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Analyzing Healthcare Data of Immigrants from the General Hospitals of East Macedonia and Trace

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Abstract

The number of immigrants entering the European Union countries the last years has been increased. Greece is one of the EU countries that accepts a lot of the immigrants. As a consequence, their pressure to the Greek national health service system has also increased and there is a need to investigate this pressure in detail. The main goal of the present research is to analyze healthcare data concerning immigrants in the region of Eastern Macedonia and Thrace. The data were collected between years 2005 and 2011 from five different hospitals belonging to the Greek national health system, covering the whole Eastern Macedonia and Thrace region. Four characteristics were analyzed, namely the duration of hospitalization, the clinic, the cost of hospitalization and the nationality, using statistical data mining methods. The results show that most of the immigrants were from Albania followed by the ones from Bulgaria, Georgia, Russia, Germany and others. The total cost of the health services applied to immigrants was generally lower than the one for Greek nationality patients and the days of hospitalization have a high impact on cost. Immigrants from specific countries are related to different clinics.

Key Words: *Immigrants, Cost, Data Mining, Healthcare, Multiple Correspondence Analyses, Linear Mixed Effects Models.*

Introduction

The number of immigrants entering the European Union countries the last couple of years has been increased dramatically (Vasileva, 20012). Greece is one of the EU countries accepting a substantial proportion of the immigrants. Migratory flows to Greece began in the early 90s in response to the radical upheavals in Eastern Europe. A small portion of incoming immigrants were political refugees from Eastern

Europe, while the largest part of the incoming people were economic immigrants were seeking in the booming then Greece better living conditions and employment. The flows of immigrants were relatively stable and high during the decades of '90 and '00. At the end of the last decade they have relatively weakened due to the economic crisis in Greece. It is noteworthy that in recent years there are significant movements of refugees to Greece from the areas southern of Greece due the war situation in many countries in the southern regions (Afghanistan, Iraq, Syria, N. Africa, etc).

The last population census of the year 2011 (Hellenic Statistical Authority, 2011) mentions that there are 712,879 foreigners from outside the EU who are legally resident in Greece. If we also include the citizens of Bulgaria, Romania, Poland (approximately 140,000 people) that were not in the EU a few years ago, then the relevant figure reaches out to 850,000 immigrants and represents approximately 8% of the total population of Greece. In the 850,000 one should also add the illegal immigrants for whom, apparently, we can only have an estimate of their number. According to rough estimates in 2008 about 280,000 are living in Greece (Clandestino Project – Final Report. Undocumented Migration: Counting the Uncountable. Data and Trends Across Europe, 2009), while a few years later this figure was calculated by the Greek European and Foreign Policy Institute, in 470,000 (Angeli et al., 2014).

In Eastern Macedonia and Thrace (EMT) the number of immigrants from countries outside the EU, based on the very latest 2011 census, is approximately 15,000 individuals or 21,000 if we citizens from Bulgaria, Romania and Poland are also included. If you also consider that at the EMT Region there is a proportionate to the legitimate number of illegal and throughout the country (in two legal immigrants corresponds to about one another irregular), then all of the migratory potential of the region exceed 20,000 people.

Thus, Greece is a country which is an important recipient of migratory flows. Specifically, it is a country that has become a host for immigrants and especially long-term immigrants. The effects of their presence are significant and affect the economic, social and political life at Greece. Existing studies investigate this issue (Rompolis, 2007; Kalofolias, 2011; Kontis et al., 2009; Emke-Polyopoulou, 2007; Maroukis, 2010; Kanellopoulos et al., 2009), but do not investigate in great detail the question of the impact of migration on the social security system, especially the system of providing health services and the National Health System (NHS). It is at most importance to thoroughly investigate the impact of immigrants on NHS especially nowadays that the economic crisis has led to a reduction of costs in all areas, including the health sector. It is also very important to investigate their impact, since the public finances of the EU Member States are trying to balance the budgets on EU NHSs. The investigation of the peculiarities of the immigrant for the health system of Greece could also facilitate the management of the health relevant services.

Materials and Methods

This section describes in detail the data collected from the General Hospitals of EMT region and the data mining methods used to analyse them.

Data

The dataset consists of healthcare data collected from 2005 to 2011 from the General Hospitals belonging to the NHS from the region of EMT. Specifically, the General Hospitals of five towns (Kavala, Drama, Xanthi, Komotini and Didimoticho) are the basis for the statistical analysis methodologies. Due to the fact that each hospital uses its own system, the collection and integration of the data was a difficult task. In addition, two of the total five datasets (Hospilas of Drama and Komotini) did not contain any clinical diagnosis information. The general conclusion is that there is an imperative need for a common Health

Management Information System that should be used from all hospitals of Greece in order to integrate and analyze clinical data and acquire significant knowledge.

Methods

In order to study the effect of several factors on the cost function, we used the Linear Mixed Effects (LME) models (Pinheiro & Bates, 2000), which is a statistical model containing both fixed effects and random effects. These models are useful in a wide variety of disciplines in the physical, biological and social sciences and they are particularly useful in settings where repeated measurements are made on the same statistical units (longitudinal study).

