

Cluster shifts based on healthcare factors: The case of Greece in an OECD background 2009-2014

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Abstract

The purpose of the present study is to explore the impact of the 2008 economic crisis on expenditure of OECD countries. Moreover, focusing on Greece, the researcher attempts to create homogenous groups of countries based on healthcare resources, in order to investigate possible shifts between groups during the crisis. The main body of the study is based on statistical information extracted from OECD and Eurostat databases. Descriptive statistics are used to present the data. The researcher uses k-means cluster analysis to create homogenous groups of countries. Following the beginning of the crisis in 2008, total health expenditure decreases in most OECD countries. Greece decreases public and out-of-pocket expenditures and manages to stabilize the number of doctors, which was rising before the crisis. Cluster analysis shows that Greece and Spain shift between clusters, leaving the core of the EU and joining low-income countries. The reforms implemented in Greece since 2008 have drastically decreased its expenditure which was in 2014 well below the OECD average. However, more structural reforms can still be implemented. Gradually decreasing the number of doctors while increasing the number of nurses would improve the efficiency of the system. Emphasis should also be placed in increasing managerial and organizational reforms.

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JEL classification numbers: H51, I18,

Keywords: Health Expenditure, healthcare resources, k-means clustering, OECD, Greece, Economic crisis.

1. Introduction

1.1 Background

Achieving economic growth is believed to be largely dependent on the health of the population. According to [1], the health of any country's population has a positive and strong correlation to economic growth. Health is defined as the state of being fit and mentally balanced and able to react to environmental changes. According to the World Health Organization [2] the official definition of the notion is as follows: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Health continuously ranks highest as the one thing that men and women desire in life [3]. The amount of resources a country spends on health and the rate at which that spending grows is usually the result of several social and economic factors, including the financing and organizational structure of that country's health system. Additionally, there is a strong relationship between the overall income level of a country and the population's out-of-pocket expenditure on health [4].

There are major disparities on the amount that each country spends on health. High income countries spend over USD 3000 per capita, while low income countries only spend USD 30 per capita. Before the 2008 global financial crisis, there were 64 countries in which per capita health expenditure was less than USD 100. Moreover, health expenditure with respect to economic growth also varies widely. Some countries are spending more than 12% of their respective GDP while others spend less than 3% [5].

1.2 Study Objectives

The purpose of this paper is twofold. On the one hand, the researcher attempts to explore the effect of the economic crisis on health expenditure of countries belonging to the Organization for Economic Co-operation and Development (OECD), focusing mainly on Greece. On the other hand, an assessment is made on the impact of the crisis on OECD Health Systems resource allocation. More specifically, the researcher sought to find the answer to the following question: "If we were to group OECD countries based on healthcare factors, would Greece shift to another group between 2008 and 2014.

The analysis utilizes secondary data publicly available from the OECD's Statistics Database and the EU Commission's Eurostat Service [6, 7].

This paper includes, beside this first introductory chapter, three other chapters. The outline of these chapters and their organization is described as follows:

The second chapter briefly explains the methodology which forms the backbone of this paper. Main ideas are explained and thoroughly explored using descriptive

statistics. Moreover, in order to support the graphic analysis, the researcher uses cluster modeling, which is based on maximum likelihood estimation. More specifically, k-means cluster analysis is performed, to attribute each OECD country to a specific cluster (group) based on several healthcare-specific factors. The hypothesis under study is that during the crisis Greece faced drastic developments that resulted in a shift of clusters.

Third chapter discusses public resource allocation to health care services before the crisis including descriptive statistics and the first clustering process (2008).

Chapter four assesses the situation during the crisis implementing the second clustering process (2014) and graphic analysis.

Final chapter summarizes and discusses the main results of the paper, commenting on changes between clusters, and concludes with some future areas of research.

2. Methodology

2.1 Data Collection and Descriptive Analysis

This study's research population includes the 35 OECD member-countries. The quantitative evidence utilized are part of the public OECD Database on Health[6]. Furthermore, mainly for descriptive purposes, the researcher used data from the Eurostat Health Database [7]. All data were collected and entered on Microsoft Excel spreadsheets for each OECD country used in the current study. Per capita total expenditure in US\$ purchasing power parity, public expenditure in US\$ purchasing power parity, out-of-pocket expenditure in US\$ purchasing power parity, density of doctors per 1000 citizens, density of nurses per 1000 citizens, were copied to SPSS Statistics, where the cluster analysis was performed.

The descriptive analyses were conducted in Excel. All charts and graphs, including those found in the appendices, pertaining to these correlation and regression analyses were produced in Excel.

2.2 Cluster Analysis

Part of this study's objective is to assess whether Greece actually shifts clusters as a result of the crisis and the measures implemented between 2008 and 2014.

Cluster analysis is a method for identifying homogenous groups of objects, called clusters. Observations in a specific cluster share many characteristics, but most importantly are very dissimilar to objects not belonging to that cluster.

The objective of cluster analysis is to identify groups of observations (in this case, countries) that are very similar with regard to their health expenditure and the state of a country's health system, and assign them into clusters. After having decided on the clustering variables (which are mentioned in sub-section "2.1. Data Collection and Descriptive Analysis") the researcher needs to decide on the clustering procedure to form the groups of objects. This step is crucial for the analysis, as different procedures require different decisions prior to analysis. There is an abundance of different approaches and little guidance on which one to use in

practice. These approaches are: hierarchical methods, partitioning methods (more precisely, k-means), and two-step clustering, which is largely a combination of the first two methods. Each of these procedures follows a different approach to grouping the most similar objects into a cluster and to determining each object's cluster membership. In other words, whereas an object in a certain cluster should be as similar as possible to all the other objects in the same cluster, it should likewise be as distinct as possible from objects in different clusters.

Since the objective of this paper is to partition a pre-specified number of countries (OECD members), the researcher implements k-means clustering, in which each country is assigned to the cluster with the nearest mean, serving as a cluster centroid. This method divides the data space into Voronoi cells based on Euclidean distance. Another argument in favor of k-means clustering is that it uses one of the simplest non-hierarchical algorithms. Specifically, the procedure aims at segmenting the data in such a way that the within-cluster variation is minimized. The clustering process starts by randomly assigning countries to a number of clusters. Countries are then successively reassigned to other clusters to minimize the within-cluster variation, which is the squared distance from each observation to the center of the associated cluster. If the reallocation of a country to another cluster decreases the within-cluster variation, this country is reassigned to that cluster.

Prior to analysis, the researcher has to decide on k , the number of clusters. The optimal choice of k will balance between maximum compression (assigning all data to the same cluster) and maximum accuracy (assigning each country to a different cluster). Based on relative literature [8–12] the researcher implemented the “elbow” method in order to determine number of clusters. The clustering analysis is performed several times for a different number of clusters (k), ideally up to the number of observations (n). The Within Groups Sum of Squares (SS) is calculated for each iteration of the analysis. Finally, a plot is created including the SS explained by the clusters, against the number of clusters. The point in which the marginal loss rises, giving an angle (elbow) in the graph, signifies the optimal k . In the present study, this number is $k=3$.

