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MORTALITY PHENOMENON ANALYSIS ON ADULT POPULATION UNDER THE INFLUENCE OF ECONOMIC FACTORS IN EUROPEAN CONTEXT

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Abstract

The mortality rate is a global indicator that reflects the standard of living and the population health condition, but also a variable that shows the social-economic development of a society. This paper proposes the investigation of some economic conditions and their influence on mortality by literature reviewing and also through a statistic analysis based on 28 European Union countries.

In order to study the tendencies of this phenomenon, it was analyzed the influence of some economic factors like the GDP per capita, income discrepancies, inflation rate, budget deficit and also the "snowball" effect for 16 years (from 2000 to 2016) using a panel regression model with fixed effects. The resulted regression model captures the major changes on a long term of mortality rate trend for the population aged 15 and 65 years.

Keywords: mortality rate, economic, panel regression model, European Union
JEL Classification: I12, C23

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1. Introduction

The mortality phenomenon analysis and subsequently the life expectancy of a population represent a valuable indicator for characterizing the level of economic and social development over time. Mortality trend is dictated firstly by social-economic characteristics like age, sex, education, occupation, health condition, life style and more. The current evolution of the European life standards has played an important role in the exponential growth of the average life-time.

The purpose of this paper is to investigate the impact of economic changes occurred over time on the mortality rate at European Union adult population level. In effect, by choosing only the adult mortality rate, we tried to reduce the impact of infant mortality and especially the effects of demographic aging. Stimulating different regression models, the pressure imposed by the economic context is the most visible for the adult population.

The second aim of this paper is to predict the levels of adult mortality rate for each country member of European Union, especially Romania's position. Although the main interest is to present valid predictions for the mortality behavior, we must take into consideration that the trend is refined first of all by demographic and social factors. Giving the fact that the life expectancy is ever-growing, it's clear that this phenomenon trend tends to evolve based on an almost systematic model, although the differences appeared intra or inter countries show that the mortality rates are volatile.

From this analysis, we wanted to conclude which are the factors with a negative or a positive influence on the number of deaths and the most affected countries by economic conditions. This paper distinguishes through presenting only the economic component and by concentrating on adult population in evaluating the consequences of a country stage of development in determining the mortality.

The structure of this article is divided between three chapters. The first chapter represents a brief study of the most concluding literary from this field. The second one details the importance of economic impulses on the mortality evolution and offers some predictions for the European Union countries. The last chapter presents the conclusions of this paper and offers some suggestions for the public policies.

2. Literature review

In the last years, in developed countries, the incomes growth has been preceded by an unprecedented historic decline in mortality rates, which led to an increased life expectancy at birth by nearly 30 years. This correlation was first analyzed by Samuel H. Preston (1975), who has described the Preston curve, an empiric transversal relation between life expectancy at birth and the gross domestic product per capita. Preston, demographer and sociologist, noted that, a few years after World War II, the difference between the life expectancy associated to each country began to be observed worldwide. The crisis that have affected European Union have been associated usually with a large income discrepancy and also a deterioration of the social conditions that have led to periods of stagnation in the development of societies, causing the declined of the average lifespan. Definitely, mortality rate can't be

studied like an economic phenomenon. But, this assuredness doesn't influence the fact that it exists a connection between economic performance and increasing or decreasing mortality. The mortality trend is very difficult to be predicted precisely because of these long-term economic changes.

The role of economic growth in health improving in poor countries has become a controversial topic in the history of declining mortality. In recent years, a number of authors have sustained that income is the most important factor and, because of that, there were a lot of politics in order to reduce the role of every public action in the field of health.

Also, according to a study realized by Becker, Philipson et al. (2005) there is a positive relation between incomes and population health condition, meaning that in countries with lower incomes life expectancy is lower comparing with developed countries.

