cohen and Morrison (2008) found that in Washington hospitals there are significant agglomeration economies, both of scale and scope. According to Dranove (1998) the scale economies exist but are substantial only for very small hospitals, concerning the Californian Health System.

Ferrier and Valdmanis (2004) and Fried *et al.* (1995) believe that hospital mergers increase productivity and efficiency. Although, Fried *et al.* (1995) explain that the increase is not immediate and it is necessary to allow time to adjust operations and solve problems associated with the restructuring.

On Portuguese hospitals, Gonçalves and Barros (2009) showed that merged entities exhibit not only economies of scale, but also for some services, economies of scope.

In Portugal, the National Health System started the hospital restructuring in the late 90's. This process is still currently in progress through the creation of more HC's. According to the decree-law no. 30/2011, released on March 2nd, 2011: " By closing these hospitals, their rights and duties are the responsibility of the HC." and "this restructuring helps to make the management of these health units more efficient".

Afonso and Fernandes (2008) studied several Portuguese public hospitals and concluded that the health sector reveals positive but small productivity growth levels between 2000 and 2004, whereas in 2005 there was a slight decrease. Also Barros and Sena (1999) report that, when merger strategy occurs, hospitals have diseconomies of scale. Carreira (1999) concludes that hospital mergers result on substantial cost savings after becoming one unit.

The study on efficiency of Portuguese hospital mergers is another small step for a better understanding of the behavior of efficiency after health mergers. The HC's will be the subject of our research, because they are the outcome of hospital mergers. We believe that we can find interesting results not only for academic purposes but also to help evaluating mergers from a managerial perspective.

Chapter 2 Health Systems

Health care plays a huge role in our life. Everyone needs to go to the doctor or the dentist, at some point in his life, and many of us definitely have already been treated in an hospital. The future of the National Health Service (NHS), in Portugal, is one of important issues that citizens consider.

Nevertheless, health care problems seem to be accentuated during recent crisis. The lack of hospital beds and the increase of patients tend to be underestimated while politicians argue endlessly over of NHS budgets.

2.1. Health Reform: Global Vision

The reforms of the public health sector have been a key point in developed countries over the last decades. It is common in public policy to find arguments supports two strong measures in these reforms: first, to insist on a fundamental reform of health structures and second, to change the way of governance and management of hospitals, towards higher efficiency - higher quality and significantly lower operating costs.

McLaughlin *et al.* (2002) have discussed four distinctive stages of development of social services: the stage of minimal state, the stage of unequal partnership, the stage of welfare state, and, finally, the stage of plural state. The first stage, from the nineteenth century, is characterized by the reduced intervention of state in social services. Social Services are guaranteed by the charity sector or the private sector. At the beginning of the twentieth century emerged the second stage - the unequal partnership, which assumes that the state has the role of providing some public services, through the partnerships with private or charity institutions. The welfare state was the dominant policy in Central Europe, between 1945-1980, in order to reconcile capitalism and democracy. The state has the role of ensuring the needs of its citizens and at the same time, a direct role in management of public services. This increasing intervention of state, in the economy and in the social life, caused a significant rise in public expenses (Rocha 2010). Finally, in recent years, the state has evolved to play a new role, named plural state, which is based on the market model. In this new model, health systems constituted by entities, as hospitals, are self-managed, where the state sets priorities, assuming a regulating role.

Generally, the budget spent by EU countries on health service absorbs an increasing proportion of gross domestic product. In fact, there was an increase of 3.6% to 7.8%, from 1960 until 1995 (Carvalho & Carvalho 2009). This remains true while countries face severe budgetary constraints, imposed by the agreements made during the last years.

The three main health systems in the world are: *national health care system*, *medical system partially arranged* and *liberal medical system*. These types of systems differ on four variables: finance, coverage, services provided and type of organization. The *national health care system* is supported by the State presenting the following characteristics: universal coverage and free preventive and curative services. This system is characteristic of Anglo-Saxonic and Scandinavian countries, and Southern Europe. The *medical system partially arranged* results from the combination of State and the financing of insurance firms. In this system coverage is selective, only preventive care is free, and curative cares are covered by a health insurance. This system is adopted by Central European countries (as Germany, Denmark or Luxemburg). And at last, the *liberal medical system* is supported only by insurance, the coverage is dependent on individual choices and financial strength of the insured, any kind of care is covered by insurance. The more well known example of this system is the U.S.A.

Healthcare systems and the way the are organized are directly influenced by the concept of health of each society. In societies where health is considered a collective and social good, everyone is entitled to receive health care, and values of fairness and solidarity prevail. In societies where health is seen as marketable and exchangeable, it is clear that prevails the idea of private good. The privatization aims to promote efficiency and reduce costs. This leads to the adoption hybrid models where the state takes the role of financer and service provider, with market-oriented efforts (Carvalho & Carvalho 2009).

2.2. Health Reform in Portugal

The evolution of the health system in Portugal is indirectly reflected in the development of its current features. Over the past 30 years there have been conscious efforts to improve health services. Generally, these efforts consisted in increasing health financing, the expansion of health services, both in terms of installations and the adoption of new medical technologies and information, and improving access to medicines and continuous efforts to improve organization and management of the National Health System (NHS). Even though, reforms were well intentioned, most often they were not completely implemented, due to constraints of management, resistance to changes or disruptive policies (Abreu 2011).

The reform of health care and assistance came into law in 1971. It recognized the right to have healthcare for every citizen, state responsibility and execution of health policies, which until then was very poor. Despite a limited deployment, this reform provided the basis for the National Health Service, as we know today.

The democratic revolution of 25th April 1974 and the Constitution of 1976 really made a huge difference. The emergence of new social policies and the creation of the National Health Service were seen as the most appropriate answer to cover more large and equitable health services. The new Constitution decreed that "all citizens have the right to protection of health", and has led to "the creation of a national health care, free for everyone." In 1979, the NHS Act -56/79 of September declared the universal access to all benefits of health care. It was also stated that the funding of the NHS was to be assumed by the Public Budget allowing national coverage in health services.

The first decade after the Revolution in April 1974 was marked by political stability without precedent. In 1986, Portugal became a member of the European Economic Community (now European Union) and made possible the application of European funding for economic and social infrastructures, including the health sector. The facilities and equipment of the NHS continued to expand. Today the necessity of management and organizational changes to improve the system and efficiency of the health sector is a shared vision by many researchers (Abreu 2011).

Five administrative health regions (Regional Health Administrations) were created in 1993, as well as "functional units" between hospitals and health centres. These changes aim to achieve: a better integration among primary, secondary and tertiary services[2] to introduce user fees in the NHS except for risk and economically disadvantaged groups (Abreu 2011); and an attempt to separate public from private hospitals.

Between 1999 and 2001, health became a social and political priority. A new model of management in state hospitals was adapted by the introduction of private management rules at the level of resources and the purchase of goods and services. This change aimed to foster a dynamic, efficient and independent management (Harfouche 2008).

In December 2002 thirty-one Decree-Laws were published, creating the same number of anonymous societies (*SA*) of hospital units, with public funds (Abreu 2011). According to this author, it was the beginning of the change of hospitals into "private" firms.

In 2005 hospitals *SA* are changed into public and private entities hospitals (*EPE*), fitting the definition of a public company, with financial and patrimonial autonomy. The reorganization of health care system was followed by several hospital mergers. For more cooperation and coordination between primary care and hospital levels were created the

[2] **Primary care** is where a patient receives a first contact with the health care system, usually involving coordination of care and continuity over time.

Secondary care is the treatment done by specialists to whom a patient has been referred by the primary care providers.

Tertiary care is the treatment given in a health care center that includes highly trained specialists and often also advanced technology.

Local Health Units. These were the answer for the necessity of creating organizational patterns that enhance a greater efficiency in the use of resources and spending. The reasons for implementing policies, related with the creation of HC's, have never been sufficiently disclosed. However they argue that economies of scale are applied to hospital mergers and, in some cases, an easy access of users to a larger variety of health care services. The Health Ministry justifies this as a "more efficient and integrated management of all assistance, human, technical and financial resources, differing in this process, the specific characteristics of current hospitals and the relevance of existing equipment" (Ordinance No 83 / 2009, Jan. 22). Under Decree Law no. 30 on March 2/2011 six additional HC's are created as a result of closing the fourteen health units, in order to continue the efficiency improvement.