3. Before the crisis

3.1 Total health Expenditure

In the decade preceding the economic crisis, health expenditure was rising significantly across Europe signifying years of continuous growth. In the OECD as a whole, health spending increased, on average, by 3.3% each year in real terms between 2000 and 2008[4]. In nine EU countries (Figure 1), expenditure on health rose steadily since 2000. More specifically, during the same time period, Greece's average annual expenditure growth rate has been 4.7%, while Germany and the USA achieved 2.5% and 2.1% respectively.

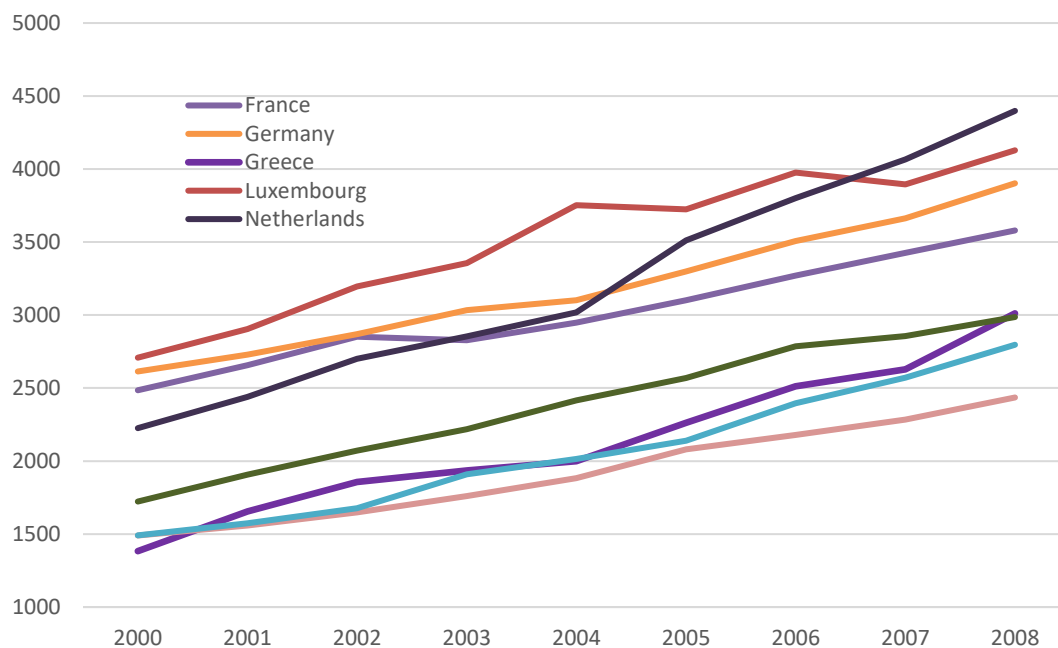


Figure 1: Health Expenditure, selected OECD countries, per capita in US\$ PPP between 2000 and 2008

Source: OECD

Higher income countries tend to devote continuously more resources on health care. However, Greece, having relatively lower income than Germany and Luxemburg, has increased per capita health expenditure by US\$1628 (PPP) or 118% over the period from 2000 to 2008. In the same period, Germany increased its own health expenditure by 49% and Luxemburg by 52%. This could indicate that spending in Greece was continuously rising, due to inefficient administrative or healthcare practices.

In order to clarify this point, the next section investigates the relationship between public and out-of-pocket health expenditure.

3.2 Public and out-of-pocket health expenditure

Before 2008, public health expenditure in OECD countries increased on average by 4.12% annually. In total, 2.3% of household spending within the European Union went towards medical goods and services[13].

As shown in Figure 2, Greece appears to be lower among the selected countries in terms of purchasing power parity. However, Greece actually doubles its per capita public expenditure from US\$852 (PPP) in 2000 to US\$1805 (PPP) in 2008, signifying an increase of 112% over the whole period. During the same years,

Luxemburg respectively increases public spending on healthcare per capita in terms of purchasing power parity by 62%. Nonetheless, Greece's public expenses account for 61.7% of total health expenditure, on average, while Luxemburg's for 83.5%. This could indicate that Greece's increase in total expenditure was mainly supported by significant out-of-pocket payments.

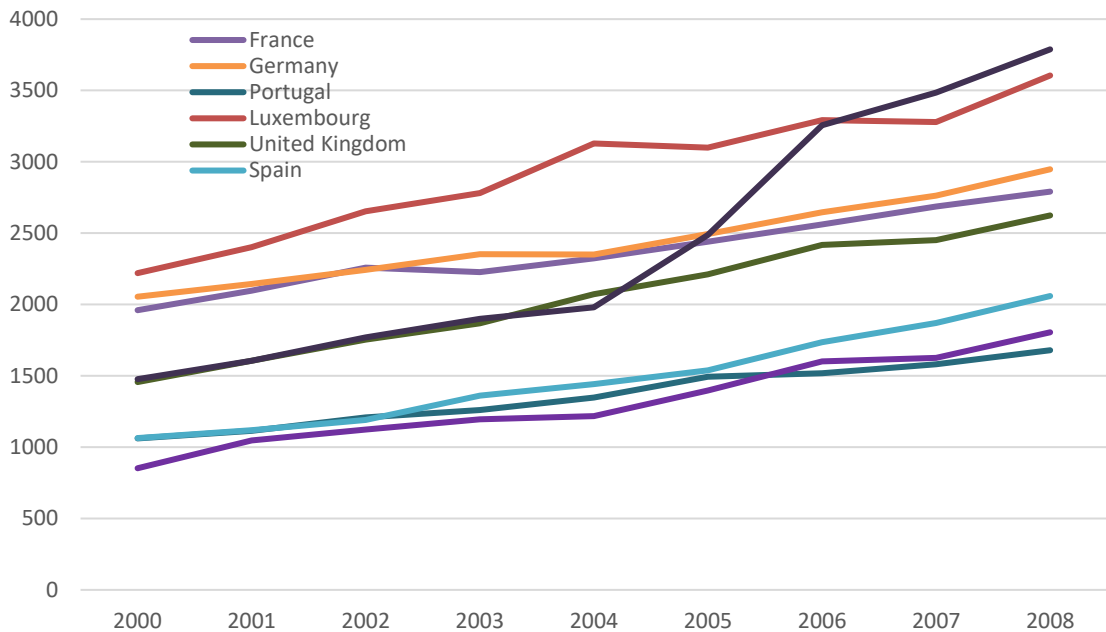


Figure 2: Public expenditure on health, selected OECD countries, per capita in US\$ PPP between 2000 and 2008

Source: OECD

Indeed, as seen in Figure 3, Greece ranks second in per capita OOP health expenditure in 2008. In the same year, many high-income European countries, such as the Netherlands, the United Kingdom and France, are below the OECD average appearing to have very limited private expenditure on healthcare.

Summing up, before 2008, total health expenditure has been rising more rapidly in Greece than in high-income OECD countries. This increase may be attributed to inefficient public healthcare services.

Combined with high out-of-pocket expenditure, this indicates that even though a lot of public resources were devoted to healthcare, citizens tended to avoid public providers either affected by low quality of services or by administrative inefficiencies in public hospitals.

