Η κατανομή της δαπάνης για την Υγεία στην Ελλάδα και στις χώρες του ΟΟΣΑ μέσω της τεχνικής Συσταδοποίησης (Clustering)

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Achieving **economic growth** is believed to be largely dependent on the **health of the population**.

According to Sachs et al. (2001), 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.

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.**

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%** (Xu et al., 2011).

The **purpose** of this presentation (which is a part of an ongoing study in the University of Piraeus and the University of Athens) 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 (Communities, 2014; OECD, 2016b)

In the next slides of this presentation we briefly explain:

- The **methodology**.

- **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.

- **section 3** discusses **public resource allocation** to health care services before the crisis including **descriptive statistics** and **the first clustering process** (2008)
- **Section 4** assesses the **situation during the crisis** implementing the **second clustering process** (2014) and **graphic analysis**.

Final section **summarizes and discusses the main results** of the 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(OECD, 2016b).

Furthermore, mainly for **descriptive purposes**, data from the **Eurostat Health Database** (Communities, 2014) are used.

Cluster analysis was performed using the following variables:

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

2.2 CLUSTER ANALYSIS

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.

Next step is 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), we implement **k-means clustering**, in which each **country is assigned to the cluster with the nearest mean,** serving as a **cluster centroid (κέντρο βάρους).**

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.

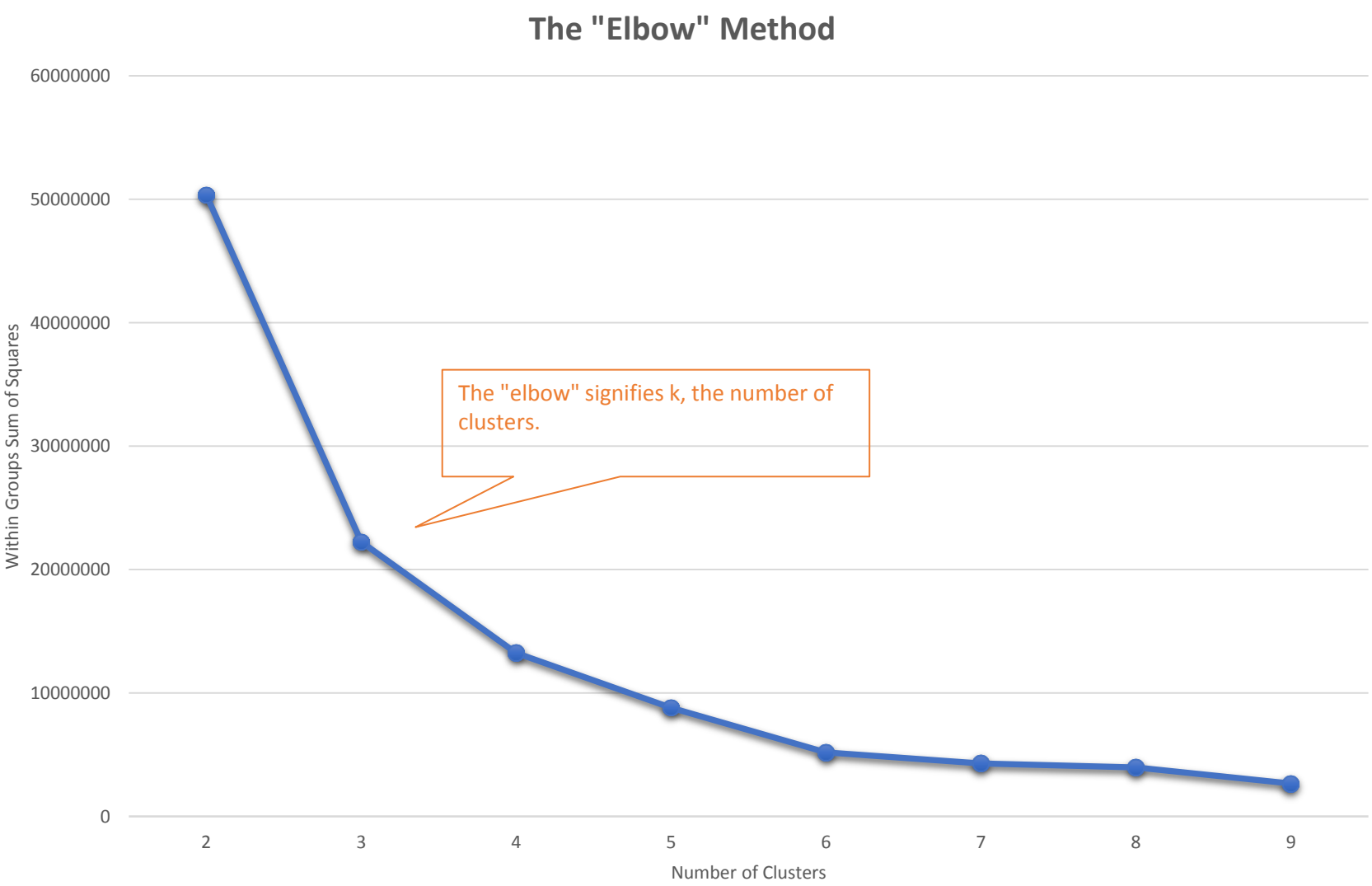
If the reallocation of a country to another cluster decreases the within-cluster variation, this country is reassigned to that cluster.

- **Prior to analysis**, the researcher has to decide on k, the **number of clusters**.

- The optimal choice of k will balance between maximum compression (συμπίεσης) (assigning all data to the same cluster) and maximum accuracy (assigning each country to a different cluster).

- Based on **relative literature** (Kodinariya and Makwana, 2013; Salvador and Chan, 2004) *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 (Figure 1).
- The point in which the marginal loss (οριακή απώλεια) rises, giving an angle (elbow) in the graph, signifies the optimal k. In the present study, this number is k=3.


The "Elbow" Method
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50000000
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30000000
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0
Within Groups Sum of Squares
The "elbow" signifies k, the number of clusters.
2
3
4
5
6
7
8
9
Number of Clusters

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(OECD, 2016a).

In nine EU countries (Figure 2), 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.