Describing briefly, repeated measurements studies involve study designs, where the value of the outcome, covariates and factors for a individual is measured at several time points. While we do not preclude the possibility that a few individuals may only be observed once, we assume that there are individuals with multiple observations. Since observations on a single individual are strongly correlated, there is a need for statistical methodologies that are able to account for such correlation in the data and, in fact, in many situations take advantage of this structure. LME models focus initially on the regression relationship restricted to observations on a single individual (Pinheiro & Bates, 2000). The model is then, extended to multiple individuals by allowing some pieces of the model to vary from individual to individual in a proscribed manner, while other components remain the same. Hence, the building of a LME model focuses on the introduction of random effects, which are in fact the variation across individuals—in addition to fixed effects of cofactors of interest, the relationships that are assumed identical for every subject.

Summarizing, the LME models were used to evaluate the effect of two factors (Nationality and Year) and one continuous variable (Days of Hospitalization) on the dependent Cost variable. More precisely, the analyses included the fitting of two separate models for each hospital. In the former model, the main objective was to study the effect of Nationality, Year and Days of Hospitalization on the response variable (Cost) and for this reason, the dataset incorporated only patients that stayed at least one day in the hospital. The second model included all the patients, even the ones that did not stay at the hospital, but the parameter Days of Hospitalization was excluded from the model. Each mixed effects model (two models for each hospital) was consisted of two parts: the fixed and random effects. The examined fixed effects of the study were the Nationality, Year and Days of Hospitalization describing the population intercept and population slopes for each level of factors, whereas the random effects (patient) describe individual variability in the outcome variable. Finally, the LME models also accounts for the correlation between repeated measurements on the same subject and the different numbers of measurements per subject due to different visits at the examined hospitals of the study.

Regarding the factor Nationality, due to the existence of many countries with a small number of cases, we decided to initially examine the effect of two distinct levels (GREEK/FOREIGNER) on the cost variable. The analysis was based on a top-down approach, in which the likelihood ratio (LR) test was used to study the main effect of each independent variable (and their interaction effect) on the response outcome by dropping out a single term in each step of the approach. Finally, the initial fitting of the models indicated departures from homoscedasticity and normality assumptions, so the logarithmic transformation of the cost variable and the days of hospitalization were used.

Finally, with the aim of gaining a more insightful representation, *Multiple Correspondence Analysis* (MCA) (Greenacre & Blasius, 2006), which is a very meaningful data representation technique, was utilized to depict the underlying structure of the relationship among Nationality, Clinic and Year of hospitalization. Describing briefly, MCA technique plots on an artificial two-dimensional space, the abovementioned categorical variables as points with different colors in such a way that the closeness of

points is interpreted as strong relation between them with respect to hospitalization instances. Due to the fact, that there was a high number of levels for the categorical variables Nationality and Clinic causing a sparse three-way cross-tabulation matrix, we decided to omit from any further analysis levels with a small portion of data.

All statistical analyses were conducted using the statistical language R (R Core Team, 2013) and the function lme from package nlme (Pinheiro & Bates, 2000). Furthermore, the Tukey's HSD procedure was used in multiple comparisons in order to control the family-wise error rate (FWER) using function glht from package multcomp (Bretz & Hothorn, 2010) of the R statistical language. The multiple correspondence analysis was conducted using the package FactoMineR (Sébastien et al., 2008) using function MCA.

Results

This section describes in detail the results from each of the LME models for each hospital and the results of the MCA analysis.

LME Models for all Patients

Fig. 1 presents the distributions of the logarithmic transformation of Cost dependent variable for the Foreigners and Greek citizens for each hospital during the examined period of the study. The distributions of the dependent variable for Drama and Komotini hospitals during the period 2005-2007 are not displayed, since there were not available observations for this time window.

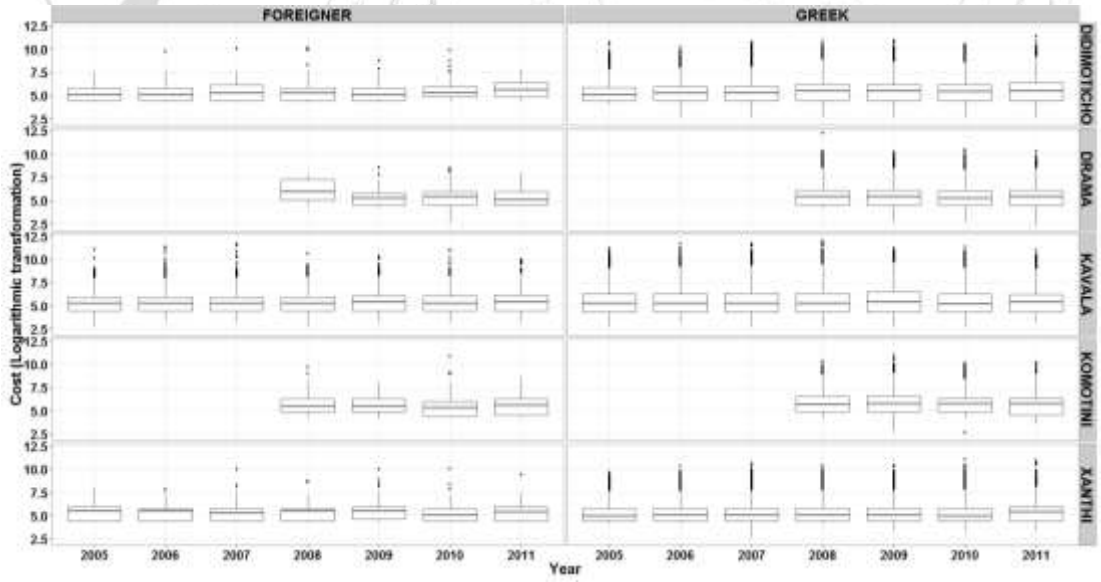

Fig. 1 Distributions of the logarithmic cost of hospitalization for Foreigners and Greeks for each hospital

