

# Analysing the Cost of Immigrants to the National Health System in Eastern Macedonia and Thrace

T. Theodosiou, P. Polychronidou, A. G. Karasavvoglou

**Abstract**—The latest years the number of immigrants at Greece has increased dramatically. Their impact on the National Health System (NHS) has not been yet thoroughly investigated. This paper analyses the cost of immigrants to the NHS hospitals of the region of Eastern Macedonia and Thrace. The data are collected from 2005 to 2011 from five different hospitals and are analysed using linear mixed effects models in order to investigate the effects of nationality and year on the cost of hospitalization and treatment. The results show that generally the Greek nationality patients have a higher mean cost of hospitalization compared to the immigrants and that there is an increasing trend for the cost except for the year 2010.

**Keywords**—Cost, Eastern Macedonia, Thrace, immigrants, national health system.

## I. INTRODUCTION

THE number of immigrants entering the European Union countries the last couple of years have increased dramatically [1]. Greece is one of the EU countries that accept 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 [2] 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.

T. Theodosiou, P. Polychronidou, and A. G. Karasavvoglou are with the Department of Accounting, Eastern Macedonia and Thrace Institute of Technology, Ag. Loukas, 654 04, Greece (e-mail: theodosiou@statnous.com, polychr@teikav.edu.gr, akarasa@teikav.edu.gr).

This research was supported by the Project "Immigrants and Health Services – The case of Eastern Macedonia and Thrace region" that is co-funded by the European Union (European Social Fund) and National Resources - ARCHIMEDES III.

According to rough estimates in 2008 about 280,000 are living in Greece [3], while a few years later this figure was calculated by the Greek European and Foreign Policy Institute, in 470,000 [4].

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 [5]–[11], 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.

## II. DATA AND METHODOLOGY

### A. Data

The dataset consists of health data collected from 2005 to 2011 from the General Hospitals belonging to the NHS from the region of Eastern Macedonia and Thrace. The General Hospitals are located at five different towns of EMT, namely the town of Kavala, of Drama, of Xanthi, of Komotini and of Didimoticho. It must be noted that there is not yet a common Health Management Information System that all hospital should use. Thus, every hospital uses its own system making the collection and integration of the data difficult.

### B. Methodology

In order to study the effect of several factors on the cost function, we decided to use the Linear Mixed Effects (LME) models [12], 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 typical sampled individual is measured at several different time points. While we do not preclude the possibility that a few individuals may only be observed once, we assume that the bulk of the sample has multiple observations. Since observations on a single individual at different times are very unlikely to be independent we need new methods of analysis that 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. 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; these are the pieces of the model that vary across individuals—in addition to fixed effects of cofactors of interest, the relationships that are assumed identical for every subject. This approach indirectly describes and interprets the covariance structure for longitudinal observations. In fact, this is the fundamental difference in approach in using a LME model as compared to a marginal model, with the latter constitutes the simplest methodology.

Summarizing, the LME models were used to evaluate the effect of factors Nationality and Year on the dependent cost variable. The study involves data originated from five hospitals of Eastern Macedonia and Trace during the study period 2005-2011. Each mixed effects model (one model for each hospital) is consisted of two parts: the fixed and random effects. Fixed effects describe a population intercept and population slopes for each level of factors. In contrast, random effects 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.

Each LME model incorporated both the main effects of Nationality and Year on the dependent variable and their interaction effect (Nationality×Year) and the random effect structure justified by the data. 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 the interaction term) on the response outcome by dropping out a single term in each step of the approach. Finally, the fitting of the model indicated departures from homoscedasticity and normality assumptions, so it was decided to logarithmically transform the cost variable and rebuilt the model.

All statistical analyses were conducted using the statistical language R [13] and the function lme from package nlme [12]. 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 [14] of the R statistical language.

### III. RESULTS

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 hospital during the period 2005-2007 are not displayed, since there was none observation for this time window.

Table I presents 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 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 ( $b=0.116$ ,  $SE=0.045$ ,  $p=0.010$ ) reveals 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 cost 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 between 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.

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 III) indicate 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 the response variable (logarithmic transformation of 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 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 ( $b=-0.113, SE=0.027, p<0.001$ ) reveals 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.