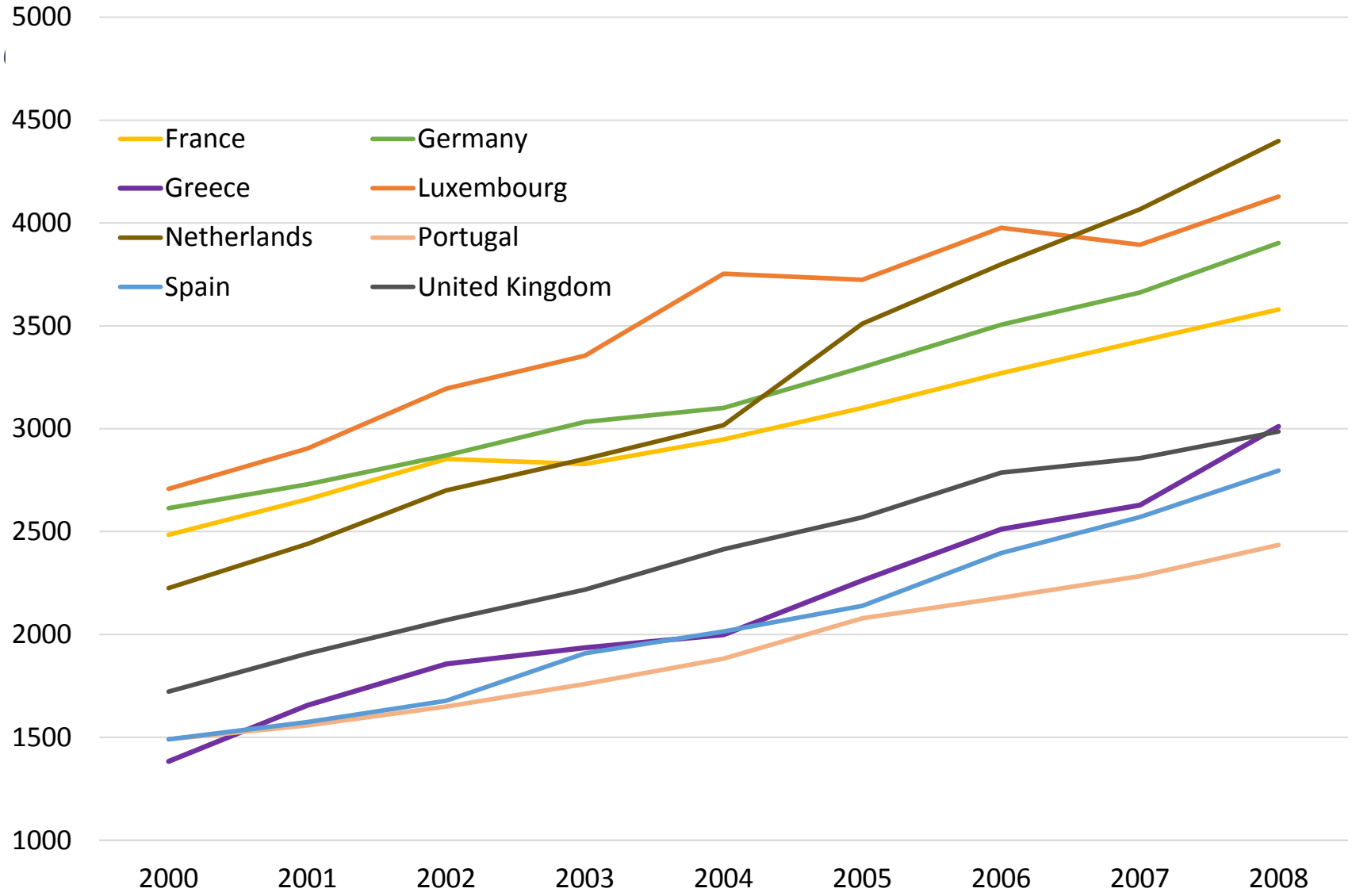

Figure 2: Health Expenditure per capita in US$ PPP between 2000 and 2008, Source: OECD

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(Eurostat, 2014).

As shown in Figure 3, **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.

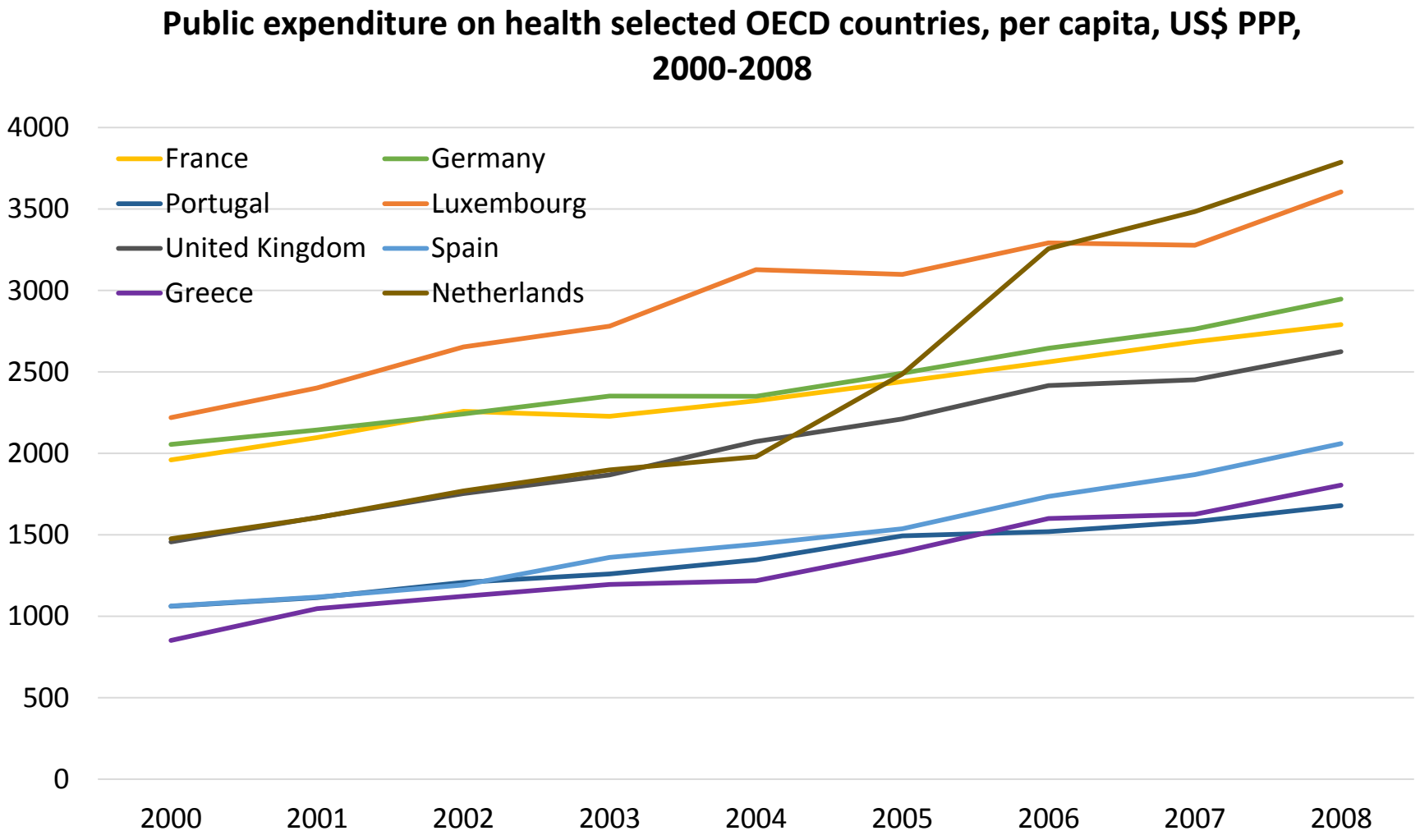

Figure 3:Public expenditure on health per capita in US$ PPP between 2000 and 2008, Source: OECD

Indeed, as seen in Figure 4, **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.