2.3. Economic view of Health Sector

Nowadays, the health sector plays an interesting role in our society, not only socially, or economically, but also being a controversial subject. The analysis of the health sector and the search for strategies to improve their performance, considering the needs of the population, may be seen from an economic point of view (Barros 2009).

The evolution of the health sector, notably the improvement of health care, over time, enhances the human quality and lifetime. Davis (1956) wrote that " the great reduction of mortality in underdeveloped areas since 1940 has been brought about mainly by the discovery of new methods of disease treatment applicable at reasonable cost [and] by the diffusion of these new methods..." (p.314).

On the analysis of the health sector is important to consider that in "study of the allocation of scarce inputs which could be used in alternative practices and in unlimited needs" (Barros 2009). Health economics problems may cover very different elements and subjects, however there are specific characteristics of each sector, which all research must consider. Some particular features differentiates the health sector from most others economic sectors (Folland *et al.* 2007), turning its study important:

a) The different health care services and products are characterized as goods duly certified, which means that, in general, a qualified professional is in charge of the certification of a product or service to be consumed, assuring their quality. However, in the absence of a public certification recognized by the consumers, suppliers must have a good reputation in order to get patients and/or doctors;
b) The consumption of products and health services is characterized by separation between final consumer and the agent responsible for therapeutic indication. This separation may result in agency problems: first, patients may want to maximize

their expected utility, according to the possible therapeutic effects of the different treatments available and/or the costs; on the other hand, the doctor responsible for prescribing drugs or for suggesting a treatment usually is concerned about the therapeutic effects or if the patient is satisfied with his service.

c) Some products and equipment of the health sector usually involve high costs for the research and the development of new processes and particularly new products. The specificity of the medical devices requires a better efficiency in the implementation of the patent law than in most other economic sectors.
d) The use of medicines generates externalities on society. A good generates externalities when the average consumption of the society has a direct impact on the welfare of each one. For example, the average rate of vaccination against certain diseases in society affects the chance that someone who is not vaccinated have that disease (Sherman 2008).
e) The access to health care and drugs is considered in many countries as a human right. We classify it as a vital good or service, it should be accessible to everyone, and its access should be ensured by the public health sector.
f) Arrow (1963) argues that the uncertainty of demand and supply, have consequences in the insurance markets in terms of risk, and explaining the emerging role of the government as a regulator and legislator these markets.
g) Healthcare costs, especially for medical devices, are relatively inelastic to income, and are essentially driven by the health of the patient. The regressive tendency in drug expenditures, coupled with the right to healthcare led several countries to implement public policies aimed at ensuring access to health services, at least for population with low income.
h) The main difference between health services and other public services such as education, is the uncertainty of individuals about their health and the existence of information asymmetry. Doctors have more information about patient needs, after the exam, than he has about himself.

Consequently, the main problems affecting hospital efficiency are the irregular demand (such as those diseases caused by contagion), problems of asymmetric information (adverse selection, moral hazard, relationship: principal-agent), uncertainty (one never knows how a patient reacts to a certain treatment), emergence of insurances as an important source of payment the fact of health not being transferable from one individual to another and the existence of significant externalities in production and consumption of health. All these factors influence the health sector and also our health condition, so the

economic analysis can be very useful for understanding the functioning of the health sector, techniques and ideas (Barros 2009).

The reason for measuring and evaluating costs in health is that resources are limited to their potential benefits. Thus, if one wishes to minimize resources expenditure, it is necessary to consider all the effects that those decisions, directly or indirectly, might have on social welfare. Analysing the cost of a disease is important because one can decide about investment priorities in health as well as determine the impact of actions and programs implemented (Pauly *et al.* 2011), given a specific set of information.

2.3.1. Portuguese Health System

The Portuguese health system is characterized by three overlapping systems that are related with each other: the National Health Service (NHS), private health insurance and another one subsystem that has special conditions to some specific jobs or enterprises (Figure 1). The Ministry of Health supplies financing for the public health care and coordinates all the system. According to Simões and Barros (2007), 20% to 25% of the population is covered by a subsystem – third type- that provides health care financing and public health, such as public employees or marines. Basically, there is a network of providers, either public or private, which are connected to the Ministry of Health, and patients that are connected to one or more providers.

In this way, the Central Government through the Ministry of Health, aims to define the national health policies, perform the corresponding normative functions, promote their implementation and evaluate the results. The Ministry of Health has, concerning NHS, to exercise functions of regulation, planning, funding, guidance, monitoring, evaluation, auditing and inspection. It is also responsible for regulation, inspection and supervision of activities undertaken by the private health sector.

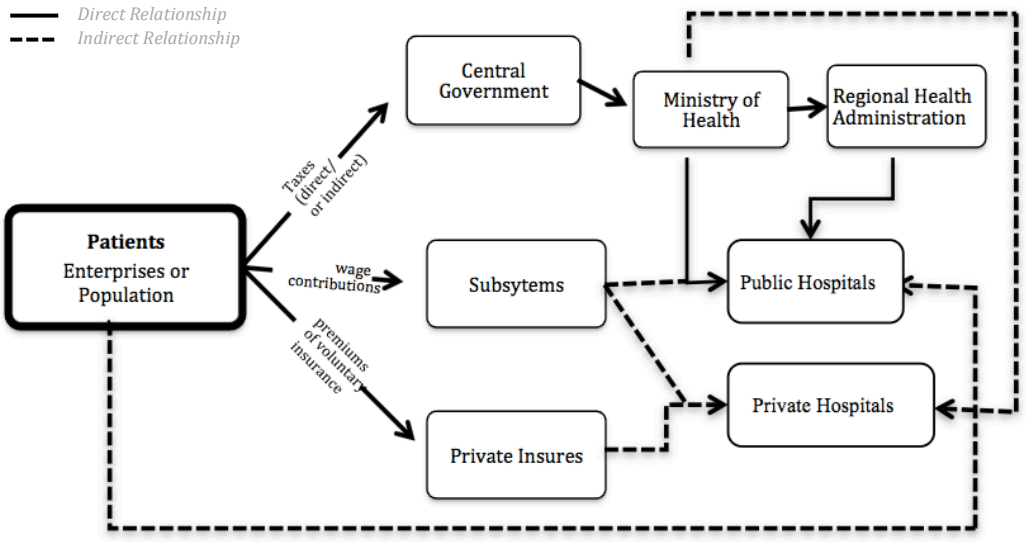

Figure 1 - Global scheme of the health system in Portugal. Adapted from Simões and Barros (2007)

The entities in the health sector we intend to study are the hospitals, so it is important to understand these units. According to the National Institute of Statistics (INE 2010), an hospital is defined as an: "health establishment provided with internment, ambulatory and diagnostic tools and therapy". The main goal of an hospital is to provide curative and rehabilitative healthcare to population, cooperating also in disease prevention, education and in scientific research. This definition of hospital embraces not only the hospitals itself but also private clinics and private non-profit institutions that provide hospitalization.

Nowadays, Portugal has about 70% of public hospitals (and 30% private ones), which address 80% to 90% of patients (Barros 2009).

With regard to its internal structure, the hospital is an institution quite complex, in which coexist simultaneously, an hierarchical medical structure and an administrative structure. According to Barros (2009) the relationship of power within the hospital hierarchy is quite different from a regular company, which makes the decisions and policies about hospitals difficult to implement.

Clearly, we can notice that doctors have a great power, because of their ability to decide the resources used, and they often become responsible for the management. The administrative managers also have a strong influence in the hospital organization because they control and allocate resources, and they are usually restricted to a budget constraint and a production technology.

