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**ANALYSIS OF THE RELATION BETWEEN CANCER DEATHS AND SOME
MACROECONOMIC INDICATORS WORLDWIDE.**

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1. INTRODUCTION:

Recent analyses have emphasized the importance of studying the relation between cancer and some macroeconomic variables. Whether a country can have higher levels of cancer or otherwise lower levels depends on a lot of factors such as, for instance, pollution, geographical location, nuclear testing, nutrition ... In this paper, we want to seek the influence of other variables with an economic character.

Our main variables will be: Gross Domestic Product (GDP), some health expenditures and population. Of particular interest is whether all these variables can explain something about the number of deaths caused by cancer per 100.000 inhabitants, which is our dependent variable, that is, the variable on which we will focus our study. It will be checked what is the degree of its explicative power, if any. To show it, we have created some econometric models using all of our variables in different ways.

In this writing, it has been taken a sample of 186 countries of every part of the world to be a reference of the entire world and also it has made an important difference between men and women, because as we will see later, both cases are very different. Thanks to our study we can show the countries with the highest number of deaths by cancer (e.g. Mongolia, some European countries and the Caribbean Islands) as far as those with the smallest number of deaths (e.g. The Eastern Mediterranean region and Central America).

In conclusion, this paper presents some results about these possible relations. Most of the information used comes from 2008. And to our knowledge, we present some important extra data provided by World Health Organization (WHO) that is very influential for our study:

- Cancer is one of the most important causes of death in the world. In 2008, there were 12.7 million of new cases and 7.6 million deaths because of this.
- Globally, 19% of all cancers are attributable to the environment, in particular to the work environment, what represents 1.3 million deaths per year.
- The WHO has classified 107 substances, mixes, and exposure situations as carcinogenic to humans.
- The external environmental causes of cancer are environmental factors that increase the risk of cancer, such as air pollution, ultraviolet radiation and radon in indoors.
- One of each ten deaths by lung cancer is closely related to risks presents in the workplace.
- Lung cancer, mesothelioma and bladder cancer are some of the most common occupational cancers.

2. MAIN RESULTS:

2.1. DATA:

We have studied the relation between deaths by cancer and some macroeconomic indicators such as GDP, total health expenditures, population... We will see later more about them. We have considered a sample of 186 countries in 2008, separating the analysis between men and women to have a better perspective of the whole sample.

2.1.1. Variables:

The following section sketches the explanation of key variables implied in the model:

Deaths by cancer:

This is the dependent variable and represents the number of deaths caused by cancer per each 100.000 inhabitants, taking an age-standardized estimation. This variable has been taken from the WHO (World Health Organization). We establish the difference between men (MEN_CANCER) and women (WOMEN_CANCER).

Gross Domestic Product (GDP):

It is the sum of the gross value added of all resident producers in the economy plus any product taxes, less any subsidies not included in the value of products. The data is expressed in dollars at current prices. So, it is GDP (US\$ to actual prices).

Total Health Expenditure (THE):

It is the sum of public and private expenditure on health. It is expressed like a percentage of GDP.

Private Health Expenditure (PRE) and Public Health Expenditure (PUE):

Private health expenditure is the percentage that represents the expenses paid by the patient, such as direct repeal of households, while Public health expenditure is a percentage of total health expenditure that includes the recurrent and capital spending from government budgets (central and local), external borrowing, grants and insurance funds of social health.

Population:

This variable represents the number of inhabitants in all the countries that we have considered in 2008.