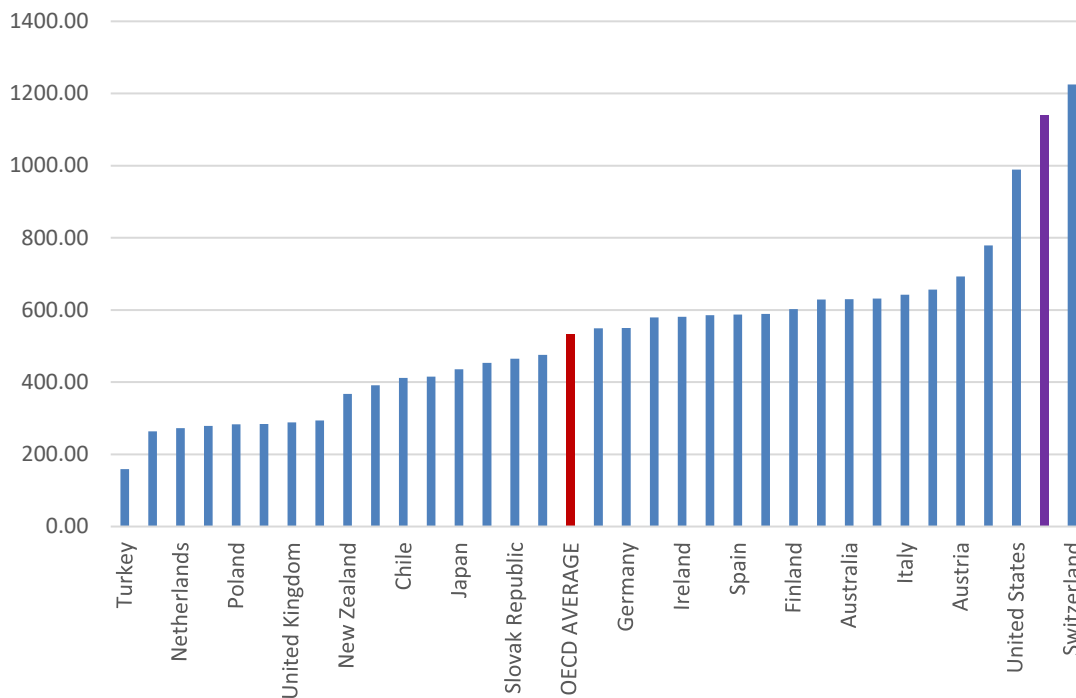


Figure 3: Out-of-pocket health expenditure per capita in US\$ PPP in 2008

Source: OECD

The next section investigates the allocation of healthcare resources in OECD countries and attempts to identify extremes involving Greece.

3.3 HealthCare Resources (doctors, nurses and hospital beds)

An adequate number of doctors is an important factor of access to healthcare. It is also crucial to achieve balance between generalist and specialist doctors, as well as an even distribution in all country regions.

Since 2000, the number of physicians has increased in almost all OECD countries. In 2008 the average number of doctors among country-members of the OECD was 3.1 doctors per 1000 citizens. However, this number has large variations. More specifically, Turkey seems to have much smaller density of doctors historically (1.4 per 1000 population). Greece on the other hand appears to lead with more than 4.5 doctors per 1000 citizens in 2000 (Figure 4). Greece experienced substantial growth of this indicator (40%) in period from 2000 to 2008.

The growth rate has also been very strong in the United Kingdom, although the number of physicians per capita still remains below the EU average.

The uneven distribution of physicians is an important concern in many countries, especially in those with remote and sparsely populated areas. The density of physicians is greater in urban regions, reflecting the concentration of specialized services. Another determinant of this are the physicians' preference to practice in

urban settings. Differences in the density of doctors between predominantly urban regions and rural regions are highest in the Slovak Republic, the Czech Republic and Greece, driven to a large extent by the strong concentration of doctors in the capital (OECD 2016a OECD 2016b;).

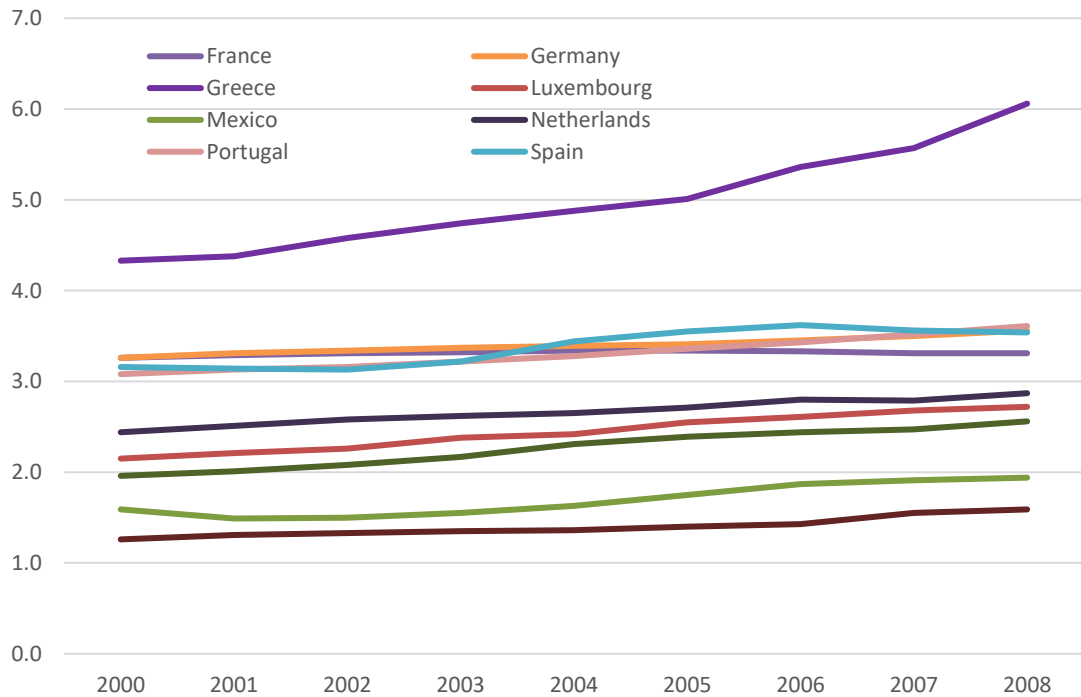


Figure 4: Physicians, density per 1000 citizens, 2000-2008

Source: OECD

In all OECD countries, nurses are the most numerous health professional group. The relevant OECD was about 8.5 nurses per 1000 citizens in 2008.