We can also highlight another entity (the State) that may have great power. Usually the State is who decide and determine the objectives of the hospital, as a business. Currently, hospital care reforms involve private management in a public hospital, the creation of Local Health Units, the establishment of responsibility centres, and the integration of hospitals in HC's. These changes must be monitored and evaluated in order to understand if these reforms are having good results and if they should be expanded or extinct (Barros

2009). The aim of this research is to contribute to this industrializing by addressing the effects of hospital mergers.

Chapter 3 Efficiency

Efficiency can be defined in different ways. Depending on the point of view these differences can cause some confusion among stakeholders for the implementation of the concept (McGlynn 2008). Efficiency is based on avoiding waste (waste of equipment, supplies, ideas, and energy). Therefore, in this scenario, efficiency is equivalent to using fewer inputs to achieve the same or better outcomes, linking concepts of resource use and quality.

Also from an economic perspective, there are some discussions about the concept. According to Palmer and Torgerson (1999), efficiency is when resources are being used to get the best value for money. On the other hand, according to Pareto, efficiency exists when no one can be better without making someone worse. This is called the social efficiency (McGlynn 2008).

These definitions are similar in some sense, notably that there is a relationship between resource inputs and intermediate outputs or final health outcomes (Palmer & Torgerson 1999).

However, when we consider various types of efficiency, the definition can go even further. Economic efficiency is making the best use of our scarce resources among competing ends, so that the economic and social welfare is maximized over time (Farrell 1957).

According to Farrell (1957) allocative efficiency denotes how different resource inputs are combined to produce a mix of different outputs, as opposed to technical efficiency which concerns achieving maximum outputs with least cost. That means technical efficiency refers to the ability of a hospital to obtain maximal output from a given set of inputs, while allocative efficiency refers to the ability of a hospital to use the inputs and outputs in optimal proportions, given their respective prices.

However, Palmer and Torgerson (1999) go even further with the definition of allocative efficiency. According to these authors it considers not only the productive efficiency (the way in which healthcare resources are used to produce health outcomes), but also the efficiency in the way these outcomes are distributed among the community. (Palmer & Torgerson 1999) .

In practice, it was proved that it is hard to infer allocative efficiency on an hospital framework so we will analyse the technical efficiency, following Farrell (1957).

3.1. Efficiency on Healthcare Services

Efficiency is a very important tool in health care because it appears to offer a precise and objective way of evaluating and comparing institutions, practices and indivuals. Furthermore, this definition is related to evaluation of different strategies in order to prove and to do cost benefit analysis (Hussey 1997). Nevertheless, efficiency should definitely be explored and the problems of its application should be analysed.

In a health care system, the inputs and outputs are sometimes hard to quantify, and efficiency is different to measure (Hussey 1997).

According to Palmer and Torgerson (1999), (p.1136) "in health care, productive efficiency enables assessment of the relative value for money of interventions with directly comparable outcomes". The traditional concept of efficiency is measuring the ratio between produced outputs and inputs used, considering that the quality of inputs is constant (Grönroos & Ojasalo 2004). However, this definition is more applicable on industry, while services are open systems, and as result, it is hard to translate a measure of efficiency. Thus, they suggest the "service productivity as the combined effect of how well a service provider manages the cost efficiency of its service production resources and processes (internal efficiency) and the perceived quality of its services (external efficiency)" (Grönroos & Ojasalo 2004, p.421).

Over the years, researchers have been facing a challenge in defining "services" due to their complexity and diversity. The concept is not so straightforward which complicates the study of these activities (Lovelock & Gummesson 2004). Several definitions have emerged based on the characteristics of the services. For instance, a service is mainly intangible and often consumed at the same time it is produced (Bannock, Graham et al., 1978). Sampson e Froehle (2006) question, on other hand, if something is a service because of its characteristics, or if it is a service that provides these characteristics. They propose as a definition of service: "... the presence of customer inputs is a necessary and sufficient condition to define a production process as a service process..." (p.331).

Since the health sector is a service that uses an input from a client, namely, the individual, it fills the condition for the definition above and it is a particular case-study. It should be observed that health service is not supplied by machines, but by specialized staff. For this reason one of the problems of services is the vital role of skilled workers, which can hardly be reduced. Another problem associated with research in health systems, in hospital context, is the dimension in which it is organized, because each one of them has its own characteristics, regarding the resources and processes (Bittar, 2000). The health system has three characteristics that we should consider in our research: the difficult reduction

of inputs, the correct measure of output, and the different structures and dimensions of health units. Thus, understanding the hospital organization is first step for our research approached.

One of the main problems in health sector in Portugal is the need to balance the growing demand and the available funds. As noted above, the merger strategy was implemented to help achieving this aim. Increasing efficiency should be the primary concern to minimize this problem.

We stress that due to these characteristics of services that any study of efficiency in services may underestimate efficiency, eventually by letting out some outputs that cannot be measured.

3.2. Measuring Efficiency

Efficiency is usually measured as a ratio between output and input. Three main methods are typically used in order to measure efficiency: ratio analysis, regression analysis and stochastic frontier analysis. There are many problems associated with these last two methods, such as choosing the right inputs and outputs as well as the weights for each parameter (Cooper et al., 2006). An alternative method as been widely used to infer efficiency based on ration analysis - the Data Envelopment Analysis (DEA) (Harris et al., 2000).

The Stochastic Frontier Analysis (SFA) - a parametric method - was developed by Aigner et al. (1977), Battese e Coelli (1988) and Jondrow et al. (1982). They estimated production efficiency by introducing a two-part error term in a regression model. One part is an ordinary statistical noise that accounts for measurement error and the other part is a disturbance term that captures inefficiency. Also, Battese e Coelli (1988) suggest a traditional random error and a non-negative error term based on the technical inefficiency. So, it captures statistical noise, measurement error, and other random external factors (as luck) that are out of the firm's control. The SFA method has both benefits and weaknesses. This method can statistically test hypotheses and create confidence intervals allowing for random errors. Nonetheless, it can lose some flexibility in model specification (Hjalmarsson et al., 1996). If a model is less specific, it may cause multicollinearity, and several theoretical restrictions may be violated. The effects of statistical noise or measurement errors may be differentiate from random errors when applying the SFA method to measure production inefficiency.

The DEA, a non-parametric method, cannot separate the statistical noise or the measurement errors from random errors. The relative efficiency scores obtained from the

DEA may be weak and confused due to the uncontrollable factors. These are the DEA's main drawbacks. Still, DEA has been the most used method to address efficiency in hospitals and an overall public sector efficiency analysis. The difficulty in defining prices of inputs and the importance of multi-output production turn this choice also the best for our research.

The DEA is, according to Cooper et al. (2006), a relatively new data "oriented" approach for evaluating the performance of a set of peer entities called Decision Making Units (DMUs), which convert multiple inputs into multiple outputs. Firstly, DEA was described by Eduardo Rhode in his Ph.D. dissertation, supervised by W.W. Cooper and his analysis involved the comparison of the performance of a matched set of schools from different districts that joined the *Program Follow Through* (program related with schools performance). The challenge was to estimate the actual technical efficiency of the schools involving multiple outputs and inputs, excluding the usual information on prices. This specific model was called CCR (Charles, Cooper, and Rhodes) model, also known as Constant Returns to Scale (CRS) (Charnes, 1994).

The CCR minimizes multiple-output/multiple-input situation (for each DMU) replacing it with single "virtual" output and "virtual" input. For a specific DMU the ratio is a measure of efficiency and it is a function of the inputs and outputs. So, the CCR model evaluates the overall efficiency, categorizes efficient and inefficient units and sets how far from the efficient frontier are the inefficient units, considering a constant returns to scale frontier.

In fact, since the beginning of the application of the DEA, different models based on CCR have been proposed, namely the BCC (Banker-Charnes-Cooper) model. The BCC model and CCR model differ only in that the former includes one convexity condition.