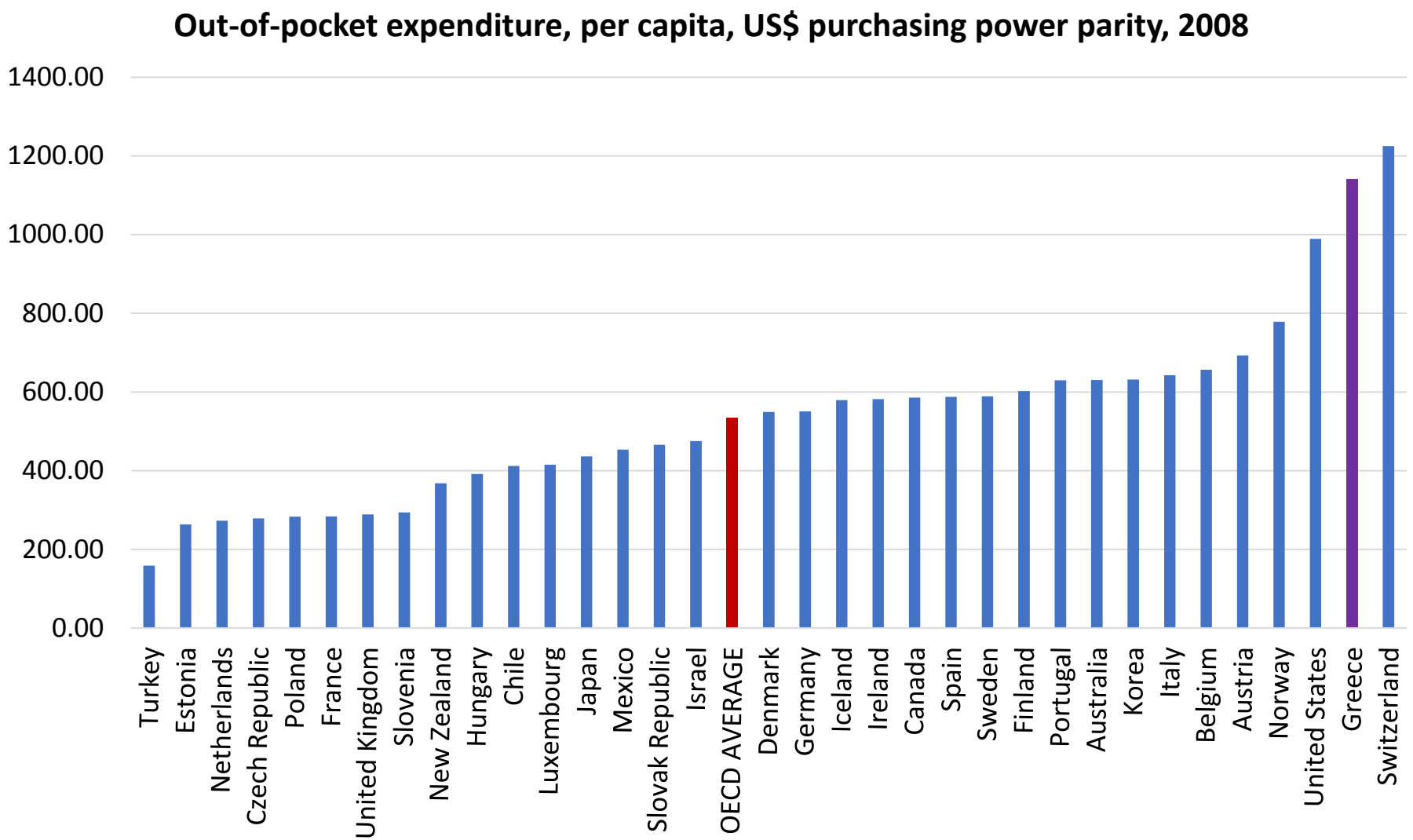

Figure 4:Out-of-pocket health expenditure per capita in US$ PPP in 2008, Source: OECD

3.3 HEALTHCARE RESOURCES (DOCTORS, NURSES AND HOSPITAL BEDS)

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

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 5), showing 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;).

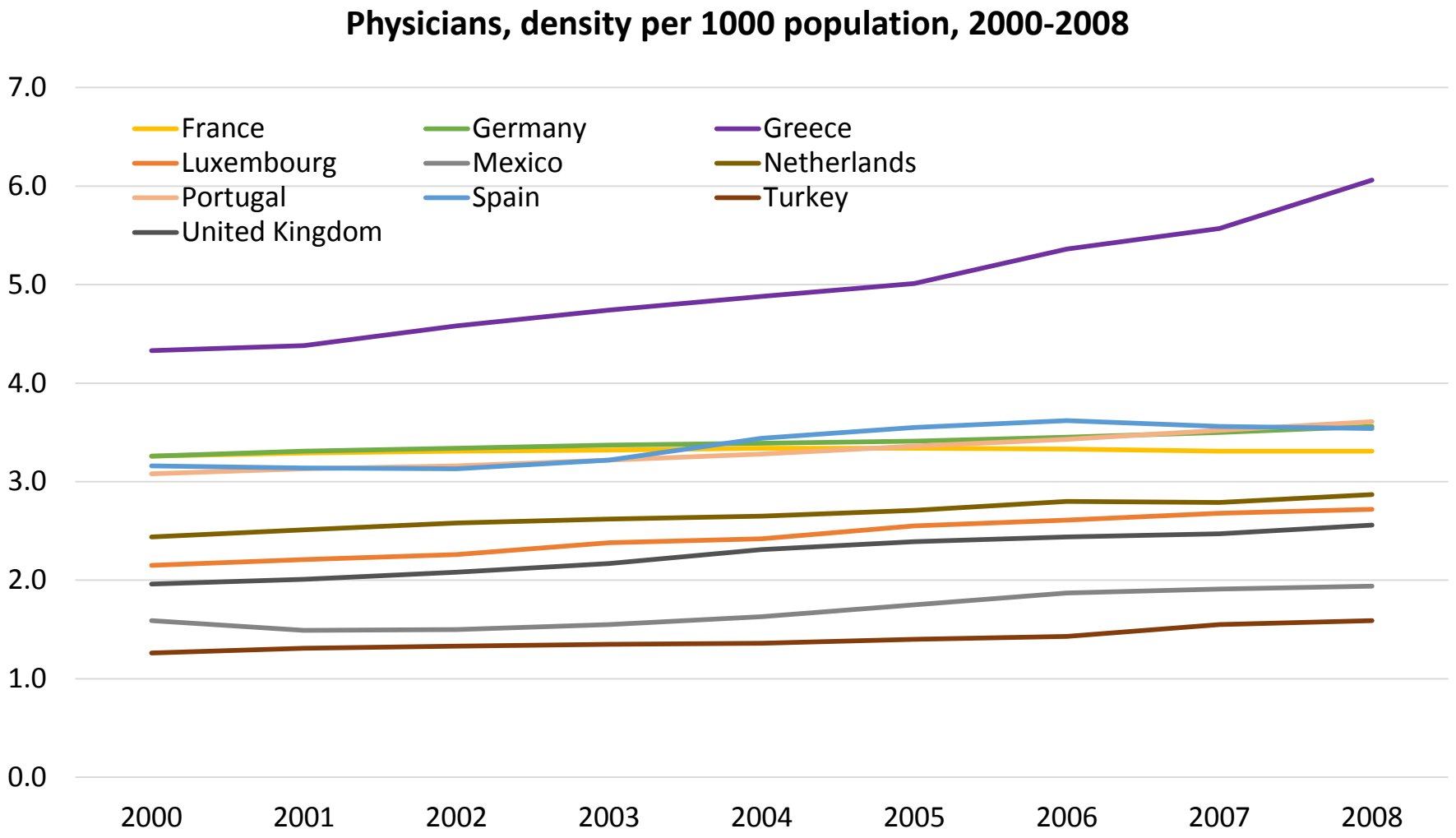

Figure 5:Physicians per 1000 citizens, 2000-2008, Source: OECD

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.