Tables I present the results of the Wald's tests for the parameters of each model and the estimates for the main effects (and interaction effect) for each hospital during the period of the study. Concerning the hospital of Didimoticho, the findings of the Likelihood Ratio (LR) statistic did not reveal a statistically significant interaction between Nationality and Year, $\chi^2(6) = 3.866$, $p = 0.695$ and the model was refitted after omitting the interaction term. The results of the final LME model (Table I) indicate statistically

significant main effects of both Nationality $F(1, 26851) = 4.5$, $p = 0.035$ and Year $F(6, 33235) = 133.7$, $p < 0.001$ on the response variable (logarithmic transformation of cost). More specifically, the estimate of the fixed effect for the factor Nationality ($b = 0.116$, $SE = 0.045$, $p = 0.010$) demonstrates that the Greek citizens presented generally higher mean cost value compared to the Foreigners. Furthermore, the parameters of factor Time (Table I) reveal statistically significant differences between distinct years of the study. The mean cost values of Greeks and Foreigners for each hospital during the period of the study are graphically presented in Fig. 2. The examination of the error bars for Didimoticho's hospital shows that the mean values of cost are generally higher for Greeks compared to the Foreigners across the whole period of the study.

On the contrary, the fitting of LME models (main versus interaction effects models) for Drama's hospital indicated a statistically significant interaction between Nationality and Year, $\chi^2(3) = 8.965$, $p = 0.030$ and the interaction term was retained in the final model. Table II indicates statistically significant main effects of both Nationality $F(1, 35860) = 5.6$, $p = 0.018$ and Year $F(3, 31861) = 13.3$, $p < 0.001$ on the response variable. More interestingly, the results of LME reveals a statistically significant interaction effect between Nationality and Year, $F(3, 31861)=3.0$, $p = 0.030$. Interpreting the interaction effect of Nationality and Year, we can infer that the difference between the mean values of the logarithmic transformation of Cost for two distinct years depends on the Nationality of patients (Fig. 2). Concerning the year of 2009, the post-hoc analysis revealed a statistically significant difference between the logarithmic mean values of Cost between Foreigners and Greeks ($p = 0.026$) and higher mean value for Greeks compared to Foreigners for this specific year.

Table 1 - Linear Mixed Effects Model for Cost with Nationality and Year as Fixed Main Effects (Hospital of Didimoticho)

	Fixed Effects						*Estimates of fixed effects*			
Parameter	*Num df*	*Den df*	*F*	*p*	*Est.*	*SE*	*t*	*p*	*lower*	*upper*
Intercept	1	33235	1045117.8	<0.001	5.213	0.046	113.696	0.0	5.123	5.303
Nationality	1	26851	4.5	0.035						
Year	6	33235	133.7	<0.001						
Nationality: Greek					0.116	0.045	2.589	0.01	0.028	0.203
Year:2006					0.070	0.017	4.237	0.0	0.038	0.103
Year:2007					0.166	0.017	9.942	0.0	0.134	0.199
Year:2008					0.304	0.017	17.678	0.0	0.271	0.338
Year:2009					0.266	0.017	15.304	0.0	0.232	0.300
Year:2010					0.226	0.017	13.010	0.0	0.192	0.260
Year:2011					0.431	0.018	24.091	0.0	0.396	0.466

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2005, respectively.

In contrast to the hospitalization of Drama, the LR statistics for the hospitals of Kavala, $\chi^2(6) = 6.115$, $p = 0.410$ and Komotini, $\chi^2(3) = 2.723$, $p = 0.436$ did not reveal statistically significant interaction terms between Nationality and Year. The examination of the findings for Kavala's hospital (Table II) show statistically significant main effects of both Nationality $F(1, 85363) = 54.6$, $p < 0.001$ and Year $F(6, 131010) = 42.7$, $p < 0.001$ on cost. More analytically, the estimate of the fixed effect for the factor Nationality ($b = 0.097$, $SE = 0.013$, $p < 0.001$) illustrates that the Greek citizens presented generally higher mean cost value compared to the Foreigners. Furthermore, the parameters of factor Year indicate statistically significant differences between distinct years of the study, whereas the inspection of error bars (Fig. 2) depicts an increasing trend of cost for the study period except from the year of 2010. The results for the hospitalization of Komotini (Table IV) are similar to the previous ones, with higher mean value of

Greeks (b = 0.117, SE = 0.035, p < 0.001) compared to the corresponding mean value of Foreigners. On the other hand, the overall cost for this specific hospital seems to present a decreasing trend during the four examined time periods.