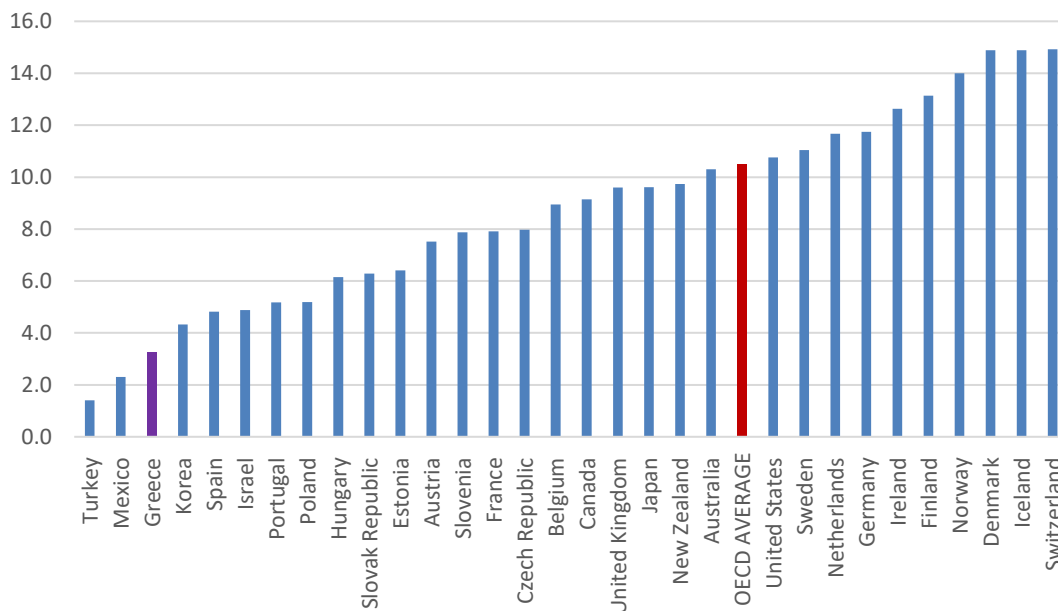


Figure 5: Nurse density per 1000 citizens, 2008

Source: OECD

There are concerns in many countries about current or future shortages of nurses, particularly as the demand for nurses is expected to continue to increase with ageing populations.

Furthermore, the ageing of the “baby boom” generation of nurses itself is expected to lead to the retirement of many nurses in the coming years [14, 15]. Greece had the fewest number of nurses per capita among EU countries (Figure 5).

The number of hospital beds provides an indication of the resources available for delivering services to inpatients. Since 2000, the number of hospital beds per population has decreased in all OECD countries. On average across OECD member states, the number fell from 5.6 beds per 1 000 population in 2000 to 5.1 in 2008.

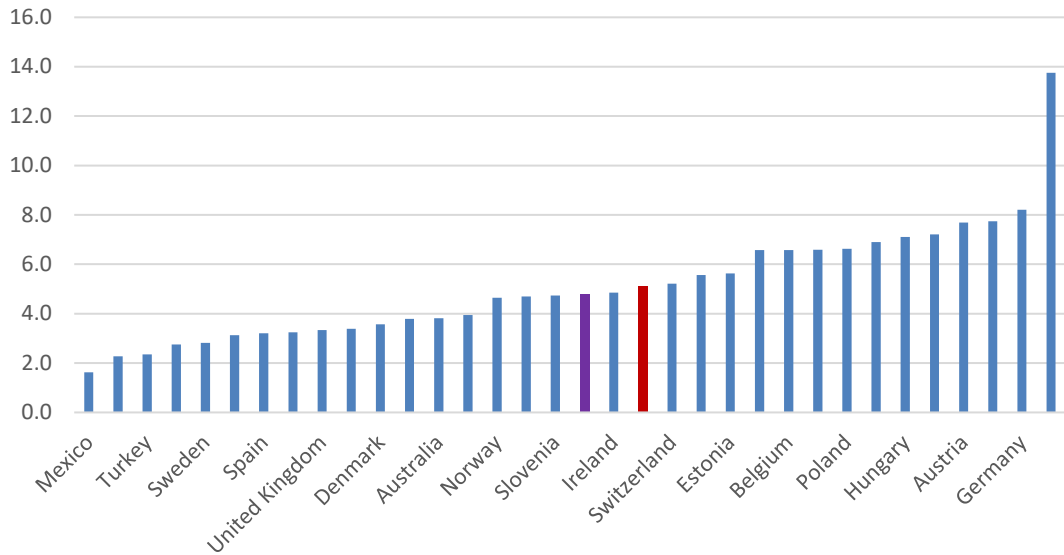


Figure 6: Hospital Beds per 1000 citizens, 2008

Source: OECD

Figure 6 presents data on the total number of hospital beds in OECD countries' hospitals in 2008. Greece ranks near the average with 4.8 hospital beds per 1000 citizens.

3.4 Clustering OECD Countries before the Crisis (2008)

Grouping similar countries is a fundamental economic evaluation activity. While scholars prefer dividing countries based on practical grounds, cluster analysis allows segments to be formed that are based on data that are less dependent on subjectivity. The clustering procedure used in this study is k-means clustering, where $k=3$ as presented in "Methodology". Therefore, the researcher created three clusters of countries, namely A, B and C for the year 2008 in order to represent the situation before the crisis. Table 1 presents summary statistics for all variables used in the clustering model. Expenditure is measured per capita and in US\$ purchasing power parities, while the number of healthcare resources is measured in density per 1000 population.

Table 1: Summary statistics for the first clustering model

Variables	Min.	Max.	Mean	Std. Dev.
Total Expenditure US\$ PPP	827,31	7428,209	2987,56	1391,81
Public Expenditure US\$ PPP	388,8189	4184,2707	2195,22	1021,54
OOP Expenditure US\$ PPP	158,6938	1225,1582	534,78	240,09
Doctors per 1,000 pop.	1,43	6,12	3,06	0,92
Beds per 1,000 pop.	1,63	13,71	5,03	2,39
Nurses per 1,000pop.	0,91	14,92	8,45	3,89

Source: OECD

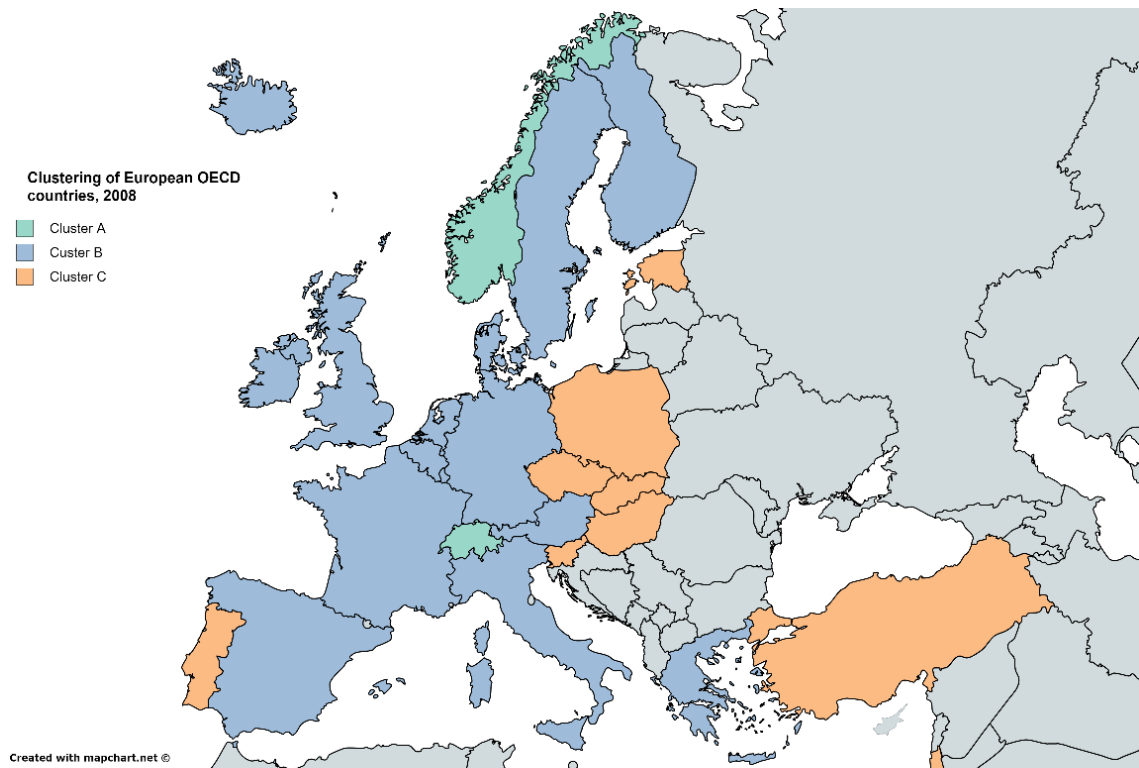


Figure 7: Clustering of European OECD countries (2008), Image created with mapchart.net