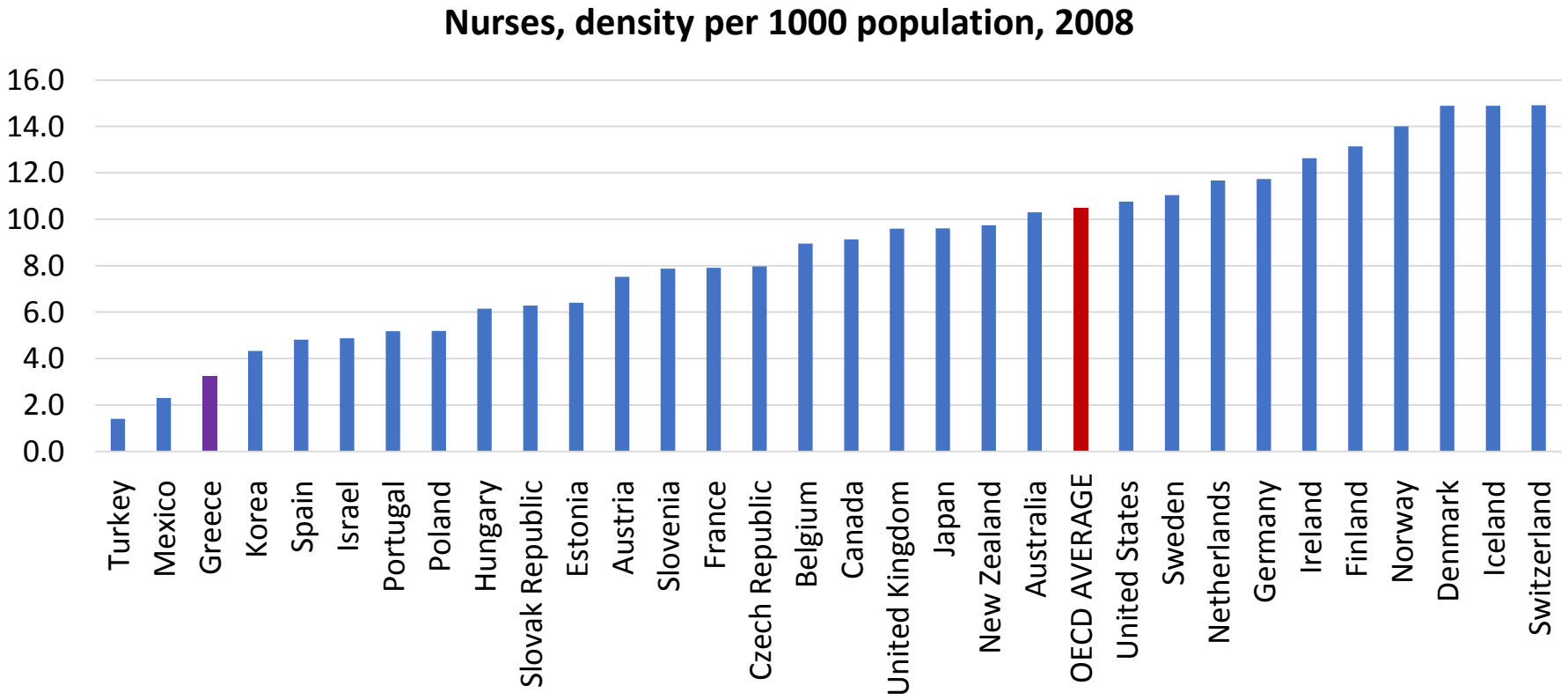

Figure 6: Nurse density per 1000 citizens, 2008, Source: OECD

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(Dean, 2009; McDermid et al., 2012). Greece had the fewest number of nurses per capita among EU countries (Figure 6).

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

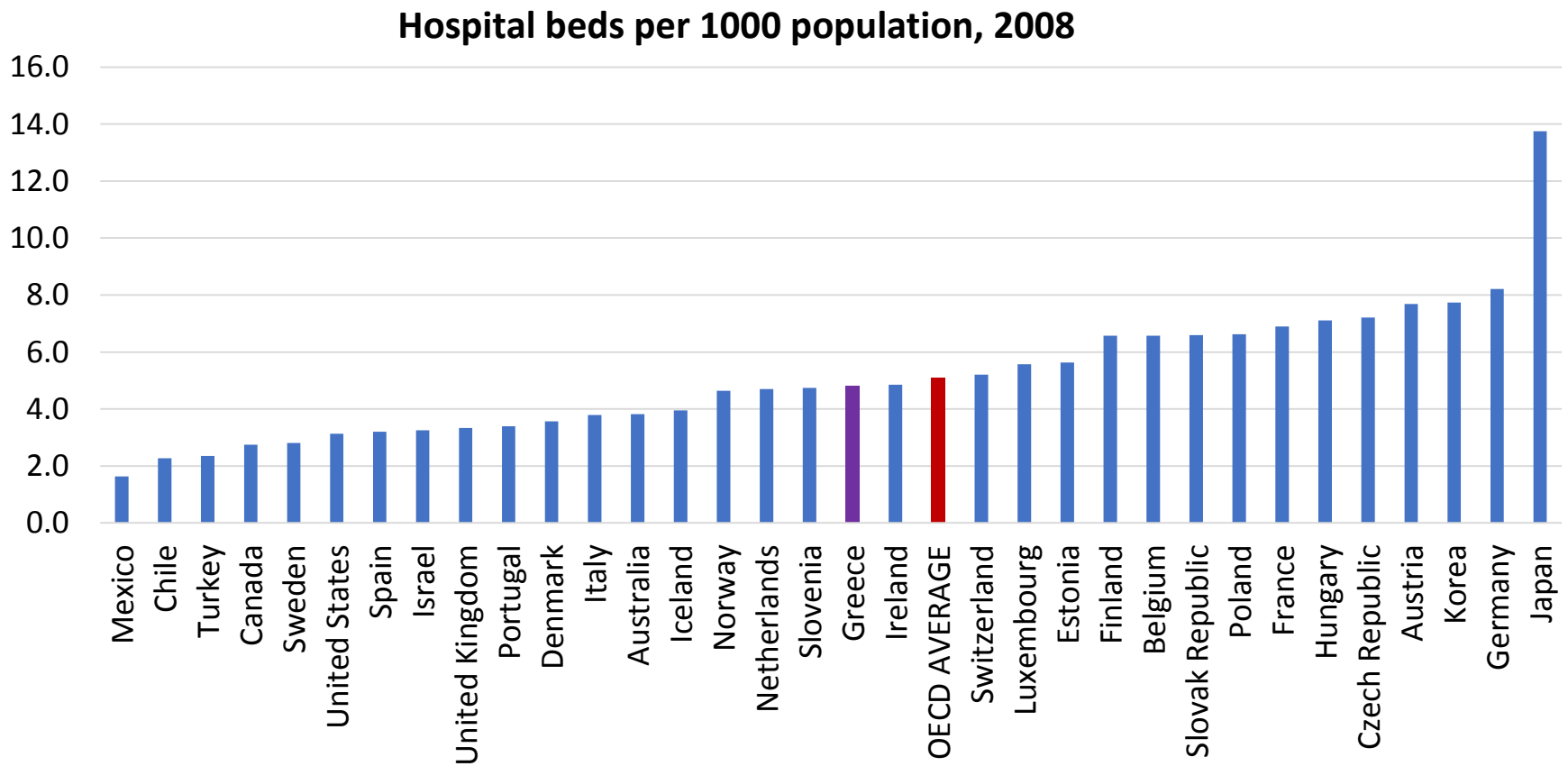

Figure 7:Hospital Beds per 1000 citizens, 2008, Source: OECD

Figure 7 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

Cluster memberships for 2008 are as follows (Figure 8):

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.