Finally, the main effects LME model, $\chi^2(6)$ = 7.438, p = 0.282) for the city of Xanthi indicates again statistically significant main effects of both Nationality $F(1, 53111)$ = 18.5, p < 0.001 and Year $F(6, 87531)$ = 84.9, p < 0.001 on the cost response variable. Contrary to the abovementioned findings, the parameter of the fixed effect for the factor Nationality (b = -0.113, SE = 0.027, p < 0.001) shows that the Greek citizens presented generally lower mean cost value compared to the Foreigners for this specific hospital (Table V). Furthermore, the parameters of factor Time (Table V) reveal statistically significant differences between distinct years of the study. Concerning the mean values for Greeks, it is clear that there was noted a trend with increasing cost mean values, except from 2010.

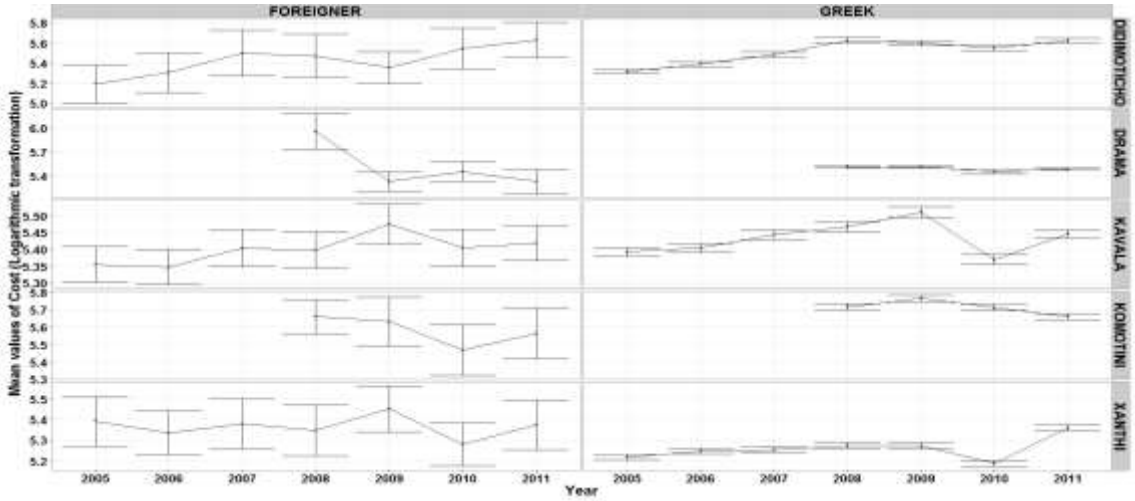

Fig. 2 Error bars of logarithmic cost for Foreigners and Greeks for the examined hospitals during the period of study

Table 2 - Linear Mixed Effects Model for Cost with Nationality and Year as Fixed Main Effects and Interaction (Nationality×Year) (Hospital of Drama)

	Fixed Effects				***Estimates of fixed effects***					
Parameter	*Num df*	*Den df*	*F*	*p*	*Est.*	*SE*	*t*	*p*	*lower*	*upper*
Intercept	1	35860	1457774.1	<	5.658	0.126	45.051	<	5.412	5.904
Nationality	1	35860	5.6	0.018						
Year	3	31861	13.3	<						
Nationality×Year	3	31861	3.0	0.030						
Nationality:Greek					-	0.126	-1.006	0.314	-	0.120
Year:2009					-	0.143	-2.807	0.005	-	-
Year:2010					-	0.141	-1.599	0.110	-	0.051
Year:2011					-	0.150	-1.951	0.051	-	0.001
Nationality:Greek×Year:2009					0.383	0.143	2.674	0.007	0.102	0.664
Nationality:Greek×Year:2010					0.156	0.141	1.104	0.270	-	0.432
Nationality:Greek×Year:2011					0.270	0.150	1.795	0.073	-	0.564

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2008, respectively.

Table 3 Linear Mixed Effects Model for Cost with Nationality and Year as Fixed Main Effects (Hospital of Kavala)

	Fixed Effects				*Estimates of fixed effects*					
Parameter	*Num*	*Den df*	*F*	*p*	*Estimate*	*SE*	*t*	*p*	*lower*	*upper*
Intercept	1	131010	2822444.4	<	5.374	0.014	387.838	<	5.346	5.401
Nationality	1	85383	54.6	<						
Year	6	131010	42.7	<						
Nationality:Greek					0.097	0.013	7.470	<	0.072	0.122
Year:2006					0.004	0.008	0.529	0.597	-	0.021
Year:2007					0.038	0.009	4.281	<	0.020	0.055
Year:2008					0.058	0.009	6.616	<	0.041	0.076
Year:2009					0.082	0.009	9.279	<	0.065	0.100
Year:2010					-0.031	0.009	-3.474	0.001	-	-
Year:2011					0.057	0.009	6.466	<	0.039	0.074

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2005, respectively.