Cluster memberships for 2008 are as follows (Figure 7): Cluster A: Norway, Switzerland, United States; Cluster B: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Spain, Sweden, United Kingdom; Cluster C: Chile, Czech Republic, Estonia, Hungary, Israel, Mexico, Norway, Poland, Portugal, Slovak Republic, Slovenia, South Korea, Turkey.

Each cluster's final centers are presented in Table 2. It seems that Cluster A

contains countries that have on significantly larger per capita health expenditures. Furthermore, these three countries appear to have slightly more doctors than the rest and significantly more nurses. On the contrary, they have less beds than countries in the other two clusters. Most European Union country members, including Greece, are assigned to cluster B. They have moderate expenses compared to the other two clusters but they appear to have higher density of hospital beds. Cluster C mostly includes low income countries, such as Mexico, Chile and Turkey, but also Portugal and South Korea.

Table 2: Final Cluster Centers for 2008

	Cluster		
	A	B	C
Total Expenditure	5778,20	3457,02	1546,60
Public Expenditure	3632,59	2699,49	1037,46
OOP Expenditure	997,74	550,15	394,72
Doctors	3,42	3,27	2,65
Nurses	13,23	9,94	4,91
Beds	4,33	5,23	4,88

Source: OECD

4. During the Crisis

4.1 Total health expenditure

Following the economic crisis in 2008, health spending slowed significantly across Europe after years of continuous growth.

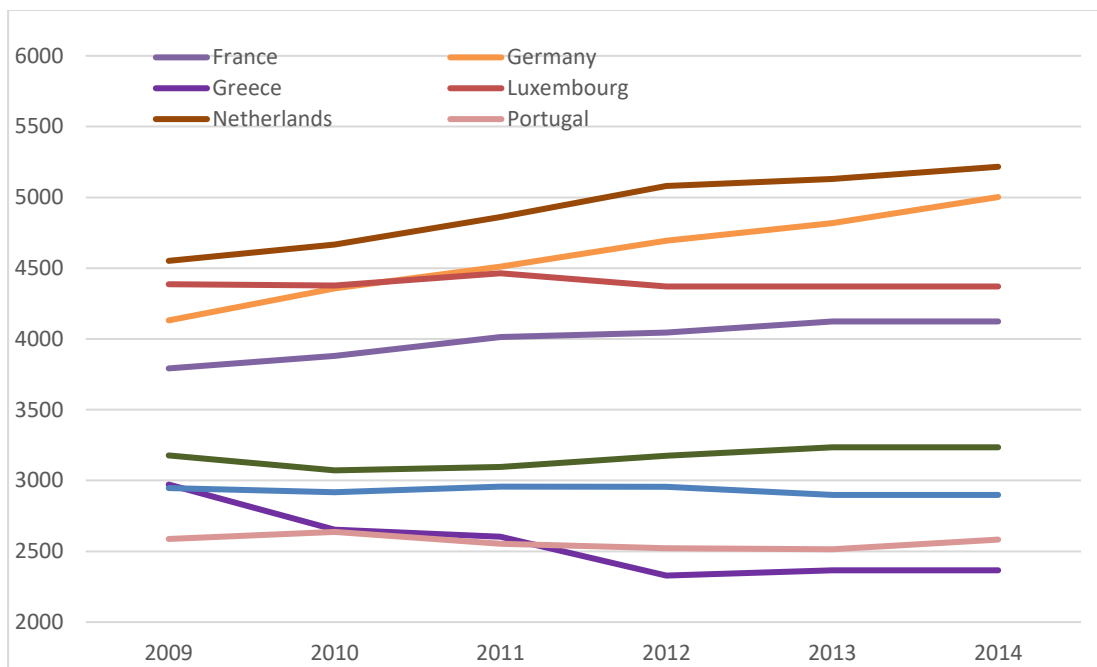


Figure 8: Health Expenditure, selected OECD countries, per capita in US\$ PPP between 2009 and 2014,

Source: OECD

In OECD, as a whole, health spending accounted for 9% of the GDP on average between 2009 and 2014. In many countries, expenditure on health retracted since 2009 whilst it significantly slowed in almost all others (Figure 8). A similar pattern can be seen in the most European countries, although the Netherlands have seen equally high health spending growth in the years since 2009 compared with the previous period. Spending more than US\$ 4500 per person, Luxembourg was by far the biggest spender in the European Union. Among the other EU member states, Germany and the Netherlands were the highest spenders. Considering the OECD as a whole, per capita health spending was US\$ 3682 in 2014.

On a per country basis, Greece completely reversed its health spending growth. Over the years before 2008, per capita health spending had been growing by about 4.5% annually. In the context of reducing public budgets, Greek health spending has seen an average annual reduction of 6.6% since 2009.

4.2 Public out-of-pocket health expenditure

As shown in Figure 9, Greece remained lower than the average among OECD countries in terms of purchasing power parity. Moreover, Greece manages to decrease its per capita public expenditure from US\$2064 (PPP) in 2009 to US\$1324 (PPP) in 2014 or -35% over the whole period. During the same years, most European countries continue to increase their public health expenditure, albeit slowly.