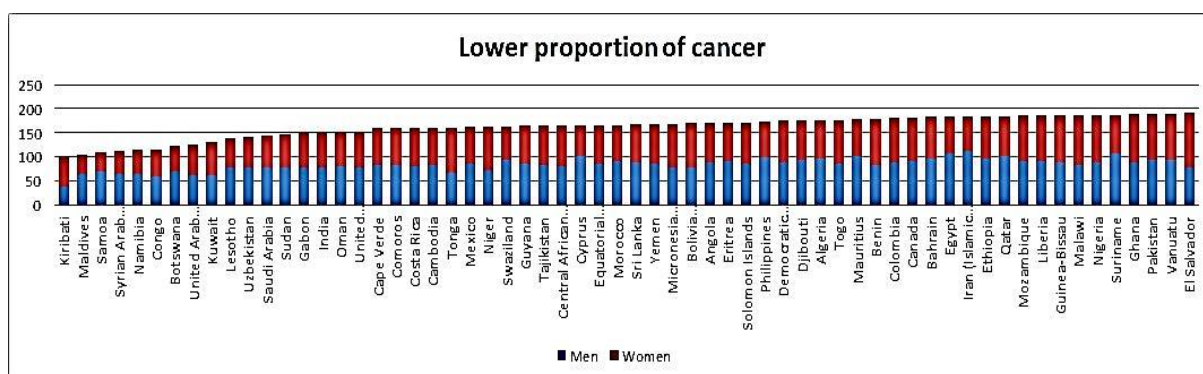
We will use these and other variable, which will be described later on, in the models. All of these variables are the independent variables and they have been taken from World Bank.

2.1.2. Descriptive analysis:

2.1.2.1. Dependent variable:

First, we analyze the dependent variable of our model: Deaths by cancer. We have represented all the countries according to it in different levels. Figure 2.1-2.3 depicts.

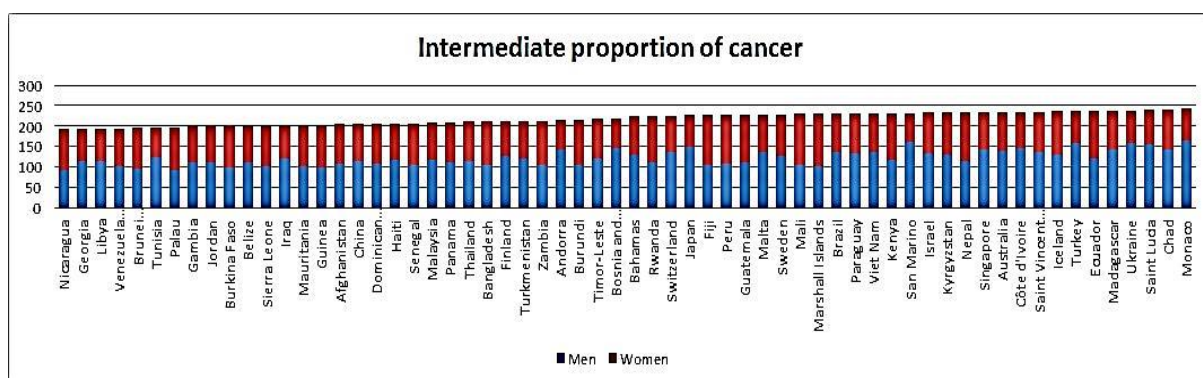
Figure 2.1: Lower proportion of deaths by cancer:



Source: WHO.

This figure shows the third part of the countries included in our sample that are the least affected by cancer deaths. It observes that men and women have a similar proportion of deaths caused by cancer in the majority of countries.

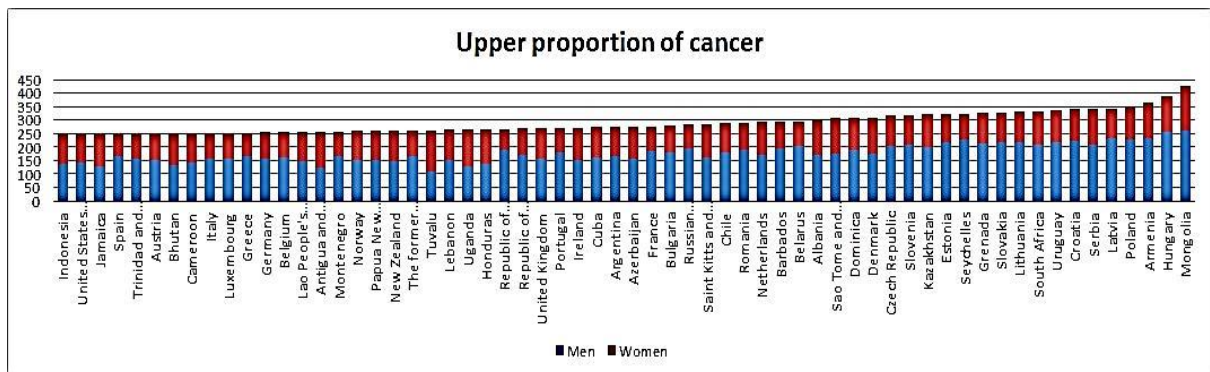
Figure 2.2: Intermediate proportion of deaths by cancer:



Source: WHO.

In this figure, we observe the countries that have an intermediate proportion of deaths caused by cancer. In many of them, deaths by cancer have affected to men more than women.

Figure 2.3: Upper proportion of deaths by cancer:



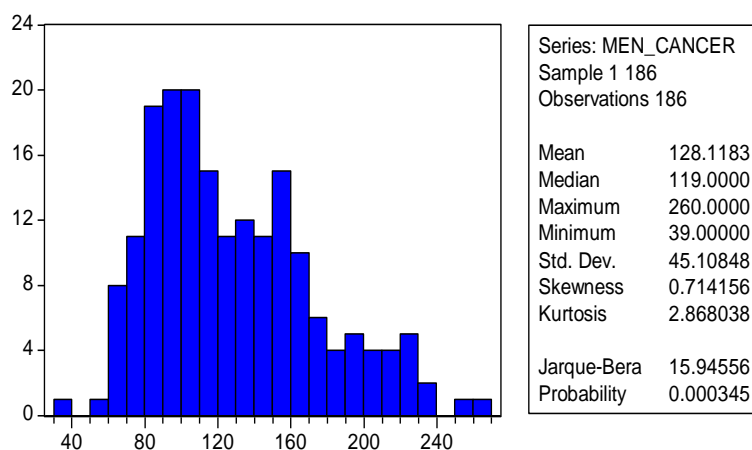
Source: WHO.

This last group shows the countries with the highest incidence of deaths by cancer. Men are more affected than women.

In general, analyzing these figures, we can observe the distribution of deaths by cancer. Women are represented in red and men in blue. Mongolia, Hungary and Armenia are the countries where the proportion of cancer per 100.000 inhabitants is the highest, while Kiribati, Maldives and Samoa are the countries with the least proportion of deaths of cancer. Spain is located in the upper group near the United States and Jamaica.

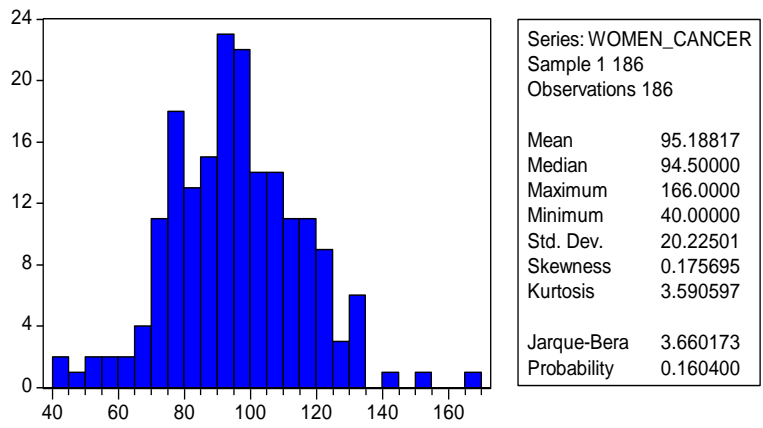
Following with the descriptive analysis of this variable, we make the difference between men and women, being the correlation between them: 0.539545.