Those inequalities in health status compared to the level of wellness are known as "gradients", according to David Cutler's definition (2016), which constituted a complex model, that correlates mortality with the economic state measures. These theories underline the mortality decline in time and the differences between countries and inside a country, as this phenomenon has become of a major importance in most of the global studies. However, a lot of countries have recorded remarkable developments in the health area, with a decreased economic growth or none or vice versa. Therefore, there are a series of possible hypotheses for which the income is not that significant. According to some studies, income and health growth aren't always associated. As in the case of some European countries, the economic growth was followed by urbanization in the poor population.

Minamimura and Yasui (2019) have developed a growth pattern similar with the Galov - Moav model, that shows the replacement of physical capital accumulation with human capital accumulation as a first system of growth. The model proves that reduced mortality promotes this replacement and the its effect on income per capita differs depending on phases of the development process. Thus, at a high level of education in an economy, it's much more probably that at a decrease in mortality, the income per capita will increase.

The relation between mortality and economic fluctuations represents a subject of global interest, which has intensified after the global financial crisis from 2008. Most authors who have expressed any interest in this area have tried to determine if the mortality responds nonlinearly and asymmetrically to unemployment in the context of national economic crisis.

Inflation, another economic indicator, is considered, by most authors, being related to the increase of the cost of goods and services, the decline of the salary and the reduction of life standards. According to some statistical analyses, it has been proved that an increase in the inflation rate during economic crises leads to an increase in mortality rates. Some authors believe that the inflation offers a predictable perspective on mortality, there being an inverse link between these two representative characteristics for a society, regardless of the level of economic development. (Juselius, 2018, Bourne and Sharpe-Pryce, 2014, Lee et al., 2016).

The Romanian authors, as well as foreigners, who focused on studying the connection between mortality and the economic environment warn that, although this phenomenon is affected by poverty and economic deprivation, those are not the only causes that trace its evolution (Încalțărău et al., 2015, Jemna, 2011, Li, 2015, Sen, 1998).

3. Mortality analysis at European level

In recent years, it has been observed that the mortality rate has followed a decreasing trend, dictated by the continuous economic development of European societies. The analysis of this phenomenon indicates that the highest values characterize countries such as Lithuania, Latvia, Estonia, Hungary, Bulgaria, Romania and Poland. These Europeans countries are marked by an economy that is still growing and with a restrictive political past, being affected by the communist regime. On the other side, the lowest values are registered in the countries of North and West Europe.