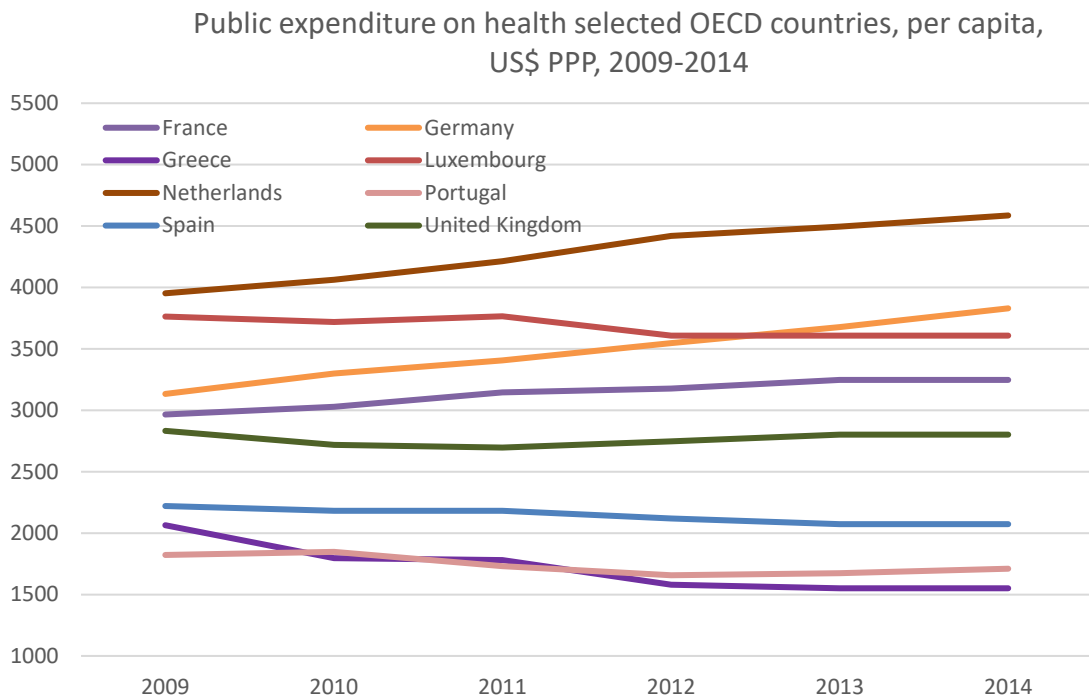


Figure 9: Public expenditure on health, selected OECD countries, per capita in US\$ PPP between 2009 and 2014
Source: OECD

Greece's decline should be accredited to recent memorandum policies which affected all public budgets, including health. Hospitals were redeployed into Trusts and the largest Health Insurance Funds were merged into a single purchaser in order to exploit economies of scale, both in supply and demand. The establishment of the DRG reimbursement system offered the opportunity to improve the pricing procedure of health care services. Moreover, the advancement of public hospitals' infrastructure and technology contributed further to expenditure reductions[16].

On the other hand, Greece remains over the OECD average concerning out-of-pocket payments, as seen in Figure 10. Even though OOP payments have been drastically reduced, mainly due to pharmaceutical pricing reforms, Greek households' OOP healthcare payments account for 4.4% of their total consumption. This share is only surpassed by Bulgaria, Malta and Cyprus in the EU.

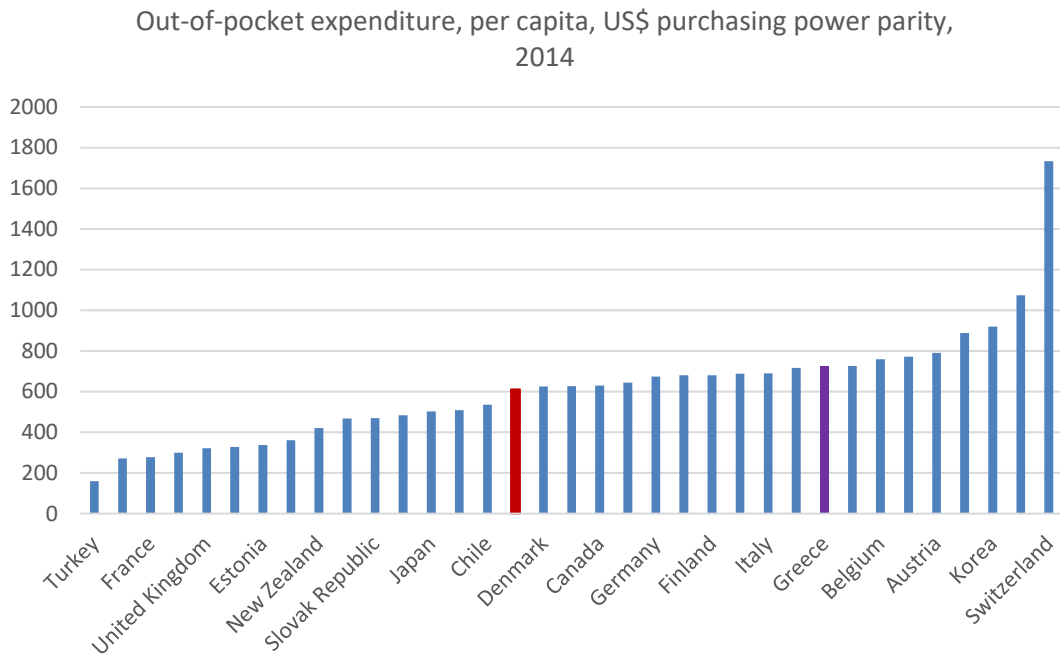


Figure 10: Out-of-pocket health expenditure per capita in US\$ PPP in 2014

Source: OECD

4.3 Healthcare resources (doctors, nurses and hospital beds)

As presented in Section 3.3 the increase in the number of doctors per capita was particularly rapid in Greece between 2000 and 2008. Since the beginning of the crisis, the density of doctors has been stabilized around 6.3 per 1000 citizens, remaining the highest among OECD countries (Figure 11). However, this number may be an over-estimation, since it includes all doctors licensed to practice [17].

Following Greece is Austria with 5.1 doctors per 1 000 population. Doctor density was lowest in Poland and Romania. The growth had been very strong in the United Kingdom, although the number of physicians per capita still remains below the OECD average. Whereas the overall number of doctors per capita has increased in nearly all countries, the share of generalists has come down in most countries. On average across EU countries, generalists made up only about 30% of all physicians in 2014.

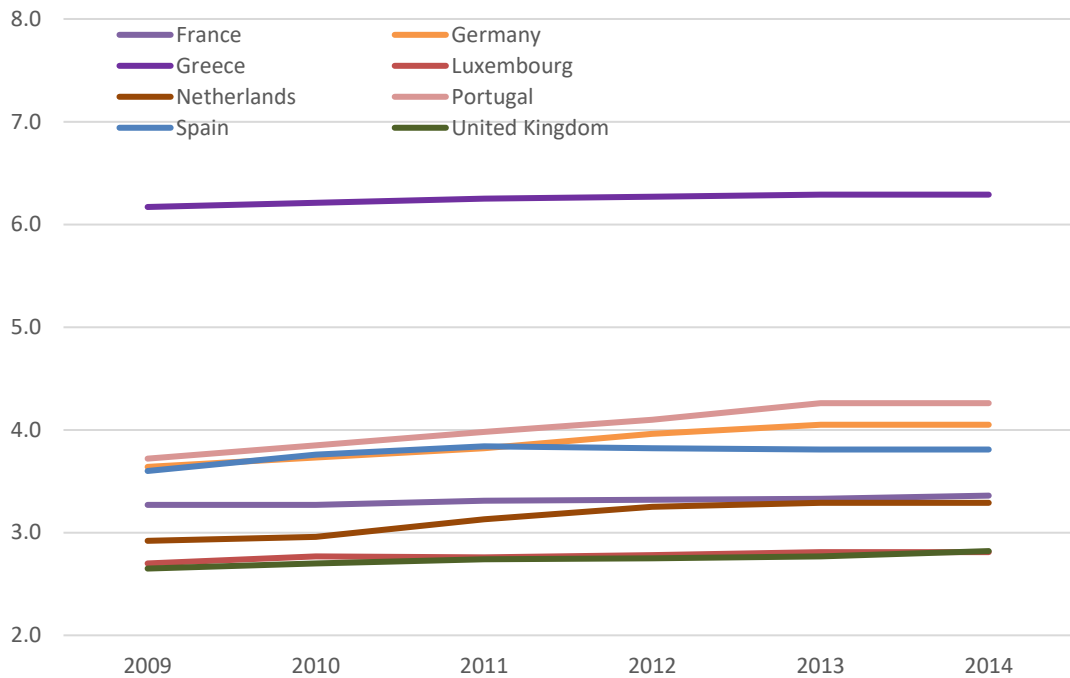


Figure 11: Physicians per 1000 citizens, 2009-2014 Source: OECD

On average across OECD countries there were 9.7 nurses per 1000 population in 2014 (Figure 12). The number of nurses per capita was highest in Switzerland, Portugal, Denmark, and Norway. In other countries, such as France, Italy, Luxembourg and Spain, there is large number of health care assistants which provide assistance to professional nurses. Greece still seems to have the fewest nurses per capita.