Figure 2.4: Descriptive analysis for men:



In the men's sample the null hypothesis of normality is rejected by the statistic by Jarque & Bera. The statistic value is 15.95 with a very low p-value (approx. zero).

Figure 2.5: Descriptive analysis for women:



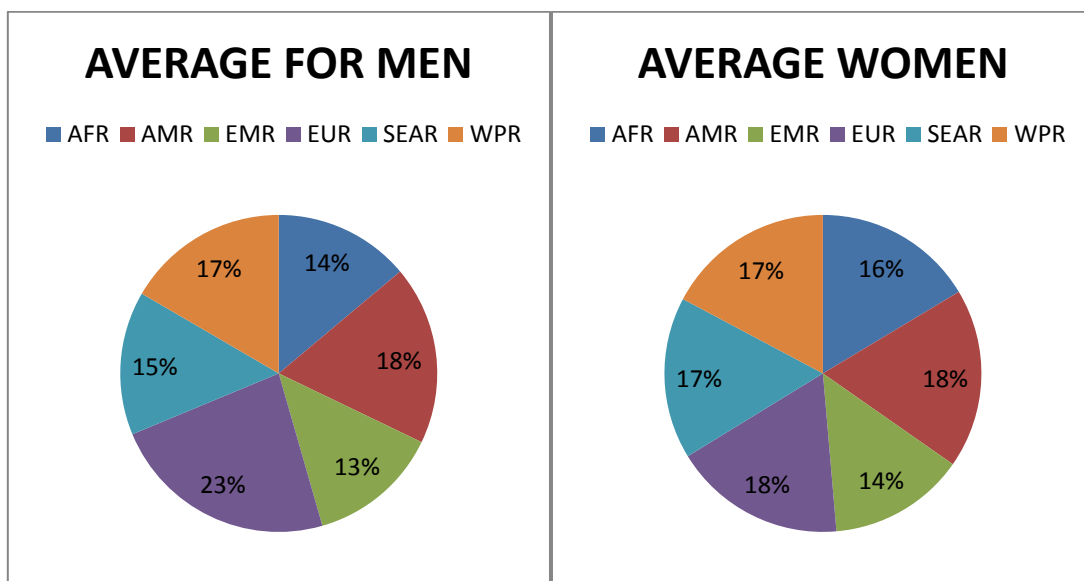
In the women’s sample the null hypothesis of normality is not rejected, because of the statistic value of Jarque & Bera is 3.66 with a p-value equal to 0.16.

Now, we study our dependent variable according to different regions:

Code	DisplayValue
EUR	Europe
SEAR	South-East Asia
WPR	Western Pacific
AFR	Africa
AMR	Americas
EMR	Eastern Mediterranean

And we represent deaths by cancer per 100.000 in two proportional graphics:

Figure 2.6: Average of incidence of deaths by cancer by regions:



We have considered the average of deaths by cancer per region to have a general vision of the percentage in each one of them. In the women's case there is much homogeneity around 17%, with the exception of Eastern Mediterranean that is lower. However, in the men's case there are many differences between regions being Europe where the incidence is higher with a 23% and on the other hand, Eastern Mediterranean is the region with the lowest incidence of deaths by cancer as in the previous case.

2.1.2.2. Independent variables:

In this section we will compute the correlation between all of the variables included in our econometric models.

Table 2.1: Correlation matrix:

	GDP	THE	PRE	PUE	POP
GDP	1.000000	0.293829	-0.222553	0.041167	0.405405
THE	0.293829	1.000000	-0.260495	0.184186	-0.071869
PRE	-0.222553	-0.260495	1.000000	-0.142647	-0.001368
PUE	0.041167	0.184186	-0.142647	1.000000	-0.148199
POP	0.405405	-0.071869	-0.001368	-0.148199	1.000000

We observe that private health expenditure (PRE) has a negative correlation with all of the rest of variables and the same happens for population, which has a negative correlation for all the variables but GDP, that is 0.405. Moreover, we stress that the correlation between private and total health expenditure is negative (-0.26), whereas correlation between public and total health expenditure is positive (0.184).