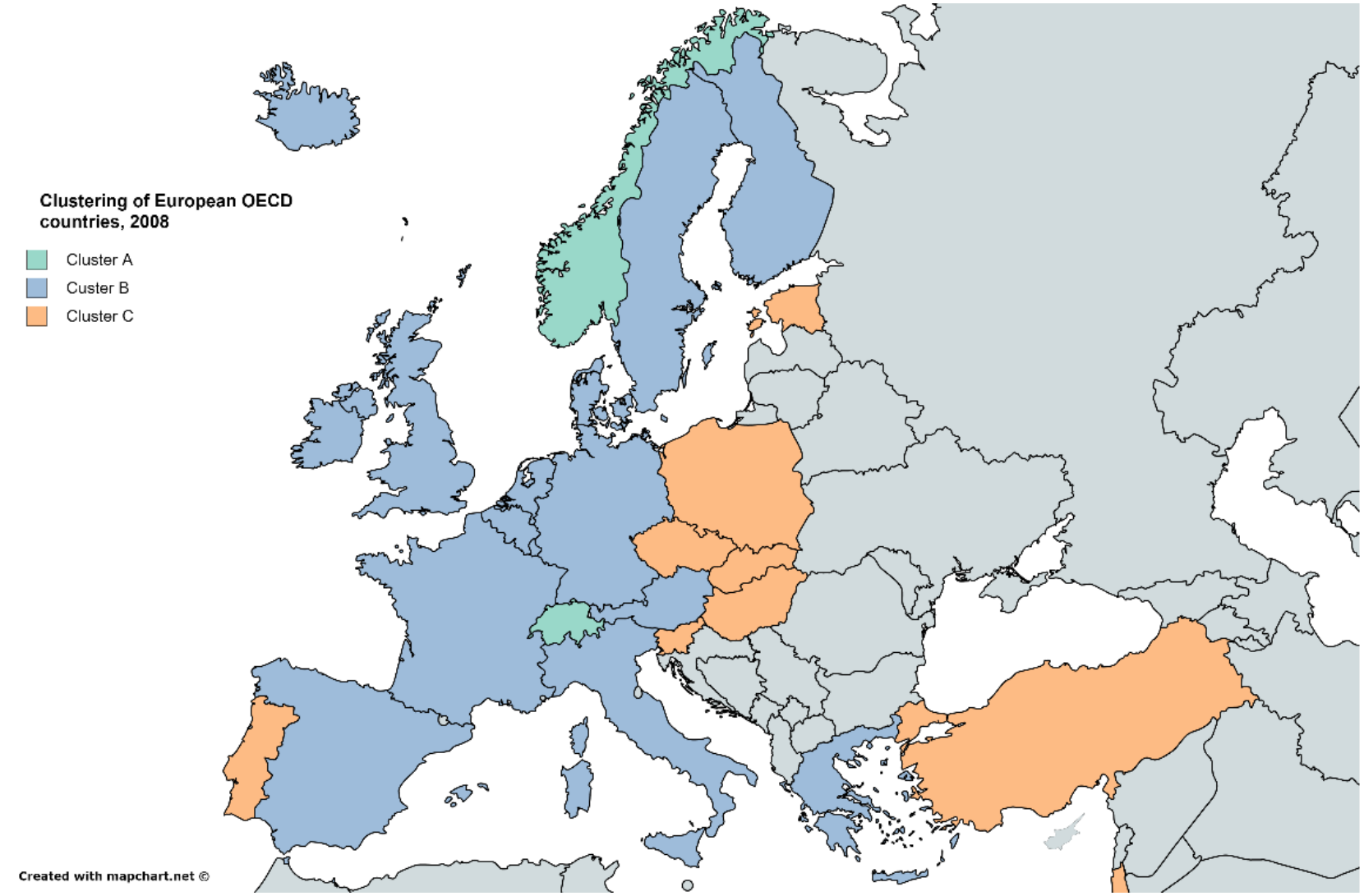

Figure 8: Clustering of European OECD countries (2008), Image created with mapchart.net

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.

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 9).

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.