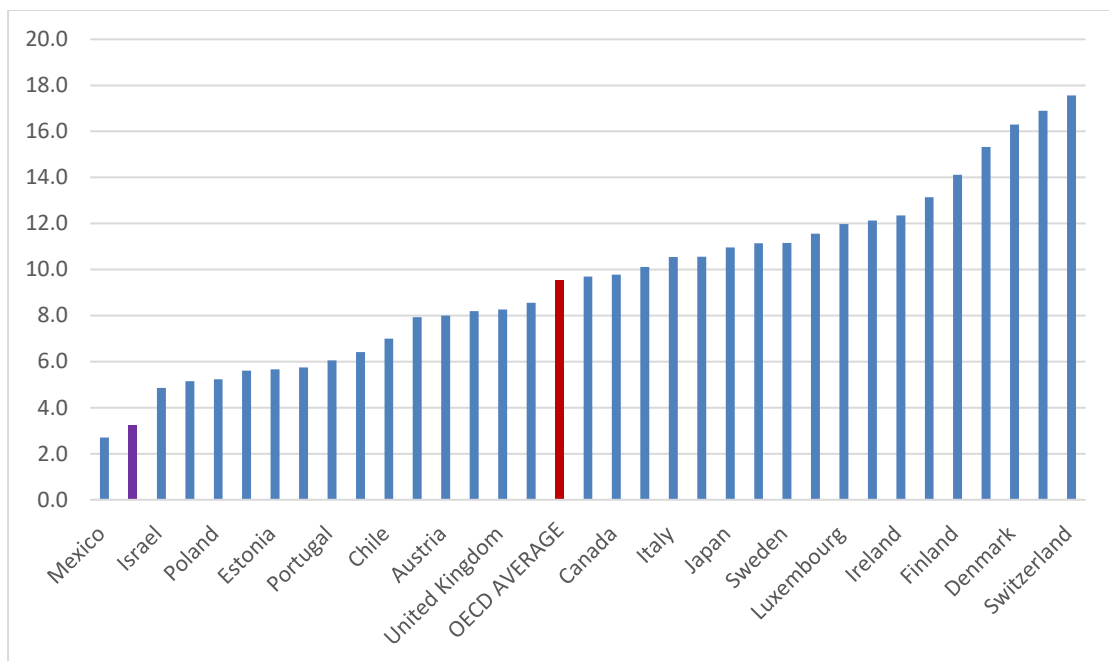


Figure 12: Nurse density per 1000 citizens, 2014, Source: OECD

In all countries, progress in medical technologies has enabled a move to same-day surgery and a reduced need for long hospitalization. In many countries, the financial and economic crisis also provided a further stimulus to reduce hospital capacity as part of policies to reduce public spending on health [18, 19].

Japan, Korea and Germany had the highest number of hospital beds per capita in 2014 (Figure 13). The relatively high supply of hospital beds in Germany is related to the large number of hospital admissions/discharges, as well as long average length of stay. Nonetheless, Sweden, Ireland, the United Kingdom and Denmark had a relatively low number of hospital beds.

The number of beds in public hospitals has decreased in most OECD countries since 2008. In some countries, such as Germany, this was accompanied by an increase in the number of beds in private hospitals [6, 7]. Greece remained stable since 2008, with about 4.8 beds per 1000 population.

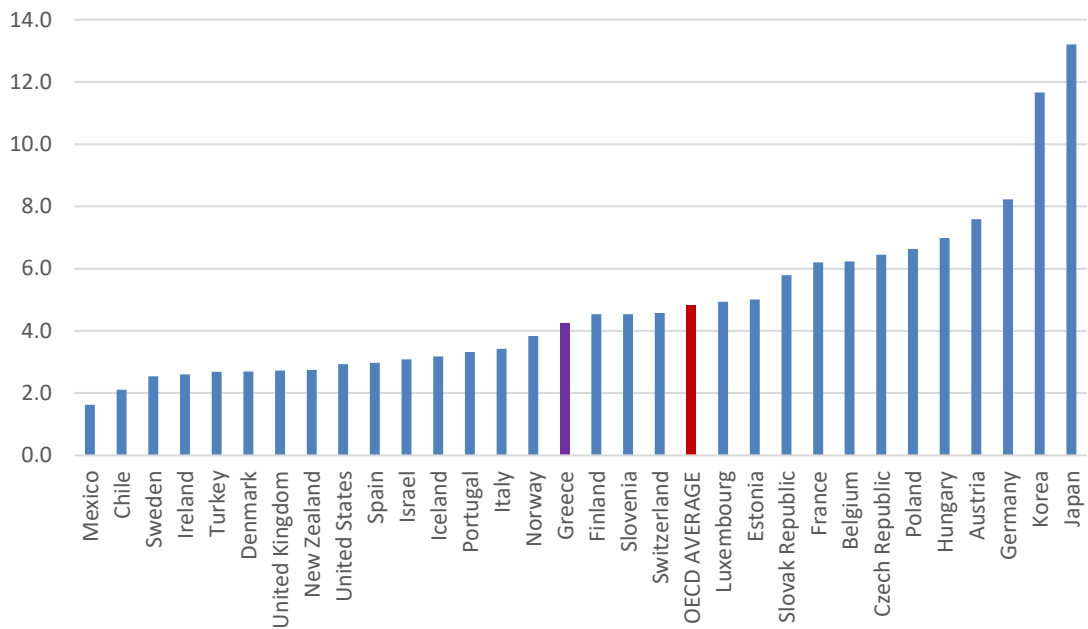


Figure 13: Hospital Beds per 1000 citizens, 2014

Source: OECD

4.4 Clustering OECD countries after the crisis (2014)

Following the same methodology and variables used in Chapter 3, the researcher created three groups of countries, named A, B and C for the year 2014. Summary statistics for all model variables are presented in Table 3.

Cluster memberships for 2014 are as follows: **Cluster A:** Netherlands, Norway, Switzerland, United States; **Cluster B:** Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Luxembourg, New Zealand, Sweden, United Kingdom; **Cluster C:** Chile, Czech Republic, Estonia, Greece, Hungary, Israel, Mexico, Norway, Poland, Portugal, Spain, Slovak Republic, Slovenia, South Korea, Turkey.