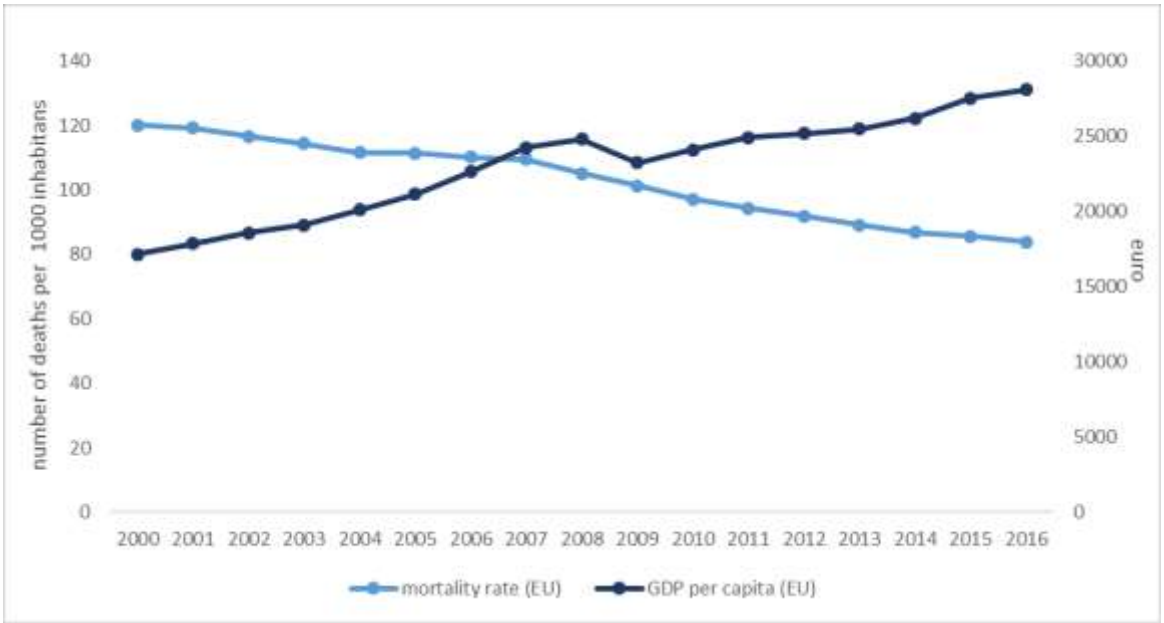


Figure 1. Mortality rate versus GDP per capita in EU (2000-2016)
Source data: Own representation based on selected Eurostat indicators

In European Union, the number of deaths per 1000 habitants has decreased considerably while an important indicator of economic development, GDP per capita, has known an ascending trend. The continuous evolution of EU member states lies at the base of human condition improvement and life extension.

In order to determine a statistical model to indicate the trends that influence the mortality phenomenon, the first step was represented by the calculation of the standardized mortality rate (SMR). In carrying out this analysis, the specific mortality rate for the European countries was used and was calculated according to the standard distribution by age groups. A first advantage offered by the use of this calculation method at the expense of the crude rate is the improvement of comparability over time and between countries. This study aims to outline a model that captures the causes of mortality of the adult population, excluding infant mortality and the known effect of demographic ageing.

The specific mortality rate was calculated as the number of deaths with ages between 15 and 65 from the total population of the selected age group, represented as a proportion. The

age SMR according was calculated by multiplying the specific mortality rate with the standard weight of the population from the base year (in this case 1991).

In order to determine the influence of each economic factor, the panel regression model was chosen to be applied. This model helps to increase the size of the sample as well as to analyze the changes over time produces on several units. The fixed effects model is used when the analysis is based only on the impact of variables that vary over time. In contrast, the random effects model assumes that the variation present in countries is random and not correlated with the dependent variable and the independent variables included in the model.

The studied population included 28 countries of the European Union: Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden and the United Kingdom. The statistical data used in the analysis was extracted from sources such as Eurostat, World Bank and the European Commission. The necessary data for each country was available from 2000 to 2016. The analysis was limited to 2016, because of missing data for some economic variables in the last 3 years.

In outlining the proposed analysis, SMR was selected as the dependent variable and as independent variables six economic factors.

Table 1. The variables used in the model

	Variable name	Unit
SMR	Standardized mortality rate	deaths/1000 habitants
GINI	Gini index calculated based on the income reported by the population	%
INFR	inflation rate	%
UNEMR	unemployment rate	%
GDPC	gross domestic product per capita	euro
BDEF	budget deficit	euro
SBE	"snowball" effect on the real value of public debt	% from GDP

The first step of the analysis was the realization of the fixed effects regression model with strong determination coefficient (R^2=0.9477). The resulting model is valid for a level of 99% guarantee of results, the probability associated with the F test being equal to 0.000, a value lower than the significance threshold of 0.01.

Equation 1. The equation of the fixed effects regression model

$$SMR_{it} = 125.9331 + 0.590466 * GINI_{it} + 1.604706 * INFR_{it} - 0.001906 * GDPC_{it} - 0.42161 * UNEMR_{it} + 0.007777 * BDEF_{it} + 0.535439 * SBE_{it} + \alpha_i + \varepsilon_{it}$$

Also, according to the t test, all parameters are significant from a statistical point of view for a significance level of 0.05. Regarding the autocorrelation of the errors, according to the Durbin-Watson test the errors are positively correlated (0.31).

In the second phase of the analysis, a regression model with random effects was performed. The regression model is statistically valid, but the SMR variation is explained only in proportion of 53.3% by the independent variables.