TABLE I  
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	Estimate	SE	t	p	lower	upper
Intercept	1	33235	1045117.8	< 0.001	5.213	0.046	113.696	0.00	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	0.00	0.038	0.103
Year:2007					0.166	0.017	9.942	0.00	0.134	0.199
Year:2008					0.304	0.017	17.678	0.00	0.271	0.338
Year:2009					0.266	0.017	15.304	0.00	0.232	0.300
Year:2010					0.226	0.017	13.010	0.00	0.192	0.260
Year:2011					0.431	0.018	24.091	0.00	0.396	0.466

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

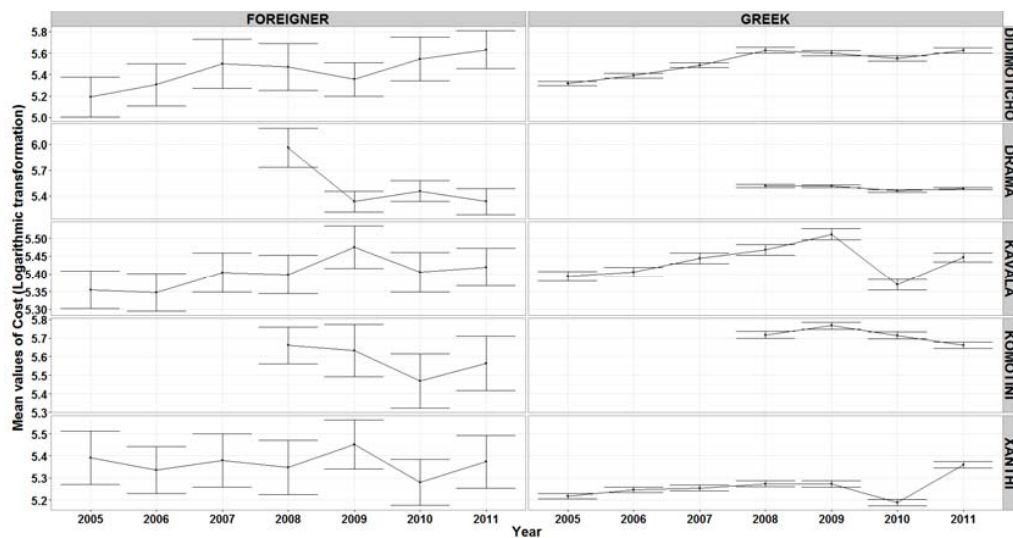


Fig. 1 Error bars of logarithmic cost for Foreigners and Greeks for the examined hospitals during the period of study

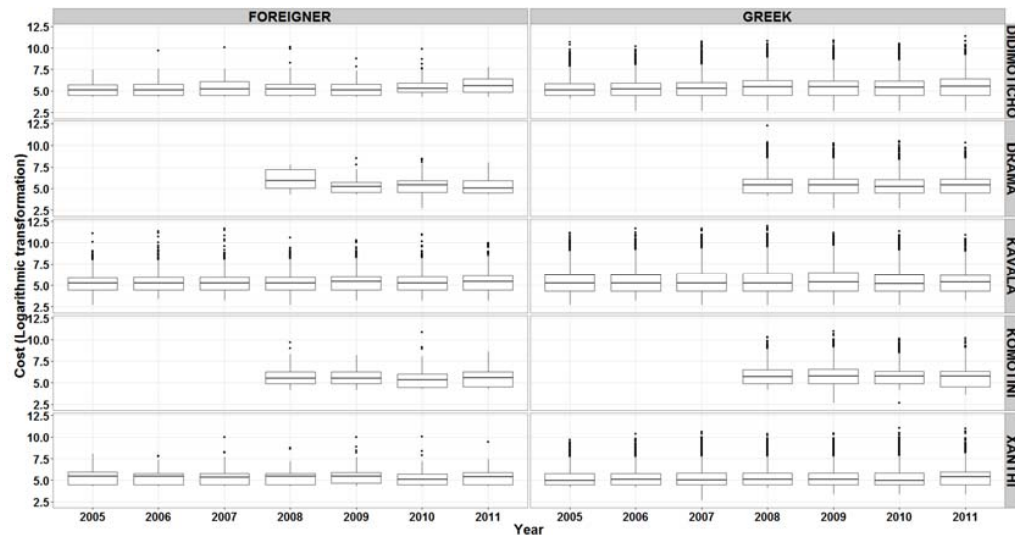


Fig. 2 Distribution of logarithmic cost for Foreigners and Greek nationality patients