Table 3: Summary statistics for the second clustering model

Variables	Min.	Max.	Mean	Std. Dev.
Total Expenditure US\$ PPP	941,20	8713,35	3452,73	1650,05
Public Expenditure US\$ PPP	535,87	4980,78	2535,98	1209,20
OOP Expenditure US\$ PPP	159,31	1629,84	600,74	272,34
Doctors per 1,000 pop.	1,76	6,29	3,27	0,93
Beds per 1,000 pop.	1,61	13,32	4,76	2,53
Nurses per 1,000pop.	1,83	17,36	9,09	4,09

Source: OECD

Figure 14 presents cluster membership for European OECD countries. It seems that the Netherlands have shifted from the second to the first cluster, which contains as in 2008 countries with bigger health expenditures, more doctors and nurses and less beds than others.

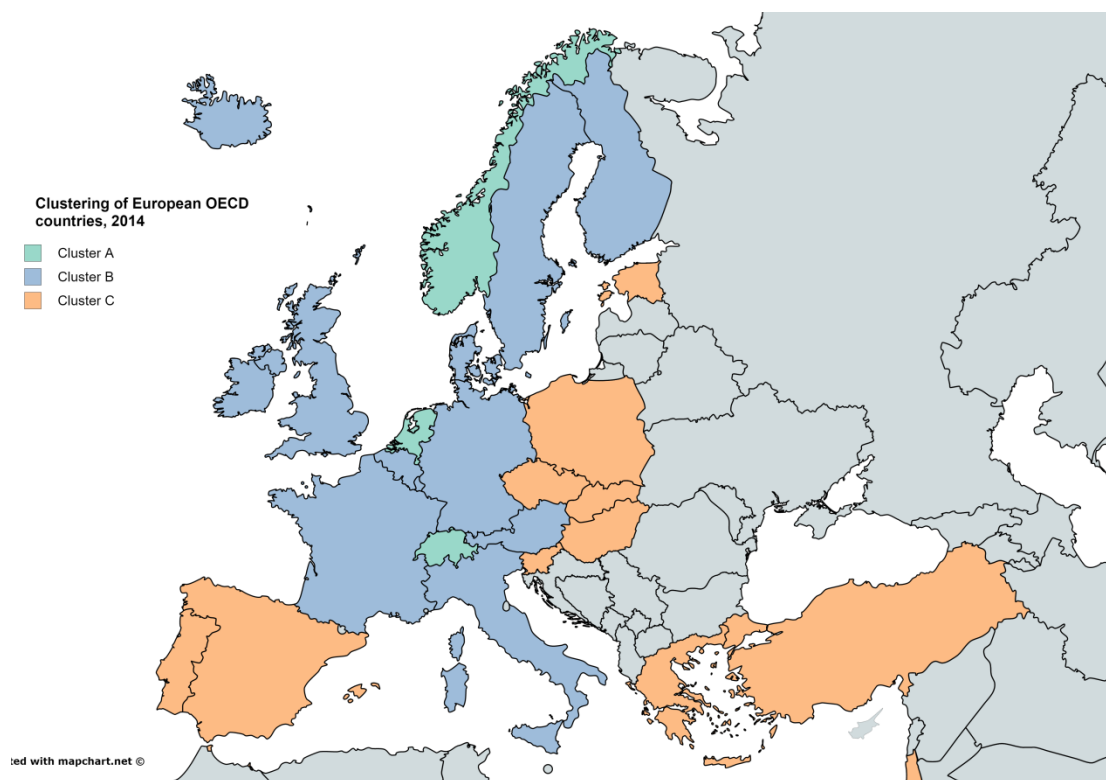


Figure 14: Clustering of European OECD countries (2014), Image created with mapchart.net

On the other hand, Greece and Spain have shifted towards the third cluster, since their healthcare data now seem to align more with countries such as Portugal,

Turkey, Chile and Mexico. Table 4 includes final centers for all clusters. Compared to Table 1, all clusters have increased their total healthcare expenditure. However, possibly because of the crisis, countries belonging to cluster C have significantly higher out-of-pocket payments per capita (US\$ 104 PPP). Furthermore, these countries appear to have increased the number of doctors since the beginning of the crisis.

Countries in group C have less expenses compared to the other two clusters, as well as less doctors and nurses. Greece and Spain have decreased their expenditures, mainly due to recent memorandum policies. This resulted in a shift of clusters, as the rest of the countries belonging to cluster B went on increasing their healthcare budgets and resources.

Table 4: Final Cluster Centers for 2014

	Cluster		
	A	B	C
Total Expenditure	6507,97	3995,71	1959,24
Public Expenditure	4462,85	3122,30	1315,35
OOP Expenditure	957,18	600,13	499,58
Doctors	3,55	3,30	3,16
Nurses	14,33	11,05	5,35
Beds	4,03	4,92	4,79

Source: OECD

5. Discussion

Part of this study's aims, as described in the introductory chapter, was to explore the impact of the economic crisis on health expenditure in OECD countries, focusing on Greece. Additionally, the researcher explored the possibility that Greece limited its healthcare resources so drastically that it is now closer to poorer countries, such as Turkey and Mexico, than to fellow EU members.

As far as the first objective is concerned, we noticed that health spending slowed significantly across most European countries. However, high-income countries such as Luxemburg, the Netherlands and Germany continued spending increasingly larger sums per capita. On the other hand, countries that were hard hit by the economic crisis, had to decrease their rate of spending. This resulted in a stabilization in the number of doctors per capita, especially in Greece where that number was rising steadily. Nonetheless, the average number of doctors in 2014 is double than it was in 2008 across all OECD countries. Nurses saw minimal increase during the crisis while hospital bed density was actually reduced.

The second scale of the analysis investigates the clustering of OECD countries in homogenous groups based on health expenditure and three healthcare resource indicators, namely the density of doctors, beds and nurses per 1000 population units. Two clustering models are formed each representing the periods before and

during the crisis. In the first model, based in 2008, most European countries belong in the same group, characterized by moderate expenditures and being in neither extreme regarding healthcare resources. Portugal however appeared to be in the upper end of the third group, which, among others, contained developing countries such as Mexico and Turkey. The second clustering, in 2014, showed that during the crisis some countries shifted between groups. The Netherlands increased their expenditure drastically, however this is only one of the unusual facts about the country's health indicators [20]. On the contrary, Greece and Spain shifted from the second to the third group, joining Portugal. This is indicative of the financial situation in these two countries during the crisis. They experienced important sovereign debt and banking issues, and on this basis, they had to implement major reforms. Greece's reforms in the healthcare sector included redeployment of hospitals, merging of all major health insurance funds into a single purchaser of services and improved pricing of healthcare services through diagnosis-related group reimbursement system. Furthermore, even though the number of physicians per capita was increased by 40% before the crisis, it was stabilized in the following years.

The reallocation of resources would improve the efficiency of the system. Such reforms could include the gradual decrease in the number of doctors followed by subsequent increase in the number of nursing staff. Emphasis should also be placed in increasing managerial and organizational reforms, so that the benefits of technological improvements would create a continuing positive impact in the future.

It has not been possible to include variables regarding the outcome of health services, such as mortality rates, number of surgeries or diagnostic tests and life expectancy, as this would exceed the purpose of the present essay. However, it would be of interest to re-organize the clustering procedure including some of the above variables, as it would provide more detailed information on OECD countries' health systems.

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