Table 4 - Linear mixed effects model for Cost with Nationality and Year as fixed main effects (Hospital of Komotini)

	Fixed Effects				***Estimates of fixed effects***					
Parameter	*Num df*	*Den df*	*F*	*p*	*Est.*	*SE*	*t*	*p*	*lower*	*upper*
Intercept	1	29304	1267522.4	<0.001	5.591	0.035	159.548	< 0.001	5.522	5.659
Nationality	1	29304	11.3	<0.001						
Year	3	17731	16.2	<0.001						
Nationality :Greek					0.117	0.035	3.339	0.001	0.048	0.185
Year:2009					0.054	0.013	4.068	< 0.001	0.028	0.079
Year:2010					0.007	0.013	0.511	0.610	-0.019	0.033
Year:2011					-0.037	0.013	-2.827	0.005	-0.062	-0.011

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2008, respectively.

Table 5 - Linear Mixed Effects Model for Cost with Nationality and Year as Fixed Main Effects (Hospital of Xanthi)

	Fixed Effects				***Estimates of fixed effects***					
Parameter	*Num df*	*Den df*	*F*	*p*	*Est.*	*SE*	*t*	*p*	*lower*	*upper*
Intercept	1	87531	3051382.9	<0.001	5.335	0.027	194.555	<0.001	5.282	5.389
Nationality	1	53111	18.5	<0.001						
Year	6	87531	84.9	<0.001						
Nationality:Greek					-0.113	0.027	-4.214	<0.001	-0.166	-0.061
Year:2006					0.031	0.009	3.447	0.001	0.013	0.048
Year:2007					0.035	0.009	3.838	<0.001	0.017	0.052
Year:2008					0.052	0.009	5.682	<0.001	0.034	0.070
Year:2009					0.068	0.009	7.285	<0.001	0.050	0.087
Year:2010					0.012	0.010	1.238	0.216	-0.007	0.030
Year:2011					0.187	0.009	19.884	<0.001	0.169	0.206

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2005, respectively.

Lme Models for Patients Hospitalized For at Least One Day

Tables 6 to 10 present the results of the Wald's tests for the parameters of each model and the estimates for the main effects for each hospital during the period of the study. Concerning the hospital of Didimoticho the results of LME model (Table 6) indicate statistically significant main effects of Nationality $F(1, 23665) = 19.1$, $p < 0.001$, Year $F(6, 23846) = 261.9$, $p < 0.001$ and the logarithmically transformed Days of Hospitalization $F(1, 23486) = 88008.3$, $p < 0.001$ on the response variable (logarithmic transformation of cost). More specifically, the estimate of the fixed effect for the factor Nationality ($b = 0.145$, $SE = 0.0292$, $p < 0.001$) reveals that the Greek citizens presented generally higher mean logarithmic cost value compared to the Foreigners.

Furthermore, the parameters of factor Year (Table 6) reveal statistically significant differences between distinct years of the study. Also, as the Days of Hospitalization increase the logarithmic cost increases by 1.040 ($b = 1.056$, $SE = 0.0036$, $p < 0.001$). As far as the post-hoc tests are concerned, they revealed statistically significant differences between all years ($p < 0.001$), except for the pairwise comparisons of years 2008 and 2009 ($p = 0.91$), years 2008 and 2010 ($p = 0.99$) and years 2009 and 2010 ($p = 0.99$).

The fitting of LME models for Drama's hospital can be seen at Table 7 indicating statistically significant main effects of both Nationality $F(1, 32390) = 7.453$, $p = 0.006$ and Year $F(3, 23179) = 109.111$, $p < 0.001$ on the logarithmic cost variable. Also, the Days of Hospitalization (logarithmic transformation) has a statistically significant main effect on the transformed cost $F(1, 23179) = 91057.874$, $p < 0.001$. In addition, the post-hoc analysis showed that there were significant differences for all pair-wise comparisons of the factor Year except from years 2008 and 2010 were the difference in cost was not statistically significant ($p = 0.490$).

The examination of the findings for Kavala's hospital (Table 8) indicate statistically significant main effects of both Nationality $F(1, 70191) = 602,802$, $p < 0.001$ and Year $F(6, 69081) = 105.427$, $p < 0.001$ on the response variable (logarithmic transformation of cost). Again, days of hospitalization presented a statistically significant main effect on the mean cost $F(1, 69081) = 99726.471$. More analytically, the estimate of the fixed effect for the factor Nationality ($b = 0.266$, $SE = 0.011$, $p < 0.001$) illustrates that the Greek citizens presented generally higher mean logarithmic cost value compared to the Foreigners. Furthermore, the parameters of factor Year indicate statistically significant differences between distinct years of the study, whereas the inspection of error bars (Fig. 2) depicts an increasing trend of cost for the study period. The post hoc analysis comparing all the possible pairs of years revealed statistically significant differences except for the years 2006 and 2005 ($p = 0.999$), 2010 and 2007 ($p = 0.804$) and 2009 and 2008 ($p = 0.107$).

The results for the hospitalization of Komotini (Table 9) are similar to the previous ones, with higher mean value of Greeks ($b = 0.195$, $SE = 0.029$, $p < 0.001$) compared to the corresponding mean value of Foreigners. The overall cost for this specific hospital seems to present a decreasing trend during the four examined time periods. Also, variable Days of Hospitalization has the higher increase on logarithmic cost ($b = 0.726$, $SE = 0.004$, $p < 0.001$).