DEA analysis requires a deeper definition of Pareto efficiency, which is very important in the analysis of any input or output relative importance. In this context Pareto efficiency defined as full efficiency is attained by any DMU and if none of its inputs or outputs can be improved without worsening some of its others inputs or outputs (Cooper et al., 2006). It is also important to understand the definition of relative efficiency, since the results from DEA are relative efficiency measures. So, a DMU is evaluated as fully efficient, on the basis of available evidence, if and only if the performances of other DMUs does not show that some of its inputs or outputs can be enhanced without worsening some of its other inputs or outputs. In other words, the efficiency of each DMU is evaluated by comparison to all others observed.

Therefore, to summarize and clarify some ideas, according to Charnes, the estimated DEA has the characteristics pointed out in Table 1, among others.

Table 1 – (Some) Characteristics of DEA Analysis

DEA:	• is centered on individual observations and in comparing it to population averages
	• creates a single aggregate measure for each DMU in terms of its use of input (independent variables) to produce wanted outputs (dependent variables);
	•can simultaneous use multiple outputs and multiple inputs with different units of measurement;
	• is value free and do not need specification or knowledge of a priori weights or prices for the inputs or outputs;
	• places no restriction on the functional form of the production function
	• results in Pareto optimal
	•focus on discovered best-practice frontiers rather than on central tendency properties of frontiers
	• satisfies rigorous equity criteria in the relative estimate of each DMU.

Our research uses DEA, which effectively considers multiple input and output measures in evaluating relative efficiencies and does not require a priori assignments of financial performance dimensions. It allows for the identification of appropriate benchmarks, which are potentially important for hospitals, especially those that are performing poorly.

3.3. DEA: Model

Goods or services can be defined as processes where a set of inputs is transformed into a set of outputs. As shown in Figure 2, according to the production function, in order to produce y units of the product we need to use x units of n input.

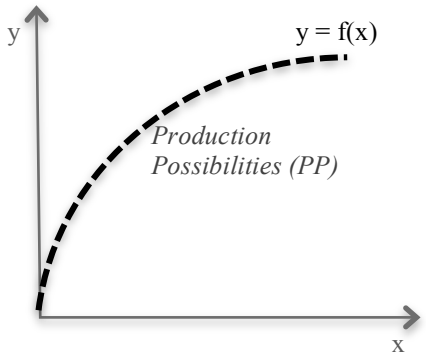

Figure 2 - Production Function

In Figure 2, any point (x, y) ∈ PP denotes a technologically feasible way of transforming a quantity x input in an amount y of outputs, but due to technological constraints, the PP is limited by the production function (y = f (x)). This function shows the maximum amount of product that can be obtained from a quantity x of inputs.

If we consider the prices of inputs, we have to replace the production frontier for the cost frontier, and then we have technical and allocative efficiency analyses.

However, our research examines the first type of efficiency, which means that we use the production function in its simplest state, without considering prices, where efficiency depends on each DMU. In our research DMU's are HC's.

The objective function is given by following expression:

$$\boldsymbol{max}\ \frac{\boldsymbol{u_r\, y_{ro}}}{\boldsymbol{v_i x_{ro}}} \tag{1.1}$$

$$subject\ to \qquad \frac{u_r\, y_{ro}}{v_i x_{ro}} \leq 1$$

$$u_{r,}\, v_i \geq 0 \ , \forall\, r, i \in \mathbb{R}$$

where u_r represents output weight and v_i represents input weight on total of inputs, y_{ro} is quantity of output r, for DMU_o and x_{r0} is quantity of input r, for DMU_o.

One of the first steps in this model is to calculate u_r and v_i for each DMU. We therefore consider some specific principles:

- the weights must be defined by the specific program used (*Frontier Analyst*);
- the firms considered as inefficient must be analysed too;
- the estimated efficiency should be calculated from the ideal weights obtained from the method attention should be taken on the choice of reference units to compare the DMU;
- number of outputs, compared to the number of inputs, should be considered important to stress that the optimal weights change from one DMU to another and they are not predefined, they are calculated applying the concepts and algorithms.

Up to this point we have not deal with the main goal of the model. The model could be designed either to minimize inputs while producing at least the given output levels- called input-oriented – or to maximize outputs while using no more than the observed amount of any input- called output-oriented (Cooper et al., 2006). An output orientation assumes that DMUs have direct control over their outputs, while an input orientation assumes little control over outputs produced.

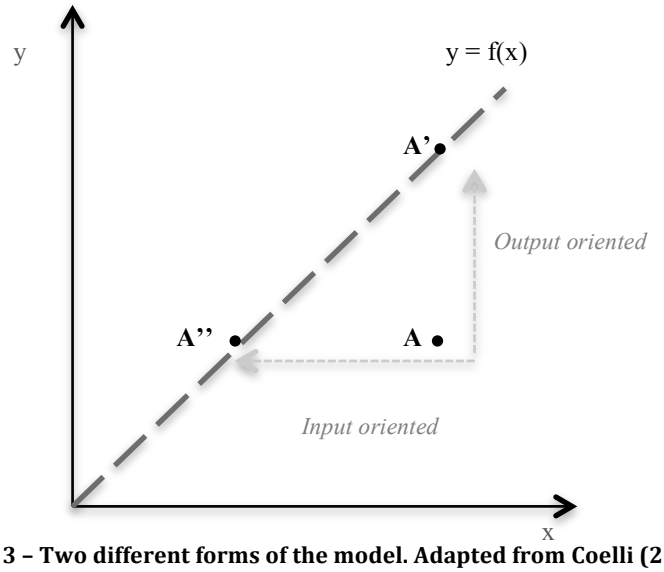

Figure 3 – Two different forms of the model. Adapted from Coelli (2005)

In Figure 3 we have the two different forms that DEA model may assume. As we can see the increase of efficiency may result in minimizing technique resources (A''), assuming constant results, or by maximizing the outputs (A'), considering resources constant.

Hospitals cannot directly control the health of community and it is more appropriate to concentrate on the inputs, for which hospitals can have more control, and there is more opportunity to reduce extra consumption (Harris et al., 2000). Therefore, the model that our research is based on is the CCR model, the most used model in this kind of research work (Appendix 1)

If we consider the CCR model, the objective function for a particular DMU is, without further additional constraints given by the following expression:

$$\max \boldsymbol{h_0}\,(\boldsymbol{u},\boldsymbol{v}) = \frac{\sum \boldsymbol{u_r y_{r0}}}{\sum \boldsymbol{v_i x_{i0}}} \tag{1.2}$$

where the weights are the u_r 's and v_i's and the y_{ro} 's and x_{io}'s are the observed output and input values, respectively of DMU_o .

The DMU, the entity responsible for transforming inputs into outputs, is the basis of the organization of DEA. Consider $DMUj$, with m inputs and s outputs, where j = 1, 2,..., n. The inputs matrix X and outputs matrix Y can be arranged as follows.

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2\,n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m3} & x_{m2} & \cdots & x_{mn} \end{pmatrix} \text{ and } Y = \begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2\,n} \\ \vdots & \vdots & \vdots & \vdots \\ y_{s3} & y_{s2} & \cdots & y_{sn} \end{pmatrix} \tag{1.3}$$

We measure the efficiency of each DMU by maximizing n times, one for each DMUj to be evaluated. As Cooper *et al.* (2006), we will consider DMUo, where o ranges over 1,2, ..., n. The fractional programming problem $\boldsymbol{FP_o}$ is obtained by the ratio:

$$\max \boldsymbol{\theta} = \frac{u_1 y_{1o} + u_2 y_{2o} + \dots + u_n y_{so}}{v_1 x_{1o} + v_2 x_{2o} + \dots + v_m x_{mo}} \tag{1.4}$$

$$subject\ to \quad \frac{u_1 y_{1j} + u_2 y_{2j} + \dots + u_n y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \dots + v_m x_{mj}} \leq 1 \ (j = 1, \dots, n)$$

$$u_1, u_2, \dots, u_s \geq 0$$
$$v_1, v_2, \dots, v_m \geq 0$$

The first step is obtaining values to input "weights" (v_i) $(i = 1, \dots m)$ and output "weights" (u_r) $(r = 1, \dots s)$. The next step is replacing the above fractional program by a linear program $\boldsymbol{LP_o}$, considering Theorem 1 and Theorem 2.