Equation 2. The equation of the random effects regression model

$$SMR_{it} = 126.3055 + 0.592279 * GINI_{it} + 1.622745 * INFR_{it} - 0.0019 * GDPC_{it} - 0.44075 * UNEMR_{it} + 0.006382 * BDEF_{it} + 0.510905 * SBE_{it} + \alpha + u_{it} + \varepsilon_{it}$$

Both the fixed-effects and the random-effects equation show that in the EU member states, the factors with the greatest impact on the mortality are the following: **inflation rate**, **income**, **"snowball" effect** and **unemployment rate**.

After analyzing the two regression models, we can deduce that in the countries with the highest GDP per inhabitant, the SMR for adults is lower and vice versa. However, it can be observed that due to an increase in the unemployment rate, the number of deaths per 1,000 inhabitants decreases. On the other hand, a European country characterized by inflation rate, a high public deficit and an increase in the discrepancy between population incomes is more likely to face increased adult mortality. This is the case for countries like Romania, Bulgaria and Lithuania, that are facing the consequences of inflation and income inequality. Also, if the interest rate associated with the debts exceeds the growth rate of GDP, the effect of "snowball" intervenes, which leads to an increase in the number of deaths (in particular countries as Romania, Bulgaria and Hungary).

After applying the Hausman test, the best model for the selected panel data is the fixed effects regression model.

Table 2. Fixed effects specific to each country

Country	Effect	Country	Effect
Belgium	0.299269	Lithuania	70.82739
Bulgaria	9.859135	Luxemburg	68.10405
Czech Republic	-14.1829	Hungary	33.31375
Denmark	21.74918	Malta	-52.3491
Germany	-15.3694	Netherlands	-7.4469
Estonia	38.09473	Austria	-2.93708
Ireland	6.281578	Poland	5.334529
Greece	-38.6794	Portugal	-27.1133
Spain	-36.3849	Romania	7.061337
France	-10.4448	Slovenia	-15.4042
Croatia	-14.8487	Slovakia	6.998796
Italy	-46.8625	Finland	12.45967

Country	Effect	Country	Effect
Cyprus	-38.6666	Sweden	-5.35619
Latvia	61.57281	United Kingdom	-15.9105

Source data: Own computations based on Eurostat database

The study of the fixed effects has an important role in understanding the impact of economic factors on the mortality evolution. Thus, it can be observed that these effects differ depending on the specific economic power of each country. For example, for countries such as Lithuania, Luxembourg, Latvia and Malta, the mark of the economic factors on the studied phenomenon has the highest weight compared to the other countries of the European Union. To understand the impact of these effects on the mortality rate of the adult population, we assumed all independent variables having a constant value (equal to 0). The resulting rate is compared, in the following graph with the average value for the selected time period.