Finally, the main effects for the hospital of Xanthi indicates statistically significant main effects of both Nationality $F(1, 43925) = 30.163$, $p < 0.001$ and Year $F(6, 39627) = 174.454$, $p < 0.001$ on the response variable. Variable Days of Hospitalization was also statistically significant $F(1,39627)=129346.554$, $p < 0.001$. The parameters of factor Year (Table 10) reveal statistically significant differences between distinct years of the study.

Table 6 - Linear Mixed Effects Model for Hospital of Didimoticho

Fixed Effects					Estimates of fixed effects					
Parameter	***Num df***	***Den df***	***F***	***P***	***Estimate***	***SE***	***t***	***p***	***lower***	***upper***
Intercept	1	23846	2378515.6	<0.0001	4.317	0.0302	142.908	<0.0001	4.258	4.377
Log Days of Hospitalization	1	23846	88008.3	<0.0001						
Nationality	1	23665	19.1	<0.0001						
Year	6	23846	261.9	<0.0001						
Days of Hospitalization					1.056	0.0036	295.775	<0.0001	1.049	1.063
Nationality:Greek					0.145	0.0292	4.978	<0.0001	0.088	0.202
Year:2006					0.0487	0.0116	4.196	<0.0001	0.026	0.071
Year:2007					0.133	0.0118	11.286	<0.0001	0.110	0.157
Year:2008					0.240	0.0118	20.334	<0.0001	0.217	0.263
Year:2009					0.253	0.0117	21.575	<0.0001	0.230	0.276
Year:2010					0.248	0.0118	21.012	<0.0001	0.225	0.271
Year:2011					0.411	0.0122	33.608	<0.0001	0.387	0.435

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2005, respectively.

Table 7 - Linear Mixed Effects Model for Hospital of Drama

	Fixed Effects				Estimates of fixed effects					
Parameter	Num df	Den df	F	p	Est.	SE	t	p	lower	upper
Intercept	1	32390	3561463.589	< .001	4.495	0.032	141.399	< 0.001	4.432	4.557
Log Days of Hospitalization	1	23179	91057.874	< 0.001						
Nationality	1	32390	7.453	0.006						
Year	3	23179	109.111	<						
Days of Hospitalization					0.981	0.003	301.657	< 0.001	0.974	0.987
Nationality:Greek					0.081	0.031	2.595	0.009	0.020	0.142
Year:2009					0.028	0.007	3.872	< 0.001	0.014	0.042
Year:2010					-	0.008	-1.415	0.157	-0.026	0.004
Year:2011					0.112	0.008	14.608	< 0.001	0.097	0.127

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2008, respectively.

Table 8 - Linear Mixed Effects Model for Hospital of Kavala

	Fixed Effects				Estimates of fixed effects					
Parameter	***Num***	***Den***	***F***	***p***	***Est.***	***SE***	***t***	***p***	***lower***	***uppe***
Intercept	1	70191	4338221.194	< 0.001	4.704	0.012	396.336	< 0.001	4.681	6.728
Log Days of	1	69081	99726.471	< 0.001						
Nationality	1	70191	602.802	< 0.001						
Year	6	69081	105.427	< 0.001						
Days of Hospitalization					0.808	0.003	315.884	< 0.001	0.803	0.813
Nationality:Greek					0.266	0.011	24.792	< 0.001	0.245	0.287
Year:2006					0.004	0.008	0.482	0.63	-	0.019
Year:2007					0.059	0.008	7.475	< 0.001	0.043	0.074
Year:2008					0.082	0.008	10.399	< 0.001	0.067	0.098
Year:2009					0.103	0.008	12.898	< 0.001	0.088	0.119
Year:2010					0.047	0.008	5.781	< 0.001	0.031	0.064
Year:2011					0.173	0.008	21.060	< 0.001	0.156	0.189

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2005, respectively.

Table 9 - Linear mixed effects model for Hospital of Komotini

	Fixed Effects				Estimates of fixed effects					
Parameter	***Num***	***Den***	***F***	***p***	***Est.***	***SE***	***t***	***p***	***lower***	***upper***
Intercept	1	26284	1862857.496	<	4.870	0.029	166.016	<	4.812	4.927
Log Days of	1	13324	25848.500	<						
Nationality	1	26284	54.605	<						
Year	3	13324	100.138	<						
Days of					0.726	0.004	161.275	<	0.717	0.734
Nationality:Greek					0.195	0.029	6.764	<	0.139	0.252
Year:2009					0.079	0.011	7.442	<	0.058	0.099
Year:2010					0.027	0.011	2.469	0.014	0.005	0.048
Year:2011					0.170	0.011	15.962	<	0.149	0.191

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2008, respectively.