Theorem 1 : *The fractional program* $(\boldsymbol{FP_o})$ *is equivalent to* $(\boldsymbol{LP_o})$

Theorem 2 (Units Invariance Theorem*):* *The optimal values of* $\boldsymbol{\max \theta = \theta^*}$ *are independent of the units in which the inputs and outputs are measured provided these units are the same for every DMU.*

The resulting problem is as follows.

$$\boldsymbol{max\ \theta = u_1 y_{1o} + u_2 y_{2o} + \dots + u_s y_{so}} \tag{1.5}$$

$$subject\ to \qquad v_1 x_{1o} + v_2 x_{2o} + \dots + v_m x_{mo} = 1$$
$$u_1 y_{1j} + u_2 y_{2j} + \dots + u_s y_{sj} \leq v_1 x_{1j} + v_2 x_{2j} + \dots + v_m x_{mj}$$
$$u_1, u_2, \dots, u_s \geq 0$$
$$v_1, v_2, \dots, v_m \geq 0$$

In our research the version of CCR model aims to minimize inputs while satisfying at least a given level of output, as explained before. Based on matrix (X, Y) above we solve the dual problem.

The same function $(\boldsymbol{LP_o})$ may now be expressed in vector matrix notation, considering the multiplier form:

$$\boldsymbol{max\ (v, u) = uy_o} \tag{1.6}$$
$$subject\ to\ \ vx_o = \mathbf{1}$$
$$\boldsymbol{-vX + uY \leq 0}$$
$$\boldsymbol{v \geq 0, u \geq 0}$$

Now as was already stressed, we have to defined the dual problem (DLP_o), which is expressed with a variable $\boldsymbol{\theta}$ and non-negative vector $\boldsymbol{\lambda} = (\boldsymbol{\lambda_1}, \boldsymbol{\lambda_2}, \dots, \boldsymbol{\lambda_n})^{\boldsymbol{T}}$ of variables as follows, using the envelopment form:

$$\boldsymbol{min}\ (\boldsymbol{\theta}, \boldsymbol{\lambda}) = \boldsymbol{\theta} \tag{1.7}$$

$$subject\ to\ \theta x_o - X\lambda \geq 0$$

$$Y\lambda \geq y_o$$

$$\lambda \geq 0$$

The "slacks", which define the input excess $s^- \in R^m$ and the output shortfalls $s^+ \in R^s$ are defined, respectively, as $s^- = \theta x_o - X\lambda \quad and \quad s^+ = Y\lambda - y_o$, with $s^-, s^+ \geq 0$, for any feasible solution (θ, λ) of dual problem (DLP_o) **.**

Chapter 4 Empirical Analysis

4.1. Data and Study Design

The primary sources of data used in this research were the financial reports published by the Central Administration of the Health System, with a few exceptions where some hospitals were contacted directly to obtain the data.

Mergers in Portugal, as mentioned above, have been taking place over the past years. However, recent mergers (2008 and follows) cannot be considered either by the lack of data or because of the fact that some organizations are still facing the period of adjustment.

Our research considers the creation of fifteen HC's that integrate thirty-eight previously independent hospitals, during a period of five years - two years pre-merger, merger year and two years after the merger. The DEA technique was used in our research allowing the use of 75 hospitals (15 hospitals x 5 years) for the size of the sample. The sample size was considered sufficient to examine the effect of mergers in terms of technical efficiency, comparing with previous research and the number of existent HC's in Portugal.

Thus our research will take into account three main stages: the mergers that occurred in 2007, the mergers from 2004 and 2005 and an overview of the performance of mergers occurred in the 90's, in order to perform an extended time analysis. We started with seven mergers in the first stage, then another five joined in the second stage and final stage incorporates other three old mergers.

The following table presents the HC's that were used in the analysis, stating the year of the merger, the underlying decree-law and its location:

Table 2 –DMU's used in the analysis

Hospital Centres	Merge Year	Date and Law	Country region
(Centro Hospitalar de Alto Minho EPE) **CHAM**	2002	Decree-Law number **295/2002, December 11**	*Norte*
(Centro Hospitalar do Médio Tejo EPE) **CHMT**	2001	Ordinance number **1277 /2001**, **November 13**	*Lisboa e Vale do Tejo*
(Centro Hospitalar de Cova da Beira EPE) **CHCB**	1999	Decree-Law number **284/1999**, **July 26**	*Centro*
(Centro Hospitalar do Baixo Alentejo EPE) **CHBA**	2004	Decree-Law number **206/2004, August 19**	*Alentejo*
(Centro Hospitalar de Setúbal EPE) **CHS**	2005	Decree-Law number **233/2005, December 29**	*Lisboa e Vale do Tejo*
(Centro Hospitalar de Lisboa	2005	Decree-Law number	*Lisboa e Vale*

Ocidental EPE) **CHLO**		**233/2005, December 29**	*do Tejo*
(Centro Hospitalar do Nordeste EPE) **CHNE**	2005	Decree-Law number **233/2005, December 29**	*Norte*
(Centro Hospitalar do Barlavente Algarvio EPE) **CHBALG**	2005	Decree-Law number **233/2005, December 29**	*Algarve*
(Centro Hospitalar do Porto EPE) **CHP**	2007	Decree-Law number **326/2007, September 28**	*Norte*
(Centro Hospitalar do Alto Ave EPE) **CHAA**	2007	Decree-Law number **50-A/2007, February 28**	*Norte*
(Centro Hospitalar de Tâmega e Sousa EPE) **CHTS**	2007	Decree-Law number **326/2007, September 28**	*Norte*
(Centro Hospitalar de Médio Ave EPE) CHMA	2007	Decree-Law number **50-A/2007, September 28**	*Norte*
(Centro Hospitalar de Trás dos Montes e Alto Douro EPE) **CHTMAD**	2007	Decree-Law number **50-A/2007, September 28**	*Norte*
(Centro Hospitalar de Coimbra EPE) CHC	2007	Decree-Law number **50-A/2007, September 28**	*Centro*
(Centro Hospitalar de Lisboa Central EPE) **CHLC**	2007	Decree-Law number **50-A/2007, September 28**	*Lisboa e Vale do Tejo*

Some of these HC's have experienced a recent merger in order to integrate the new local health units or big centers. Our research only considers the values of HC's, as first established, since the idea is evaluating the effect of mergers overtime.

4.1.1. The DEA Measures

The variables chosen for data analysis are based on the CCR model, input-oriented, as we discussed previously. Data from pre merger years (N-2, N-1), merger year (N) and post merger years (N+1, N+2) was examined. Pre-merger year's data was calculated by summing the data from those two or more hospitals that merged together to form the corresponding hospital operating in merger and post-merger years. In other words the information from pre-merged hospitals was combined as a single large hospital (theoretical). This can result in duplication of some factors, however this duplication is exactly the aim of what the present analysis does.

The inputs and outputs selected for the DEA analysis were based on two criteria: previous health studies and the productivity measures available in hospital financial reports.

We used eleven different variables in order to evaluate the levels of efficiency. The measurements of outputs and inputs are listed on the Table 3. The variables can be

classified into two types: "controllable" or "uncontrollable". Even though they are considered *a priori* as controllable. Only variables like “environmental factors” or “space floor” are most often considered “uncontrollable”. Variables were chosen by previous research works (Appendix 1).