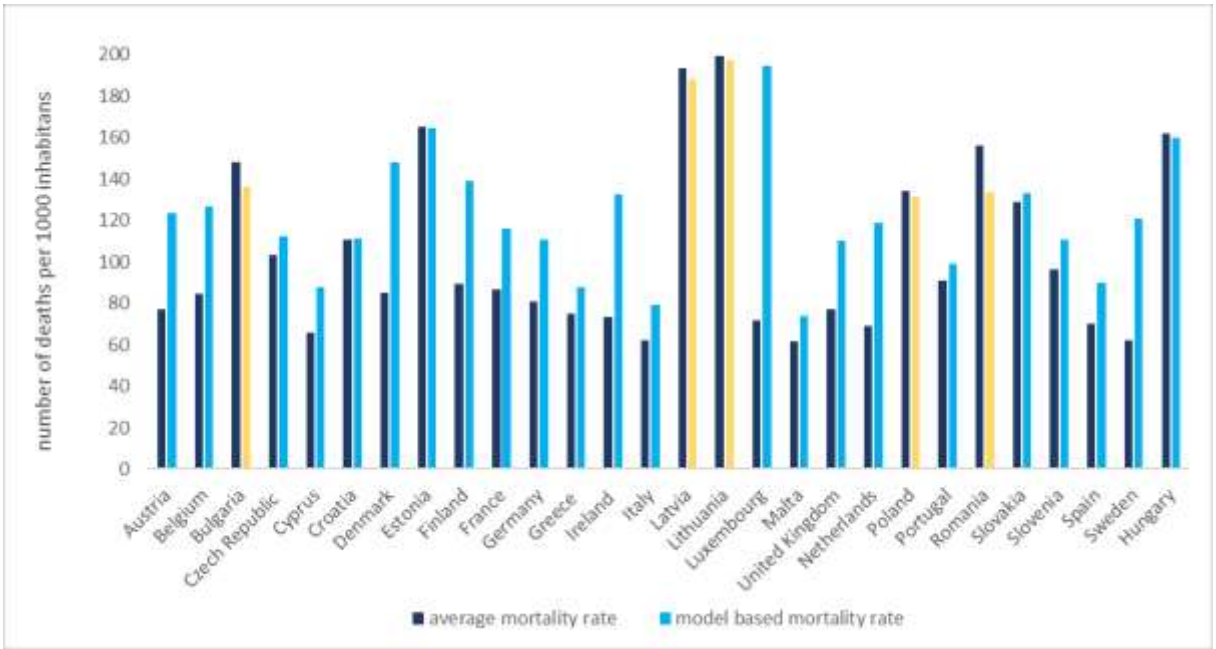


Figure 2. The average standardized adult mortality rate versus the rate based on the fixed effects model

Source data: Own representation based on selected Eurostat indicators

After the application of country-specific fixed effects, it can be observed that, for the same level of independent variables, most countries in the European Union would have a much higher mortality rate than the average rate recorded in the last 16 years. Therefore, it is proved that the economic mechanisms of a society are some of the main engines that support the life extension process.

Noteworthy is the fact that, in the case of countries with high levels of adult mortality such as Latvia, Lithuania, Poland, Romania and Bulgaria, economic influence is a negative factor in drawing the studied trend. This paradox is triggered by economic instability in the mentioned countries, these being former communist states. The restrictive political regime

they have faced has slowed down their socio-economic development. Therefore, in the case of these states, from 2000 to 20016, the economic factors played an important role as in the developed countries, only that it had a negative impact. Thus, by diminishing the economic influences, the specific adult mortality rates would decrease considerably for these states, in contrast to the rest of the European Union countries. This economic paradox characterizing the European Union states can be an alarm for the adoption of measures to extend to the Europeans' life expectancy.

4. Conclusions

The relationship between the mortality phenomenon and the economic factors that characterize a nation represents a subject of global interest, which has intensified in recent years due to the exacerbated development of Europe. Most authors who have expressed interest in this field have tried to determine if mortality responds to the incentives created by the pressure of the economic market.

In order to respond to the main questions proposed by this study, we have used a panel regression model with fixed effects, which reveals the impact of economic factors on adult mortality rate for European Union countries for a period of 16 years.

The study proves that the original hypothesis sustaining that the economic context influence the adult mortality rate is valid, therefore an acceleration of economic growth can produce a decline in mortality rate for European Union countries. Thus, the countries with strong economies support a qualitative lifestyle and manage to contribute to increase the number of years of life. Also, the regression model shows that a country with a developing economy is often accompanied by a high adult mortality rate, meaning that with the economy further developing the rate will decrease.

The recent intensification of the economic impact on the member countries of the European Union has led to a mortality decline, but some countries, including Romania, still face a much higher rate than the European average. Following the analysis outlined in this study, we were able to determine that the economic factors related to the labor market, purchasing power, as well as the budget deficit that explains the state of economic development of a state can shape this phenomenon.