Table 10 - Linear Mixed Effects Model for Cost with Nationality and Year as Fixed Main Effects (Hospital of Xanthi)

	Fixed Effects				Estimates of fixed effects					
Parameter	***Num***	***Den***	***F***	***p***	***Estimate***	***SE***	***t***	***p***	***lower***	***upper***
Intercept	1	43925	5290683.262	<	4.536	0.021	219.007	<	4.495	4.576
Log Days of	1	39627	129346.554	<						
Nationality	1	43925	30.163	<						
Year	6	39627	174.454	<						
Days of					0.952	0.003	359.735	<	0.947	0.957
Nationality:Greek					0.111	0.020	5.528	<	0.072	0.150
Year:2006					0.002	0.007	0.275	0.783	-	0.016
Year:2007					0.039	0.007	5.333	<	0.024	0.053
Year:2008					0.052	0.007	7.095	<	0.038	0.066
Year:2009					0.057	0.008	7.592	<	0.042	0.072
Year:2010					0.026	0.008	3.336	0.001	0.011	0.041
Year:2011					0.221	0.008	28.211	<	0.205	0.236

Note: The reference categories for factors Nationality and Year are Foreigner and Year 2005, respectively.

MCA Analysis

MCA analysis was applied as already mentioned for the hospital of Xanthi, of Kavala and Didimoticho. The data from the hospitals of Komotini and Drama did not include information about the clinics and thus MCA could not be applied on these datasets. Concerning the General Hospital of Xanthi, the results of MCA (Fig. 3) indicate that Bulgarians are mostly related with the Orthopedic Clinic, whereas there were also a high proportion of admissions during 2009 and 2011. Furthermore, the plot reveals a close relation between Germans and Urological occurrences. Finally, the admissions of Albanians, which is the nationality with the highest percentage (43.83%) were mostly related with the Pediatric and Obstetric Clinics.

The findings of MCA (Figure 4) for the General Hospital of Kavala reveal again that Pediatric Clinic received a high number of Albanians' admissions and mostly during 2006 and 2009. In addition, Albanians' MCA point is equally distanced from Pediatric and Gynaecology Clinics indicating a strong relation between the former and these two distinct clinics. There was also noted a relation pattern concerning Bulgarians and Pathological/Surgery Clinics during 2011 with especially high marginal frequencies.

Finally, the MCA plot (Figure 5) for the General Hospital of Didimoticho shows that Bulgarians are strongly related with Gynaecology Clinic, whereas Georgian immigrants is mostly associated with the Surgery Clinic. Furthermore, the number of admissions of both Armenian and Georgian immigrants was especially high during 2009. Finally, during 2005 there was noted a high proportion of Irak immigrants that were hospitalized at Pathological Clinic.