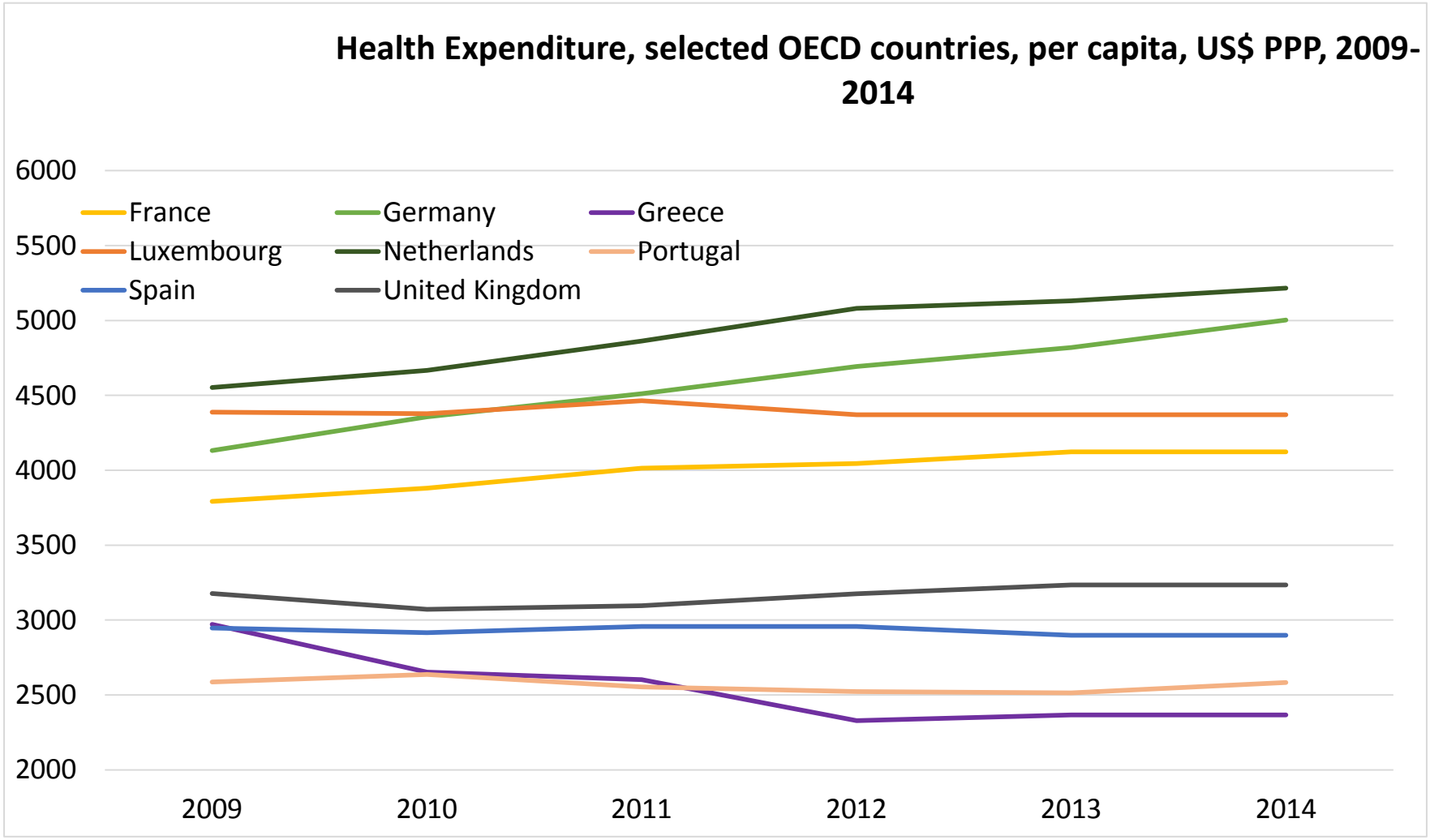

Figure 9: Health Expenditure per capita in US$ PPP between 2009 and 2014, Source: OECD

4.2 PUBLIC AND OUT-OF-POCKET HEALTH EXPENDITURE

As shown in Figure 10, **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.

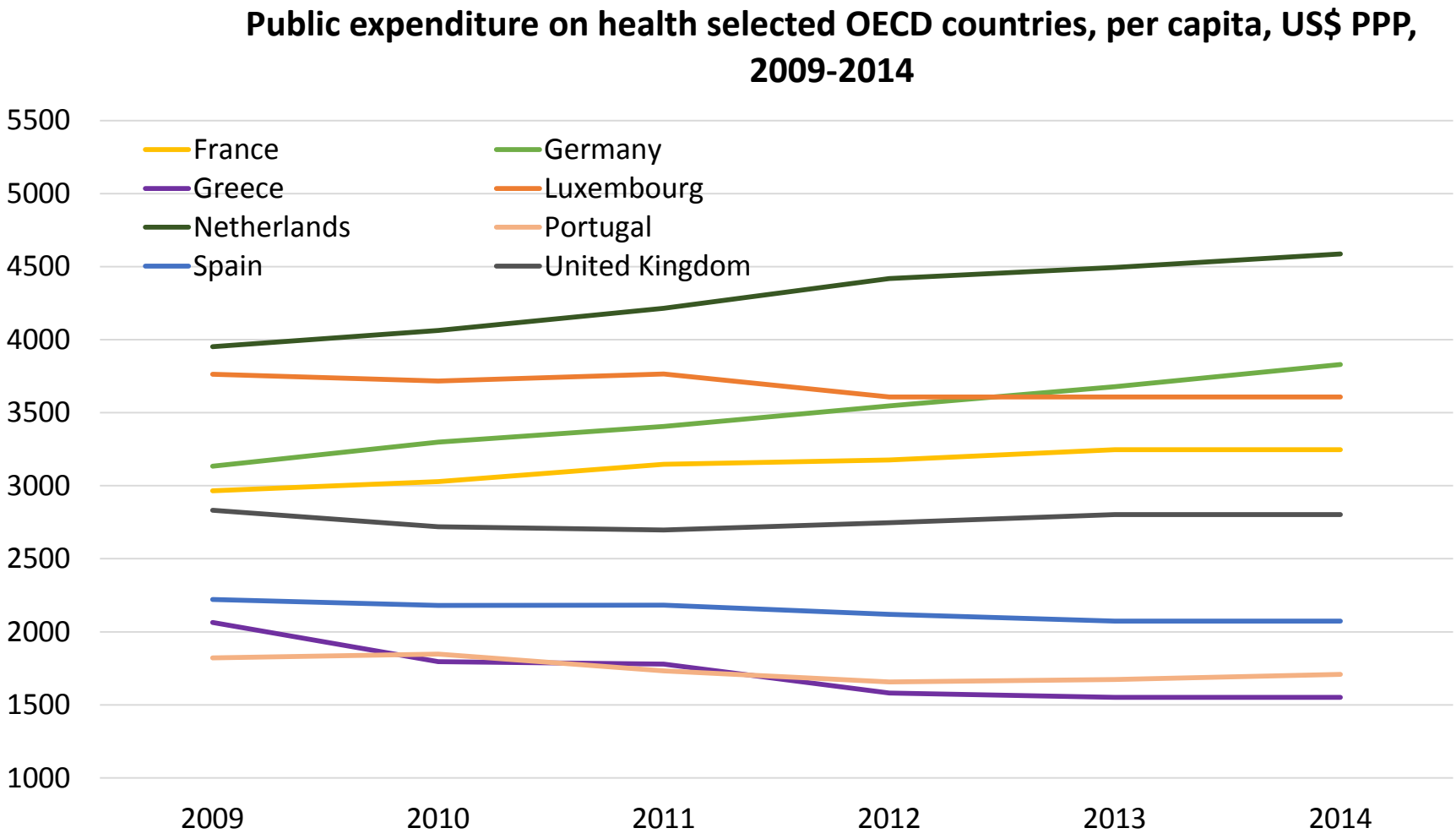

Figure 10:Public expenditure on health per capita in US$ PPP between 2009 and 2014, Source: OECD