Table 3 – Definition of DEA measures

	Variables	Description
Inputs	Beds (BDS)	Number of operational hospital beds, except cribs
	Total Staff (STAF)	Number of total employees.
	Operational Costs (COSTS)	Amount of operational expenses, meaning, the amount spent by the enterprise to develop their activities.
Outputs	Outpatients Consulting’s (OUTCONS)	Number of booked-consultations such as observation, diagnosis, treatment and monitoring, and even small surgical treatments or similar examinations.
	Births (BIRTHS)	Childbirths, meaning the complete expulsion the mothers body of one or more fetuses of 22 or more weeks of gestation; or fetus with 500 grams weight or more, regardless his survival; any labor whether it is spontaneous or induced
	Surgeries (SURGERIES)	Number of total surgeries: predetermined or emergency
	Discharges (DISCH)	Number of patients who no longer are admitted: either by a positive feedback from the physician or against medical advice. Deaths are also contemplated in this measurement.
	Treatments (TREATM)	Number of sessions where patients receive, on a schedule, health care, under supervision, in a period shorter than 24 hours.
	Emergency Cases (EMERG)	Number of acts of assistance provided in the hospital to someone with a sudden change or aggravation of his health.
	Occupancy Rate (OCCUPANCY)	Ratio between total hospital days in the year and its capacity (the capacity is the sum total of days available, ie capacity x 365 days).
	Outpatient / bed (OUTBED)	Number of outgoing patients per bed, which is obtained by dividing the number of number of outgoing patients for capacity of the hospital over the same period.

4.2. Our sample: regional distribution analysis

The statistical analysis of the sample that we used is very important both for the analysis of results as well as to be aware the relevance of the sample. As implemented policies by the government are different in each region, it seemed important to analyze the results according to geographical criteria. There are different administrations in each region. Despite each area has a separate regional management, they all belong to the Ministry of Health, and they share the same aim that, which is to develop and to improve the health system of each region. Thus, we have five distinct regions: *Norte*, *Centro*, *Lisboa e Vale do Tejo*, *Alentejo* and *Algarve*.

From Figure 4 we can verify that in *Norte* we research seven HC's, two in *Centro*, four of *Lisboa e Vale do Tejo* and in *Alentejo* and *Algarve* we studied a hospital from each region.

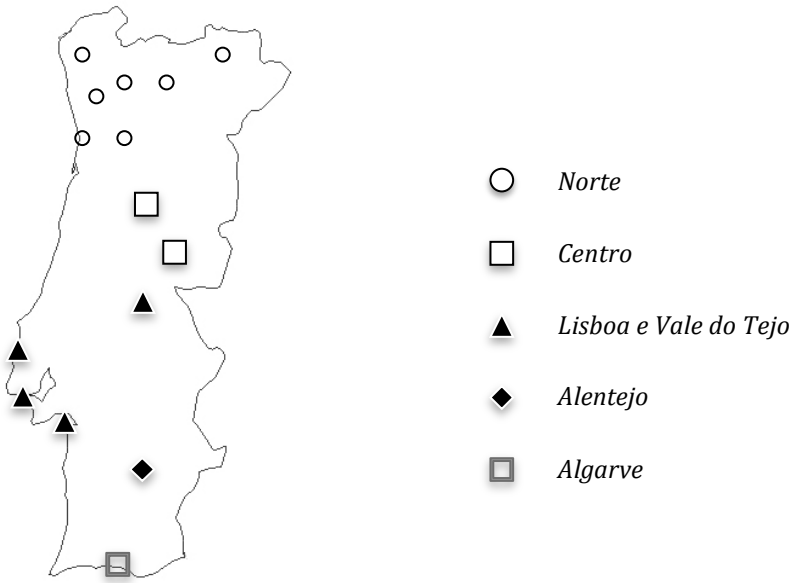

Figure 4 - Geographical distribution of central hospitals in Portugal

One of the factors that we considered was the number of users served by each hospital, per region. According to CENSUS, the distribution of the population between 2001 and 2010 shows no significant changes. On Figure 5 we have the evolution of Portuguese population. It can be seen that about 37% of the population is in *Norte*, 28% in *Lisboa e Vale do Tejo*, 24% in *Centro* and a small percentage in *Alentejo* and *Algarve*, 8% and 4%, respectively. Groups are explained in Appendix 2.

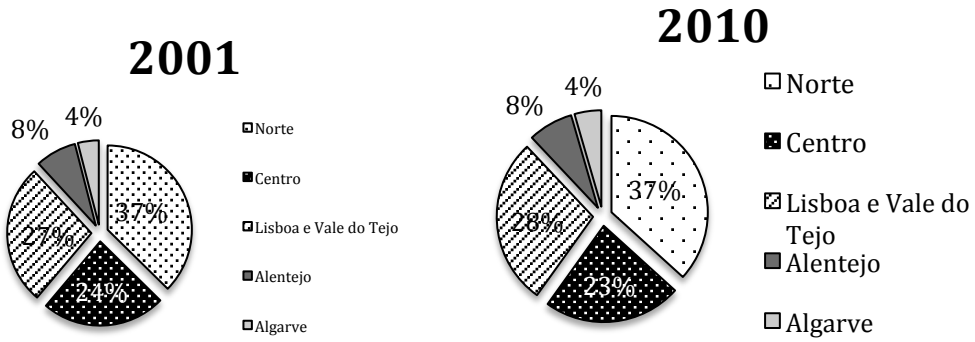

Figure 5 - Evolution of Distribution of Portuguese Population

Our analysis does not include other non-centralized hospitals or the private hospitals, but it gives us an idea of the "market" from each region, in terms of the resources.

Examining both figures together (1 and 2) we can clearly observe that to satisfy the users of *Norte*, 37% of the population, there are seven hospitals centers, which means that there is an average of 5,28% of population per hospital; to satisfy the users of *Lisboa e Vale do*

Tejo, 28%, there are four hospitals, so 7 % for each hospital; to satisfy the users of *Centro*, 23%, there are two hospitals, which means 11,5% per hospital; for the remaining 12% of *Alentejo* and *Algarve*, there are two hospitals, an average 6% for each one.

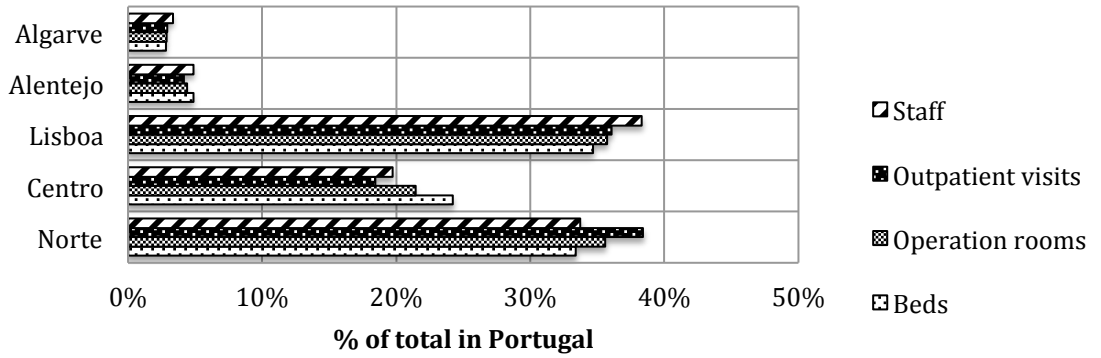

Figure 6 - Distribution of some inputs and outputs per Region (2010) – INE

In Figure 6 we have the distribution of some inputs and outputs measures per region. As we can see *Lisboa* has the higher percentage of all inputs (staff, operating rooms and beds), except number of visits. The *Norte* also presents more than 30%, of total of all regions, for all inputs and it shows the highest number of outputs, 36%. The central region, presents intermediate values (between 10% and 25%), in which the percentage of beds comprises the highest value for the remaining indicators. Despite Alentejo and Algarve are the regions with lower percentages, bellow than 7%, it seems that they can satisfy users easier.

The all analyse may give us an idea of how these main indicators used in the analysis are spread over the country.

4.3. Empirical Results of DEA

4.3.1. First Step: Recent Mergers

The inference of efficiency results will be discussed the using CCR model, in two steps. In the first approach, we analyze the values of technical efficiency over the years (N-2) to (N+2) for each DMU. In the second approach we explore the differences between the various hospital centers.

Efficiency scores obtained from the DEA window analysis using CCR model are presented in Table 4. For each DMU we have the efficiency scores for the pre-merger years (N-2; N-1), the merger year (N) and post-merger years (N; N+1; N+2). There is also the rate in terms of changes in efficiency scores from each hospital from N-1 to N+1 and for N-2 to N+2. So this table has the necessary information to answer if there are the potential gains

in technical efficiency following a merger in Portuguese hospitals, our main research question.