2.2. MODELS:

2.2.1. General models:

We first build two models with all the independent variables that we have described before against the number of deaths by cancer per 100.000 for men and women. We take logarithms in our variables to reduce the homogeneity.

2.2.1.1. Men's case:

The regression that we use is:

$$\begin{aligned} \text{Log (MEN_CANCER)} = & \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (THE)} + \beta_3 * \text{Log (PRE)} \\ & + \beta_4 * \text{Log (PUE)} + \beta_5 * \text{Log (POP)} + \varepsilon_i \end{aligned} \quad (1)$$

Table 2.2: Model for deaths by cancer in men using OLS:

Dependent Variable: LOG(MEN_CANCER)
 Method: Least Squares
 Date: 03/25/13 Time: 16:13
 Sample: 1 186
 Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.727792	0.402582	6.775737	0.0000
LOG(GDP)	0.090513	0.016273	5.562118	0.0000
LOG(THE)	0.229241	0.052971	4.327692	0.0000
LOG(PRE)	0.201214	0.047378	4.246973	0.0000
LOG(PUE)	-0.043163	0.062792	-0.687401	0.4927
LOG(POP)	-0.077865	0.019297	-4.035183	0.0001
R-squared	0.295223	Mean dependent var		4.792818
Adjusted R-squared	0.275646	S.D. dependent var		0.348710
S.E. of regression	0.296783	Akaike info criterion		0.440097
Sum squared resid	15.85446	Schwarz criterion		0.544153
Log likelihood	-34.92903	F-statistic		15.07999
Durbin-Watson stat	1.839482	Prob(F-statistic)		0.000000

Our sample has 186 observations (one for each country). All the variables are significant, but Log (PUE), which is not significant, because its p-value is high (0,4927). The only variable that rejects H_0 is Log (PUE): Public Health Expenditure. The rest of the variables do not reject H_0 at any percentage. We can observe that Log (PUE) and Log (POP) have negative coefficients.

2.2.1.2. Women's case:

In this case, the regression will be:

$$\text{Log (WOMEN_CANCER)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (THE)} + \beta_3 * \text{Log (PRE)} + \beta_4 * \text{Log (PUE)} + \beta_5 * \text{Log (POP)} + \varepsilon_i \quad (2)$$

Table 2.3: Model for deaths by cancer in women using OLS:

Dependent Variable: LOG(WOMEN_CANCER)
 Method: Least Squares
 Date: 03/25/13 Time: 16:24
 Sample: 1 186
 Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.982172	0.294054	13.54231	0.0000
LOG(GDP)	-0.005040	0.011886	-0.424059	0.6720
LOG(THE)	0.147599	0.038691	3.814841	0.0002
LOG(PRE)	0.096129	0.034606	2.777821	0.0061
LOG(PUE)	-0.017739	0.045864	-0.386773	0.6994
LOG(POP)	0.004092	0.014095	0.290302	0.7719
R-squared	0.094227	Mean dependent var		4.531978
Adjusted R-squared	0.069066	S.D. dependent var		0.224674
S.E. of regression	0.216776	Akaike info criterion		-0.188175

Sum squared resid	8.458559	Schwarz criterion	-0.084118
Log likelihood	23.50025	F-statistic	3.745043
Durbin-Watson stat	2.065770	Prob(F-statistic)	0.002996

This case is very different, because we can observe there are three variables that are not significant: Log (GDP), Log (PUE) and Log (POP) (GDP, Public Health Expenditure and Population), with a p-value of 0,672; 0,6994 and 0,7719, respectively. They are very high values, so for these variables, we do not reject the null hypothesis of individual significance.

2.2.2. Other models:

In this section, we are going to talk about some specific models, making the difference between men and women.