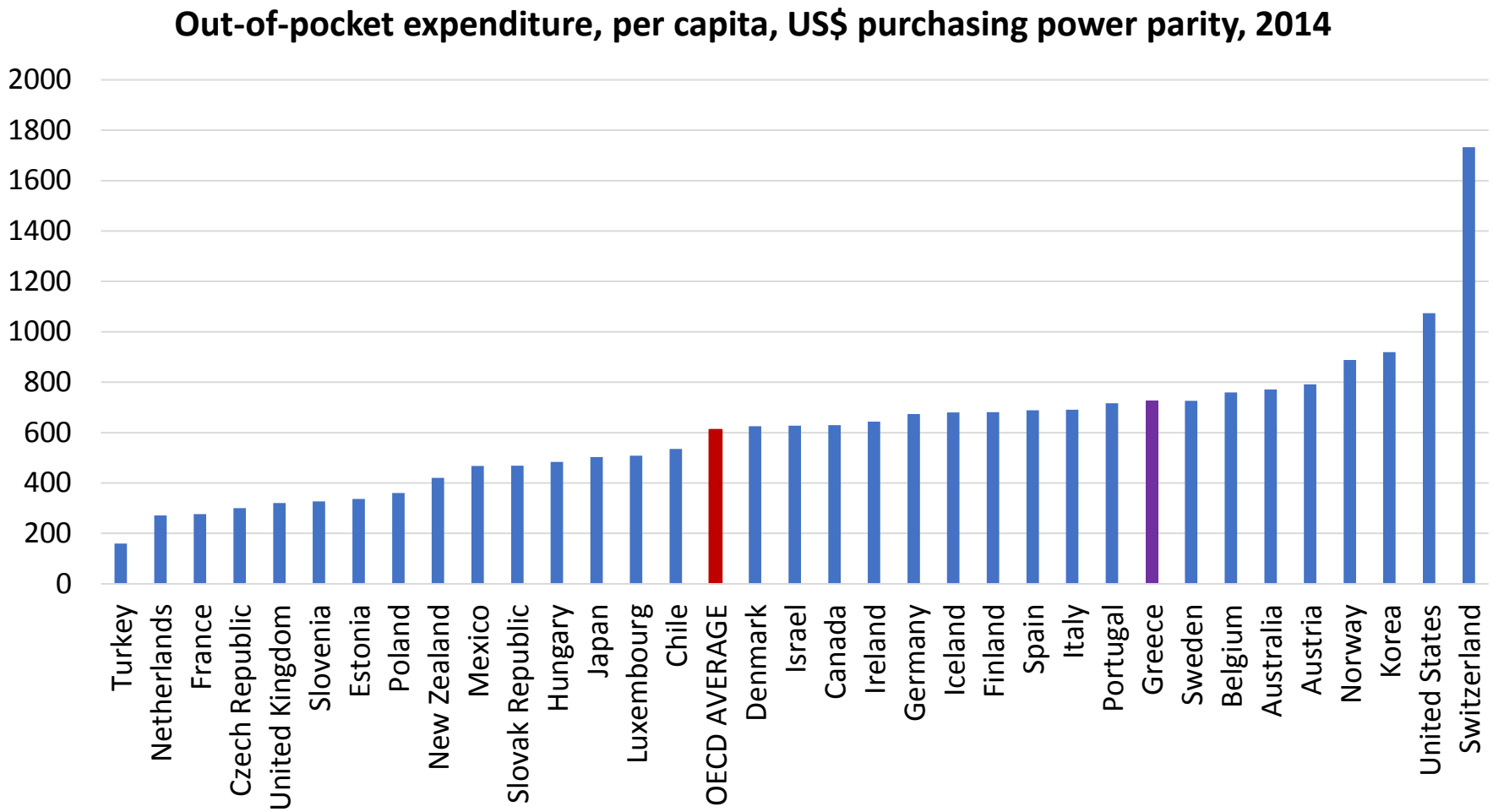

Figure 11:Out-of-pocket health expenditure per capita in US$ PPP in 2014, Source: OECD

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 12).

However, this number may be an over-estimation, since it includes all doctors licensed to practice (OECD, 2016c).

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

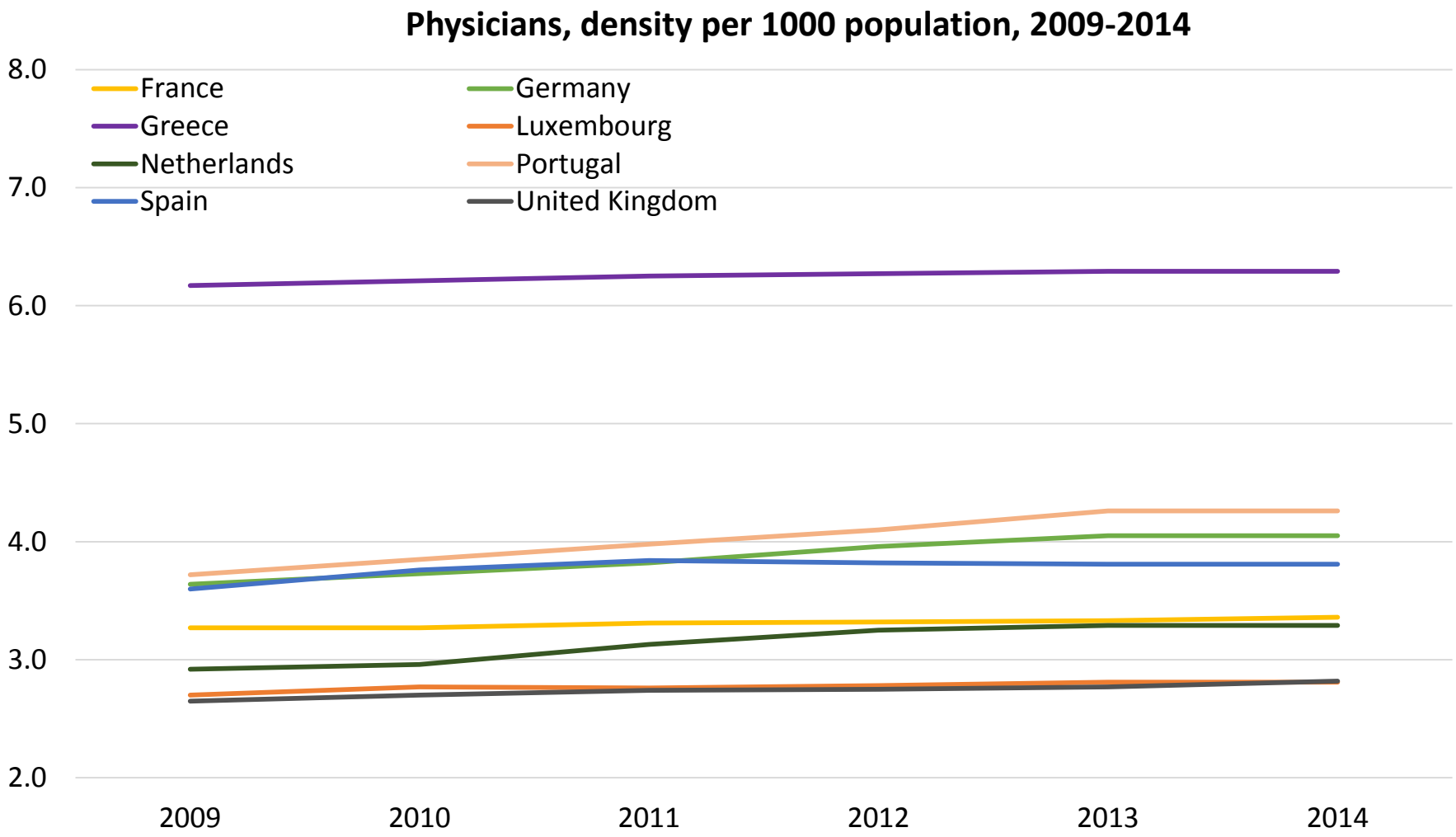

Figure 12: Physicians per 1000 citizens, 2009-2014 Source: OECD

On average across **OECD countries** there were 9.7 nurses per 1000 population in 2014 (Figure 13).

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.