However, it seems important to mention that the year of the merger "N" is not the key point. "N" is a year of adjustment, changes and, sometimes, the merger begins along the year. Besides many of the mergers started in the middle of the year or even at the end of the period, the results therefore require a careful interpretation.

Considering all the years of our research (Table 4 – 8th column) we can observe that 7 hospitals (58,30%) maintain or improve their efficiency scores, while 5 (41,70%) had decreased efficiency scores, in which two of the DMUs had a significant decline (near 20%). Only one hospital improves its efficiency score by more than 5%.

Analyzing the three middle years (N-1; N and N+1), 4 hospitals (33,30%) increase their efficiency scores, and 5 (41,70%) remain on the same level of efficiency, while only 3 hospitals (25%) had decreased their efficiency scores. Note that the efficiency increase over than 25% in one of the hospitals studied.

Table 4 - Efficiency Scores under CCR model

DMU	**N-2**	**N-1**	**N**	**N+1**	**N+2**	**%Change (N-1 to N+1)**	**%Change (N-2 to N+2)**
CHP	100	100	100	100	100	0	0
CHAA	100	100	100	100	92,19	0	-7,81
CHTS	100	100	100	100	100	0	0
CHMA	100	96,17	100	100	100	3,83	0
CHTMAD	100	83,98	100	84,02	80,81	0,04	-19,19
CHC	97,93	93,67	92,59	98,52	95,86	4,85	-2,07
CHLC	100	87,48	64,82	67,29	77,55	-20,19	-22,45
CHNE	100	100	100	96,45	98,81	-3,55	-1,19
CHLO	75,25	78,71	84,08	70,22	82,46	-8,49	7,21
CHBAlg	100	100	100	100	100	0	0
CHS	100	100	100	100	100	0	0
CHBA	100	71,55	93,76	98,01	100	26,46	0

Figure 7 provides a graphic display of the evolution of mergers over the five years analyzed. The graphs help to conclude more clearly that there is no tendency for the all sample. However, it seems to be clear that four of the DMU's have been stable (CHP, CHTS, CHBAlg and CHS), while the remaining have peaks over years. We found that the efficiency has decreased after the fusions, especially in large units. These results are consistent with the literature, which states that large hospitals operating in the area of diseconomies of scale. This fact may be due to the intrinsic features of the regional management.

Figure 7 - Efficiency scores over the years for each DMU

After analysing the obtained results, we can imply that hospitals do not respond in the same way after a merger. There are several factors that may explain the differences in efficiency performance: the market that the hospital needs to satisfy, the structural organization of the hospital, or even the medical specialties offered by the hospital. For example, ophthalmology patients from *Hospital de Aveiro* (now the *Centro Hospitalar do Baixo Vouga*) are most often transferred to the *Centro Hospitalar de Coimbra.* This also happens in Algarve: when it does not have a specialty, they transfer patients to the *Centro Hospitalar de Lisboa Ocidental/Central*.

In fact, if the treatments required are more expensive and they need more intensive care, patients are often moved to higher units. With that being said, we suggest that further studies should underline the costs of each speciality, transfers made to each hospital and the specific treatments associated with each unit. We can not do it in our research due to lack of analysed data are. We needed larger and longer contact with hospitals and each department to address this.

It would be important to further explore mergers, concerning the specialties of each hospital and how the merger modifies its organization. Note that hospital units that integrate additional services allow for the exploitation of synergies, whereas when there are repeated services it becomes impracticable taking advantage of synergies.

In a vertical analysis of the results obtained, we can conclude that the efficiency seems to be different among various regions (Table 5).

Table 5 - Share of hospitals considering efficiency score and regions.

Efficiency scores	**[90;100]%**	**[80;90]%**	**[50;80]%**
Norte	0,83	0,17	0
Centro	1	0	0
Lisboa e *V.T.*	0,33	0	0,67
Alentejo and *Algarve*	0,5	0	0,5

In *Norte* we can observe that about 83% of hospitals have over the years levels of efficiency greater than 90%, two of them have actually 100% efficiency from N-2 to N+2. The remaining 17% have values over the years in efficiency between 80 and 90%. In *Centro*, since we consider only one hospital for the analysis, 100% have levels above 90% of technical efficiency.

In *Lisboa e Vale do Tejo*, only 33% of DMUs showed an efficiency score above 90%, while 67% have efficiency values below 80%. In the region of *Alentejo* and *Algarve* note that the *Centro Hospitalar do Barlavente Algarvio* had the best efficiency values over the years, while the *Centro Hospitalar do Baixo Alentejo* exhibit efficiency scores below 80%.

It is worth noting that the region of *Lisboa* and *Vale do Tejo* has generally the lowest level of efficiency, In the opposite place, *Norte* presents the higher and the more regular efficiency scores over the five years. So, it also seems important in a future research consider the different regional health authorities, and how they manage the different regions, because as we found in the north of the country hospitals exhibit stable levels and higher efficiency.

Another relevant point of analysis is the potential improvement in inputs or outputs. This means looking for which values would cause a better efficiency in each merged hospital.

We found that is worthwhile to analyse the potential improvements in the year in which the hospitals had the lower efficiency. So, the analysis was restricted to N+1 year.

Table 6 - Potential improvement (%) for N+1

	CHC	CHBA	CHNE	CHTMAD	CHLO	CHLC
Beds	-1,48	-1,99	-22,66	-15,98	-29,78	-32,71
Total Staff	-24,69	-1,99	-3,55	-15,98	-29,78	-42,13
Costs	-92,26	-5,06	-77,68	-72,91	-81,97	-69,94
Outpatient Visits	0,00	38,88	44,36	9,45	0,00	0,00
Births	16,88	0,00	201,28	72,53	54,67	162,42
Discharges	0,61	21,86	0,00	0,00	1,17	3,69
Treatments	0,00	63,04	48,32	45,23	35,66	0,00
Emergency	53,31	124,57	31,52	3,09	39,49	0,00
Occupation_Rate	19,10	0,00	0,00	15,57	39,38	52,03
Patient/Bed	42,64	9,63	9,90	35,53	41,68	102,81
Surgeries	0,00	57,69	71,62	136,82	53,15	28,35

Looking to the results in Table 6 we can see that the need for improvement is different for each DMU. For some of them one can clearly see that they require better improvements than others. Therefore, considering an average percentage of improvement for each DMU, we can observe that the average *Births* is the input that needs the higher increase (22,36%). The variable *Costs* should be decreased on 17%. *Treatments* and *patient/bed* need to improve in 11,50%. The other variables only need small adjustments, some improvements (0,96% and 2,8% respectively) for *discharges* and *outpatient_visits*, and few decreases on the rest of the variables, lower than 10%.

Unfortunately, all of the HC's have improvements to do, namely the *Centro Hospitalar de Lisboa Ocidental* and the *Centro Hospitalar de Lisboa Central*. The C*osts* is definitely the value that needs more decrease in all DMUs studied, as is present in all public policies in this sector nowadays.

4.3.2. Second Step: Old Mergers

On this section we are infer the case of older mergers. In this way we may compare them in a four-year period, from 2003 to 2006. The analysis can help us understand what is the long-term effect on efficiency after the merging, and if the merger performance of the hospital turns more stable over time.

Table 7 - Window analysis results for old mergers in 4 years

DMUs/ Efficiency Scores	**2003**	**2004**	**2005**	**2006**
CHAM	100	100	100	100
CHCB	100	100	100	100
CHMT	100	100	100	93,42

In Table 7 we have the efficiency scores for old mergers in four years. As we can observe efficiency had stable values all over the years. In our opinion and based on results the performance after three or more years following a merger are clearly stable. However it is hard to conclude that these three hospitals are really efficient because we can not compare them with the others in pre-merge and post-merge years. Unfortunately the information about the others merges is recent, considering merger year.