When the other factors chosen for this study remain unchanged, the mortality trend is perceived like a paradox. Thus, the developed countries would face a higher mortality rate, because in this case the economic impact is a positive one. On the other hand, countries like Romania, Bulgaria, Latvia, Lithuania and Poland would have a reduced adult mortality rate if the economic growth would accelerate in order to progress. This developing countries are marked in the past by restrictive economic policies, so the reduction in the number of deaths over time is a slow process. Romania, a country still facing instability and poverty, is the country most affected by the current situation of the financial system. If Romania would be able to be on the list of developed countries, it could experience an impressive decrease in mortality.

In conclusion, this analysis of country effects demonstrates the importance of economic development in studying the phenomenon of mortality. The different condition of a country's economic growth will impact on the adult mortality rate in a different way. All variables

show the importance of studying this phenomenon in economic context and taking this result into consideration in public policies elaboration. The evolution of a society is based on ensuring optimal living conditions for all citizens, providing opportunities and preserving cultural values. Certainly, despite the studies and analyzes, mortality cannot be regarded as a purely economic phenomenon. However, this certainty does not influence the fact that there is a connection between economic performance and rising or falling mortality.

The public policies adopted for reducing adult mortality should be, based on this study, in function of the progress stage of each country. Furthermore, countries like Romania should create strategies to increase the national income, because the discrepancy between the incomes of rich people and poor people is at this moment too high, leading to migration out of the incapacity of having a qualitative lifestyle. Also, for the purpose of reducing mortality, authorities should attract foreigners and local investors to have a stack in the country economy, because the progress of the business world means creating jobs and so reducing unemployment. On the other hand, inflation problem is one of the subjects that has to be taken in consideration, besides resolving the public deficit.

Summing up, this paper covers up the economic influence for developed and developing countries for a period of 16 years, in which time an economic crisis has stroked. Therefore, the results revealed in this article should be further explored by studying the impact of this factors for the crisis period and separately for rich and poor countries.

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Annex 1. Panel regression model with fixed effects

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	125.9331	9.079391	13.87021	0
GINI	0.590466	0.286671	2.059734	0.04
INFR	1.604706	0.162451	9.878075	0
UNEMR	-0.42161	0.163089	-2.585142	0.0101
GDPC	-0.001906	0.000121	-15.75371	0
BDEF	0.007777	0.002853	2.725795	0.0067
SBE	0.535439	0.197653	2.708985	0.007
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.947738	Mean dependent var		102.8004
Adjusted R-squared	0.943836	S.D. dependent var		43.00267
S.E. of regression	10.19115	Akaike info criterion		7.549665

Sum squared resid	45905.87	Schwarz criterion	7.847195
Log likelihood	-1762.82	Hannan-Quinn criter.	7.666658
F-statistic	242.8918	Durbin-Watson stat	0.310515
Prob(F-statistic)	0		

Source data: Own computations based on Eurostat database

Annex 2. Panel regression model with random effects

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	126.3055	10.50211	12.02668	0
GINI	0.592279	0.280284	2.113142	0.0351
INFR	1.622745	0.162096	10.01101	0
UNEMR	-0.440751	0.162353	-2.71477	0.0069
GDPC	-0.001899	0.000114	-16.65568	0
BDEF	0.006382	0.002734	2.334293	0.02
SBE	0.510905	0.197325	2.589159	0.0099

Effects Specification		
	S.D.	Rho
Cross-section random	29.30184	0.8921
Idiosyncratic random	10.19115	0.1079

Weighted Statistics			
R-squared	0.533203	Mean dependent var	8.640898
Adjusted R-squared	0.527231	S.D. dependent var	14.90573
S.E. of regression	10.24891	Sum squared resid	49263.83
F-statistic	89.28647	Durbin-Watson stat	0.289992
Prob(F-statistic)	0		

Unweighted Statistics			
R-squared	0.411716	Mean dependent var	102.8004
Sum squared resid	516739	Durbin-Watson stat	0.027647

Source data: Own computations based on Eurostat database

Annex 3. Hausman Test

Correlated Random Effects - Hausman Test			
Test cross-section random effects			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	11.331727	6	0.0786

Source data: Own computations based on Eurostat database