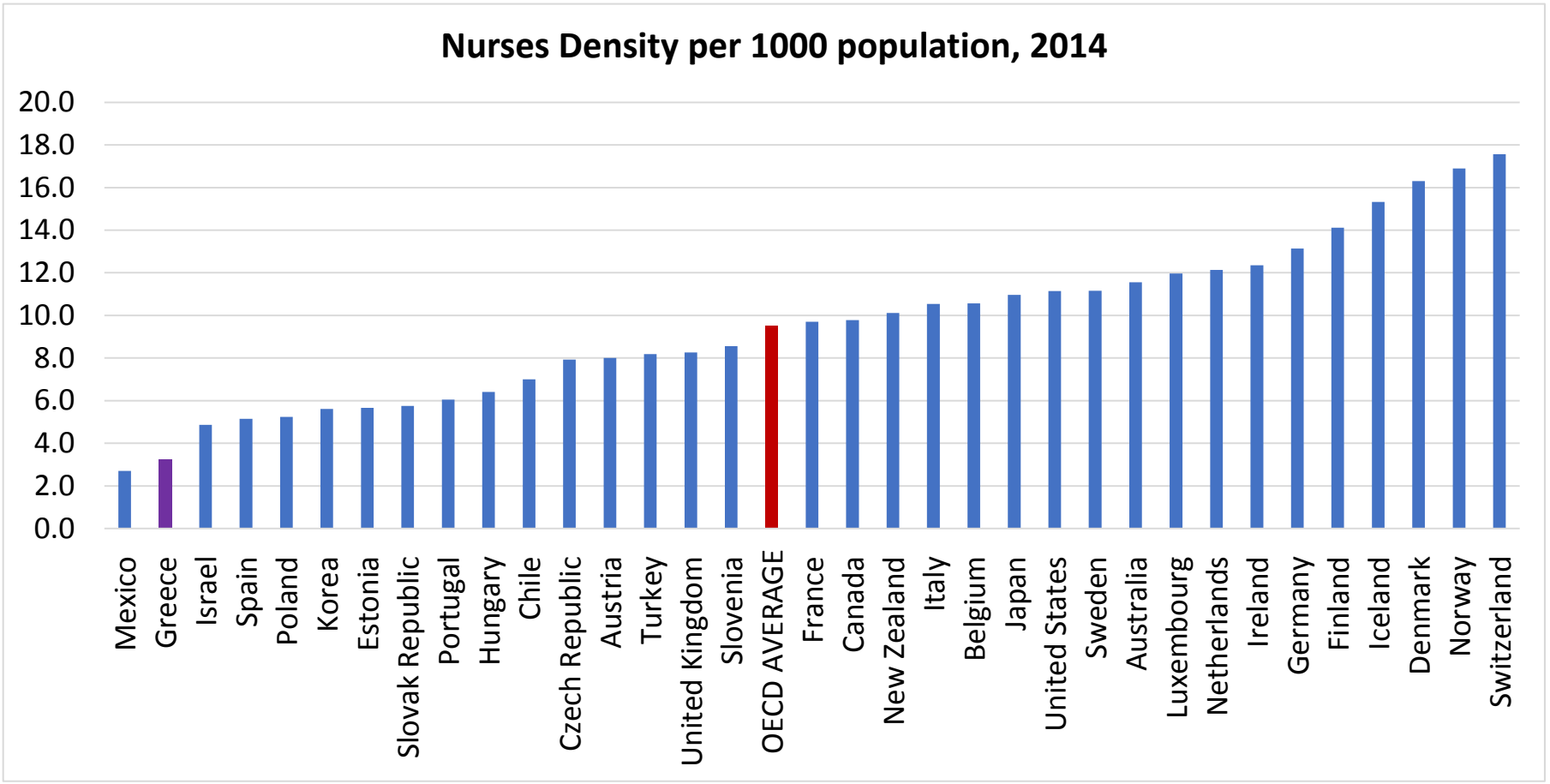

Figure 13:Nurse density per 1000 citizens, 2014, Source: OECD

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** (Karanikolos et al., 2013).

Japan, **Korea** and **Germany** had the highest number of hospital beds per capita in 2014 (Figure 14).

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.

Greece remained stable since 2008, with about 4.8 beds per 1000 population.

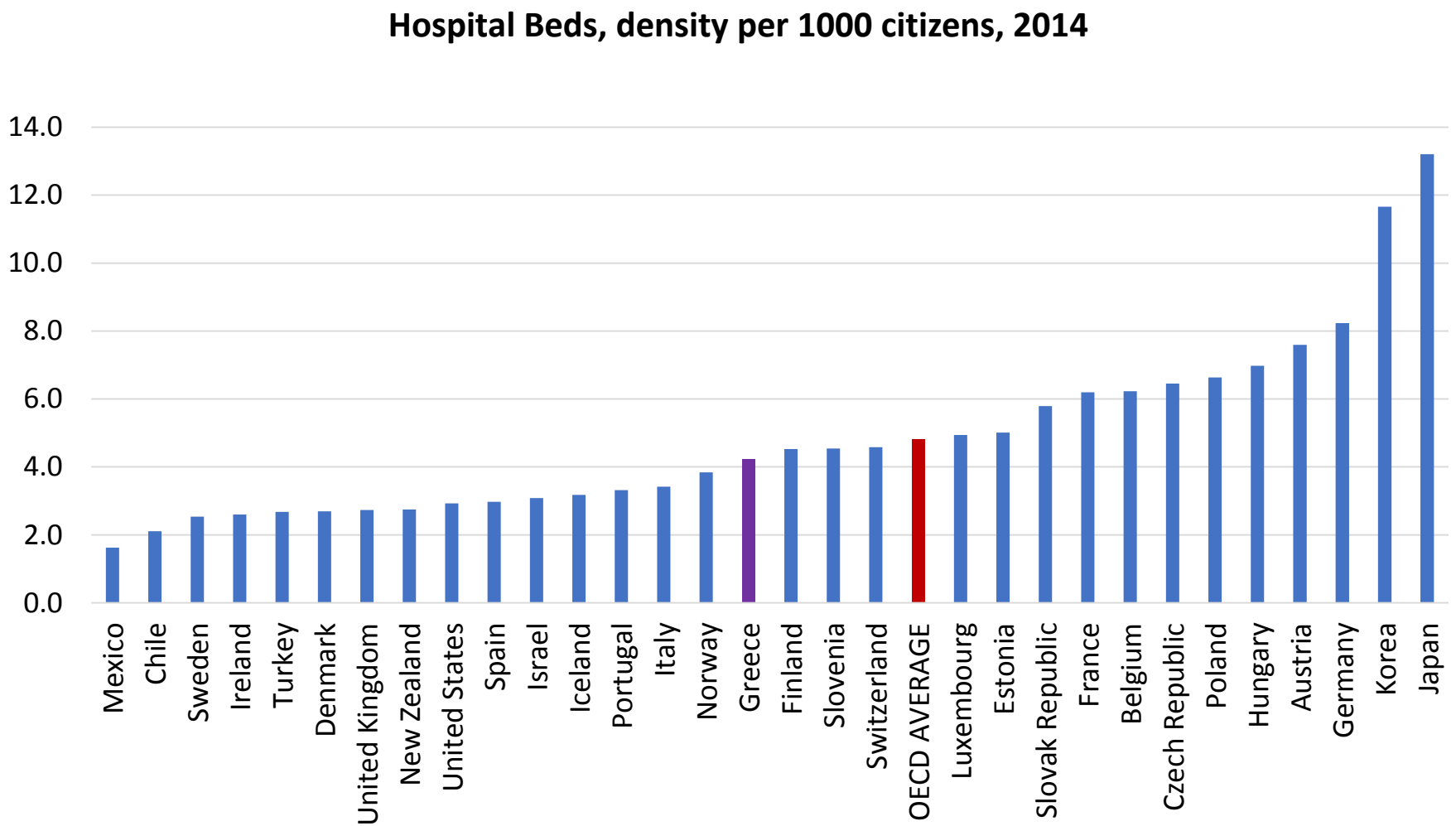

Figure 14:Hospital Beds per 1000 citizens, 2014, Source: OECD

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

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 15 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.

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**.

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.

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 (OECD, 2014).

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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