The *Centro Hospitalar do Médio Tejo* in 2006 presented a lower value of efficiency on 2006. Table 8 have the potential improvements to CHMT in 2006. Results suggest that major improvements are involved in increasing *emergency* for 41,3% and decrease for 14,52% in *Total Staff*.

Table 8 - Potential Improvements in CHMT

	Beds	***Total Staff***	***Costs***	***Outpatient visits***	***Births***	***Discharges***	***Treatments***	***Emergency***	***Occupation Rate***	***Patient / Bed***	***Surgeries***
CHMT	-6,58	-14,52	-0,06	0,02	0	0	0	41,3	3,28	0	2,41

Conclusion

Since the mid the 90's hospital mergers have become emerging subjects not only for economist and politicians, but also for citizens overall. Several research contributions on hospital mergers can be found on several countries and their conclusions were increasingly broader and more diverse. Many of these studies refer as the main objective of a hospital merger the reduction of costs. However this purpose is often questioned by politicians, physicians and other stakeholders.

A literature review about the efficiency of hospital mergers shows that the DEA has been the method most chosen by the researchers. There is however, to the best of our knowledge, no analysis of efficiency for Portuguese hospital mergers. We strongly believe that this analysis is relevant and a hot topic because nowadays there are six hospitals involved in a merger process, which are a significant share of hospital units. Adding to this it is expected that increasing integration of the units will be in the future a policy to keep being supported by the government. A topic like health is always interesting and therefore our contribution to the existing literature may be our added value.

The main objective of our research is to analyse the effects of hospital mergers on efficiency in Portugal. This study showed several interesting results. The creation of twelve hospitals, by combining existing units, does not seem advantageous in terms of efficiency since there are diseconomies of scale. To obtain better results, some hospitals should be restructured, possibly re-dividing the bigger HC's. More additional services may be shared allowing better exploitation of synergies and decreasing on costs. Another important and surprising result are the differences found between large and small hospitals centres. This could be explained by having different peaks of requirements in terms of resources and also because of specificities of some services present only in large centres.

Although our research is not fully extended, it can be considered as a source of ideas and hypotheses, which is quite significant and relevant for future studies in the health sector in Portugal.

Our research helps to understand some interesting facts about hospital mergers but at the same time leaves some questions and some ideas for future research work.

Unfortunately, broader aspects regarding the quality inherent to healthcare services (e.g.: such as friendliness, wellbeing, happiness) was not considered in the research due to the need of contact with the patients for interviews and to the short time available. The technical efficiency chosen excludes factors such as friendliness, speediness and personal wellness that are essential to the overall experience.

Data available, about hospitals performance, namely on the financial reports, would improve the scope further analysis if more homogeneous structure and content was present. Some variables that were relevant for our research were not available in all reports.

It would also be interesting to analyse hospitals that had very different performances and trying to understand if the extension of hospitals needs to be considered before the merger, since the structures, organization and expertise available to the user vary across hospitals and may be relevant facts.

The variable that seems important to include in future studies is "transfers" between hospitals. This “transfers” occur in specific specialities that have an important share in the total amount of expenses. Different specialties may have different costs and may require specific resources or treatments.

In order to increase efficiency, inputs should be improved and explored. For instance, to reduce the number of hospitalization days is necessary to know the conditions that each patient has at home and minimize the days of waiting for test results. It would be very interesting in a further stage of our research understand which inputs can be actually reduced and their effects in terms of hospital expenses or even in the welfare of user.

Finally, it would be also a great asset and a source of new hypotheses or findings if we considered the data of mergers after 2007, including those who still are in progress.

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Centro Hospitalar do Médio Tejo EPE, 2003-2006. Relatório de contas. CHMT, Tomar

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Appendix 1 Hospital Efficiency - Previous Studies

Author	Year	Application	Method	Variables		Results
			Type (Others)	Inputs	Outputs	
(Aletras)	1999	Greek Hospitals	*Translog Function*	Number of beds; Total hospital expenses; Expenses for wages, services and supplies	Total number of hospitalized cases; number of outpatients' visits; case-mix index; dummy for the presence of teaching activities.	Constant Economies of scale
(Barros & Sena)	1999	Portuguese Hospitals	*Direct Costs Function*	Annual global change according to consumer price index	Homogenization of the three types of final output: Adjusted-patient-day Output measure	Increase in expenditure which is not offset of increased productivity; Diseconomies of Scale
(Carreira)	1999	Portuguese Hospitals	*Translog Function*	Variable Costs; Work price; Other factors price; share of different expenditures	Outpatients; inpatient days; number of medical consultations	Substantial cost savings after produce together
(Cohen & Morrison)	2008	Washington Hospitals	*Translog Function*	Number of employees (different areas); Inputs prices; beds; case mix	Outpatients visits; Inpatient days	Significant agglomeration economies; scale economies, and some evidence of scope economies
(Dranove)	1997	California Health	Semi-parametric cost function	Cost; Change in costs; wages; teaching	Number of Outpatients visits; number of discharges	Scale economies exist but are substantial only for very small hospitals.
(Farrell *et al.*)	2009	USA: Hospitals inpatient admissions	Regression - DID[3]	Amount paid by the insured; amount paid by patient; information about patient; information about the admission	Price charged	Prices increases are not uncommon following mergers.
(Gonçalves & Barros)	2009	Portuguese Hospitals	*Translog Function*	Staff costs; non-staff costs; number of beds	Variable cost (for different departments)	Economies of scope for some of the services; Evidence for economies of scale
(Harris *et al.*)	2000	USA Hospitals	DEA CCR/BCC *Input-Or.*	Service mix (proxy variable); size (proxy variable); employees; operational expenses.	Adjusted discharges; outpatient visits	Reduction in input after merger; Scale efficiency is the dominant source of improvement, despite the changes were not statistically significant.
(Harrison)	2008	American Hospitals	Cost function: regression which including time	Expenses; Demographic characteristics; Urban Location; Teaching Status	Outpatients; Inpatients; Admissions	Economies of scale; Cost savings immediately following a merger. Over time, cost savings from the merger decrease; positive cost savings declines
(Dafny)	2009	American Hospitals	OLS regression	Price; Beds	Discharges; Asset ratio; occupancy rate	Hospitals increase price
(Kittelsen &	2003	Norwegian	DEA CRC	Operating costs	Medical	Economies of scope

[3] DID is *Difference-in-Differences* method and it estimate the effects of consummated mergers.

Magnussen)		hospitals				emergency care visits; Medical elective visits; Surgical emergency care visits; Surgical elective visits; Births, Outpatient income; Long term care	for the surgical and outpatient dimensions.
(Kjekshus & Hagen)	2007	Norwegian hospitals	DEA	CRC	Physicians; Other employees; Medication, consumer medical Equipment; Running expenses	Adjusted inpatient stays; Outpatient revenues	Large mergers with radical restructuring improve efficiency But most mergers do not.
(Kristensen *et al.*)	2010	Danish hospitals	DEA	BCC	Adjusted operational expenses; Beds; University Hospital (Y/N)	Inpatients; Grey zone patients; outpatients	Some mergers do not seem to lower costs; Some merged hospitals become too large and therefore experience diseconomies of scale; Economies of scope
(Ferrier & Valdmanis)	2004	USA Hospitals	DEA	BCC	Beds; Physicians; Residents; FTE registered nurses; other labour	Adjusted admissions; surgeries; ER visits	Increase in productivity. More efficiency.
(Fried *et al.*)	1995	American Hospitals	DEA	CRC	Costs; Admissions	Discharges; inpatient and outpatient surgical operations; Emergency; Ambulatory and other visits;	Gain in productive efficiency: efficiency gain increases as merged hospitals have time to adjust their operation and overcome problems associated with restructuring and training personnel

Appendix 2 Groups by region

Setting groups:

- *Norte*: CHP, CHAA, CHTS, CHTMAD, CHMA, CHNE and CHAM
- *Centro*: CHC and CHCB
- *Lisboa and Vale do Tejo* : CHLO, CHLC, CHS and CHMT
- *Alentejo:* CHBA
- *Algarve*: CHBAlg