TABLE II  
LINEAR MIXED EFFECTS MODEL FOR COST WITH NATIONALITY AND YEAR AS FIXED MAIN EFFECTS AND INTERACTION (NATIONALITY×YEAR) (HOSPITAL OF DRAMA)

Parameter	Fixed Effects				Estimates of fixed effects					
	Num df	Den df	F	p	Estimate	SE	t	p	lower	upper
Intercept	1	35860	1457774.1	< 0.001	5.658	0.126	45.051	< 0.001	5.412	5.904
Nationality	1	35860	5.6	0.018						
Year	3	31861	13.3	< 0.001						
Nationality×Year	3	31861	3.0	0.030						
Nationality:Greek					-0.127	0.126	-1.006	0.314	-0.373	0.120
Year:2009					-0.401	0.143	-2.807	0.005	-0.681	-0.121
Year:2010					-0.225	0.141	-1.599	0.110	-0.500	0.051
Year:2011					-0.292	0.150	-1.951	0.051	-0.586	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	-0.121	0.432
Nationality:Greek×Year:2011					0.270	0.150	1.795	0.073	-0.025	0.564

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

TABLE III  
LINEAR MIXED EFFECTS MODEL FOR COST WITH NATIONALITY AND YEAR AS FIXED MAIN EFFECTS (HOSPITAL OF KAVALA)

Parameter	Fixed Effects				Estimates of fixed effects					
	Num df	Den df	F	p	Estimate	SE	t	p	lower	upper
Intercept	1	131010	2822444.4	< 0.001	5.374	0.014	387.838	< 0.001	5.346	5.401
Nationality	1	85383	54.6	< 0.001						
Year	6	131010	42.7	< 0.001						
Nationality:Greek					0.097	0.013	7.470	< 0.001	0.072	0.122
Year:2006					0.004	0.008	0.529	0.597	-0.012	0.021
Year:2007					0.038	0.009	4.281	< 0.001	0.020	0.055
Year:2008					0.058	0.009	6.616	< 0.001	0.041	0.076
Year:2009					0.082	0.009	9.279	< 0.001	0.065	0.100
Year:2010					-0.031	0.009	-3.474	0.001	-0.048	-0.013
Year:2011					0.057	0.009	6.466	< 0.001	0.039	0.074

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

#### IV. DISCUSSION & CONCLUSION

The LME models show that the cost depends on the Nationality of the patients and on the Year of the study. Furthermore, the results show that the mean cost for the NHS is higher for Greek nationality patients than the patients from other nationalities except for the General Hospital of Xanthi.

A possible explanation for this maybe that at the region of Xanthi there is a rural development concerning mainly tobacco leafs and thus an increased number of immigrants choose to go there in order to find job. 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. 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, etc.

TABLE IV  
LINEAR MIXED EFFECTS MODEL FOR COST WITH NATIONALITY AND YEAR AS FIXED MAIN EFFECTS (HOSPITAL OF KOMOTINI)

Parameter	Fixed Effects				Estimates of fixed effects					
	Num df	Den df	F	p	Estimate	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 V  
LINEAR MIXED EFFECTS MODEL FOR COST WITH NATIONALITY AND YEAR AS FIXED MAIN EFFECTS (HOSPITAL OF XANTHI)

Parameter	Fixed Effects				Estimates of fixed effects					
	Num df	Den df	F	p	Estimate	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.

It must be also noted that although the cost of immigrants for the NHS for the region of EMT is lower the than those with Greek nationality there is and need to stabilize the increasing trend. A possibly solution would be the administration of the hospitals to try to improve the management of patients' hospitalization and treatment. After all, that the solution more and more EU countries are trying to apply to their NHS's in order to decrease the cost for the health system.

In a future work, we would like to include more years in our research and incorporate in our models the days of hospitalization and the diagnosis. 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 systems.

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