2.2.2.1. Men's models:

The first model will be the relation between the regressors: GDP and population according to the dependent variable (Number of deaths by cancer in men), using logarithms. So, the regression is:

$$\text{Log (MEN_CANCER)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \varepsilon_i \quad (3)$$

Table 2.4:

Dependent Variable: LOG(MEN_CANCER)
Method: Least Squares
Date: 04/05/13 Time: 14:00
Sample: 1 186
Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.765969	0.231037	16.30027	0.0000
LOG(GDP)	0.093230	0.015061	6.190239	0.0000
LOG(POP)	-0.077874	0.017071	-4.561823	0.0000
R-squared	0.173571	Mean dependent var		4.792818
Adjusted R-squared	0.164538	S.D. dependent var		0.348710
S.E. of regression	0.318733	Akaike info criterion		0.567072
Sum squared resid	18.59112	Schwarz criterion		0.619100
Log likelihood	-49.73772	F-statistic		19.21725
Durbin-Watson stat	1.747416	Prob(F-statistic)		0.000000

We can see that β_1 and β_2 are significant and they reject the null hypothesis. Moreover, $\beta_1 \approx |\beta_2|$. It can be proved by the following regression:

$$\text{Log (MEN_CANCER)} = \beta_0 + \beta_1 * \text{Log (GDP/POP)} + \varepsilon_i \quad (4)$$

Table 2.5:

Dependent Variable: LOG(MEN_CANCER)
 Method: Least Squares
 Date: 04/05/13 Time: 14:00
 Sample: 1 186
 Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.034347	0.128041	31.50817	0.0000
LOG(GDPPC)	0.089638	0.014877	6.025385	0.0000
R-squared	0.164795	Mean dependent var		4.792818
Adjusted R-squared	0.160256	S.D. dependent var		0.348710
S.E. of regression	0.319549	Akaike info criterion		0.566882
Sum squared resid	18.78852	Schwarz criterion		0.601567
Log likelihood	-50.72001	F-statistic		36.30526
Durbin-Watson stat	1.756663	Prob(F-statistic)		0.000000

We can notice this regression satisfies (3), what it means that both variables have the same meaning than GDP per capita.

Now, we change the orientation of the variables included in regression (3) to prove the causality of them respect to others:

First, we focus on Private Health Expenditure (PRE):

$$\text{Log (PRE)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \beta_3 * \text{Log (MEN_CANCER)} + \varepsilon_i \quad (5)$$

Table 2.6:

Dependent Variable: LOG(PRE)
 Method: Least Squares
 Date: 04/05/13 Time: 14:01
 Sample: 1 186
 Included observations: 186

	Coefficient	Std. Error	t-Statistic	Prob.
C	2.475950	0.535412	4.624379	0.0000
LOG(GDP)	-0.019914	0.024512	-0.812407	0.4176
LOG(POP)	0.036365	0.026662	1.363916	0.1743
LOG(MEN_CANCER)	0.359579	0.109403	3.286744	0.0012
R-squared	0.065553	Mean dependent var		4.285785
Adjusted R-squared	0.050150	S.D. dependent var		0.484010
S.E. of regression	0.471717	Akaike info criterion		1.356397
Sum squared resid	40.49812	Schwarz criterion		1.425768
Log likelihood	-122.1449	F-statistic		4.255889
Durbin-Watson stat	1.898859	Prob(F-statistic)		0.006208

We can observe Log (GDP) and Log (POP) are not significant and they do not reject H_0 . However, Log (MEN_CANCER) is significant with a p-value equal to 0.0012.

Second, we focus on Public Health Expenditure (PUE):

$$\text{Log (PUE)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \beta_3 * \text{Log (MEN_CANCER)} + \varepsilon_i \quad (6)$$

Table 2.7:

Dependent Variable: LOG(PUE)
 Method: Least Squares
 Date: 04/05/13 Time: 14:01
 Sample: 1 186
 Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.969408	0.401383	9.889317	0.0000
LOG(GDP)	0.136361	0.018376	7.420470	0.0000
LOG(POP)	-0.179441	0.019988	-8.977527	0.0000
LOG(MEN_CANCER)	-0.096401	0.082016	-1.175387	0.2414
R-squared	0.317657	Mean dependent var		3.993574
Adjusted R-squared	0.306409	S.D. dependent var		0.424621
S.E. of regression	0.353633	Akaike info criterion		0.780156
Sum squared resid	22.76024	Schwarz criterion		0.849527
Log likelihood	-68.55454	F-statistic		28.24262
Durbin-Watson stat	1.858888	Prob(F-statistic)		0.000000

In this case, it is the opposite that the previous case (3). GDP and population are significant and they reject H_0 . However, the variable MEN_CANCER is not significant having a p-value of 0.2414.