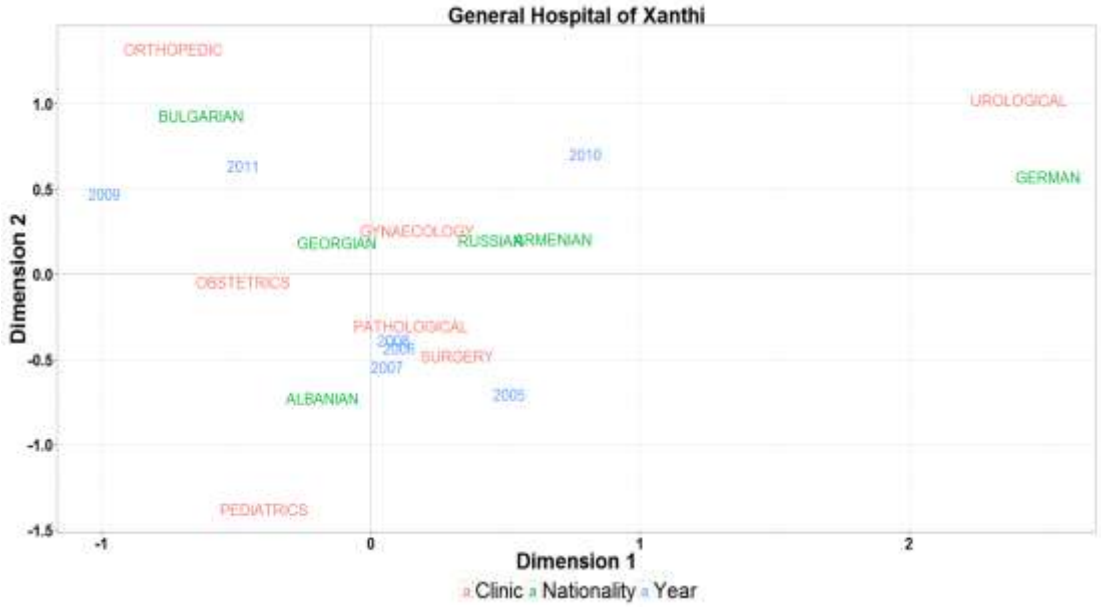

Fig. 3 MCA results for the General Hospital of Xanthi

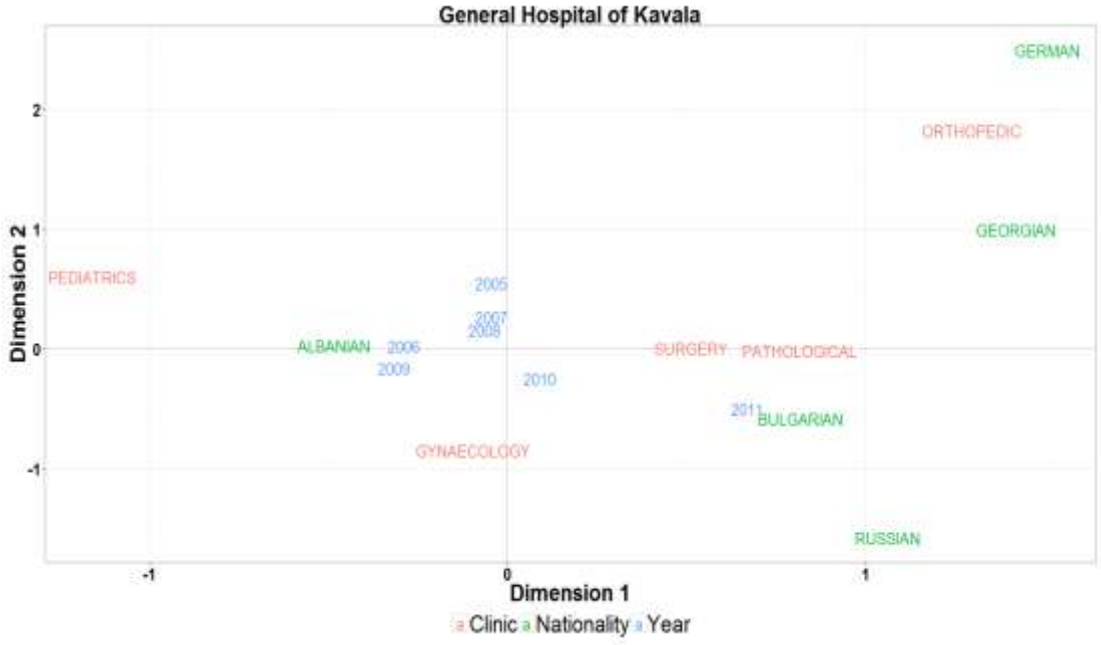

Fig. 4 MCA results for the General Hospital of Kavala

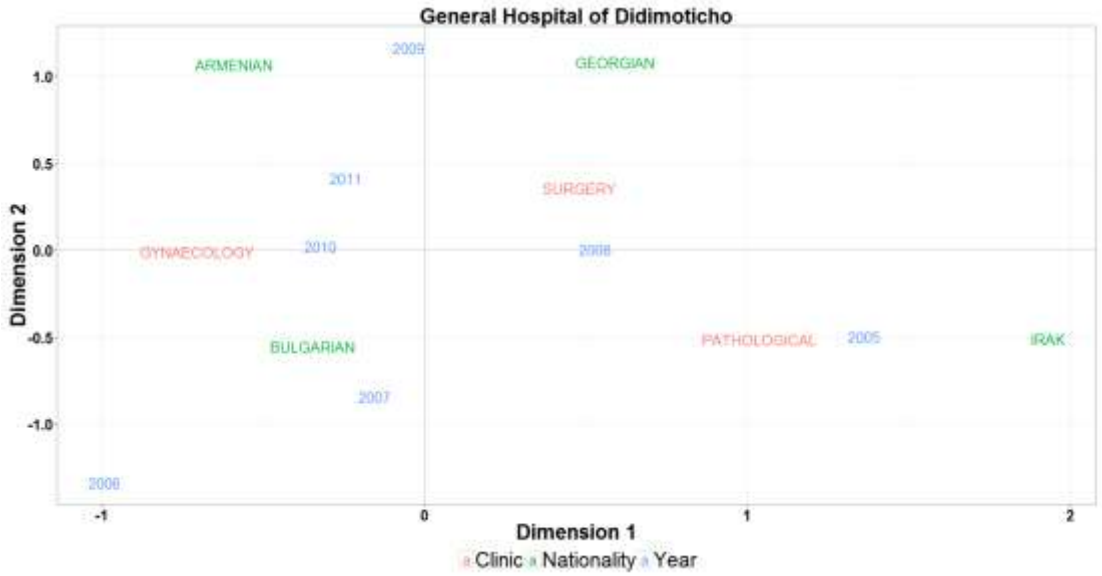

Fig. 5 MCA results for the General Hospital of Didimoticho

Conclusions

The LME models show that the cost depends on the Nationality of the patients and on the Year of the study. It also increases significantly as the Days of Hospitalization increase. Furthermore, the results show that the mean cost for the NHS is higher for Greek nationality patients than the patients from other nationalities. There is also a clear trend of the cost to increase during the year of the study expect for 2010 where there is a clear decrease of the cost for NHS for both the Greek nationality citizens and immigrants in most of the hospitals. The decrease in cost for 2010 maybe due to the fact that the Greek government starting from 2010 took a series of legislation in order to achieve a great cut in the expenses for health, e.g. it promoted the use of generic drugs, it placed a limit on the number of drugs a doctor could prescribe, it made obligatory to pay 5 Euros for each visit at the hospitals, etc.

It must be also noted that the mean cost for Greek patients does not fluctuate so much as the mean cost of immigrants as can been seen at Fig. 2. Independent of nationality the administration of the hospitals should to try to improve the management of patients' hospitalization and treatment in order to decrease mean costs. After all, more and more EU countries are trying to reform their NHS's management in order to decrease the cost for the health system.

In a future work, we would like to include more years in our research. The last couple of years, in order the Greek government to help the administrations of the hospital decrease costs by better management it has upgraded the information systems of the hospitals. Thus, it is now possibly to extract more useful information and more easily from the hospitals' systems.

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