Finally, we study Total health expenditure (THE):

$$\text{Log (THE)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \beta_3 * \text{Log (MEN_CANCER)} + \varepsilon_i \quad (7)$$

Table 2.8:

Dependent Variable: LOG(THE)
 Method: Least Squares
 Date: 04/05/13 Time: 14:01
 Sample: 1 186
 Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.684663	0.473728	1.445265	0.1501
LOG(GDP)	-0.004860	0.021688	-0.224099	0.8229
LOG(POP)	-0.015737	0.023590	-0.667098	0.5056
LOG(MEN_CANCER)	0.308362	0.096799	3.185596	0.0017
R-squared	0.068456	Mean dependent var		1.802257
Adjusted R-squared	0.053101	S.D. dependent var		0.428914
S.E. of regression	0.417371	Akaike info criterion		1.111590

Sum squared resid	31.70418	Schwarz criterion	1.180961
Log likelihood	-99.37784	F-statistic	4.458174
Durbin-Watson stat	2.341261	Prob(F-statistic)	0.004766

It is the same situation than the first case (5), where the p-value for GDP and Population is very high, so they are not significant and they do not reject H_0 . On the other side, the variable MEN_CANCER is significant with a p-value of 0.0017.

In this way, we can see the influence of deaths by cancer in men according to Public, Private and Total Health Expenditures. We notice that MEN_CANCER has much influence in Private Expenditure and Total Expenditure, whereas that it does not have influence in Public Expenditure.

The idea is that if one person can pay a treatment against cancer, he will have more probability of avoiding to die than a person who lives in a country where the investment in private health expenditure is fewer and so he could not pay a private treatment. In this last case, he will have to go to public health service that depends on population and GDP. As private health expenditure is a part of total health expenditure, we conclude that if private health expenditure is high in a country, total health expenditure will be it too. In this way, the relation between this two indicators and deaths by cancer in men is high.

2.2.2.2. Women's models:

In this part, we repeat the same process for deaths by cancer in women:

$$\text{Log (WOMEN_CANCER)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \varepsilon_i \quad (8)$$

Table 2.9:

Dependent Variable: LOG(WOMEN_CANCER)
Method: Least Squares
Date: 04/05/13 Time: 14:02
Sample: 1 186
Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.558845	0.163721	27.84522	0.0000
LOG(GDP)	-0.002466	0.010673	-0.231040	0.8175
LOG(POP)	0.002078	0.012097	0.171818	0.8638
R-squared	0.000292	Mean dependent var	4.531978	
Adjusted R-squared	-0.010634	S.D. dependent var	0.224674	
S.E. of regression	0.225865	Akaike info criterion	-0.121759	
Sum squared resid	9.335765	Schwarz criterion	-0.069731	
Log likelihood	14.32357	F-statistic	0.026742	
Durbin-Watson stat	2.016706	Prob(F-statistic)	0.973616	

We can see that β_1 and β_2 are significant and they reject the null hypothesis. Moreover, $\beta_1 \approx |\beta_2|$. So, they satisfy the following regression:

$$\text{Log (WOMEN_CANCER)} = \beta_0 + \beta_1 * \text{Log (GDP/POP)} + \varepsilon_i \quad (9)$$

Table 2.10:

Dependent Variable: LOG(WOMEN_CANCER)
Method: Least Squares
Date: 04/05/13 Time: 14:03
Sample: 1 186
Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.552076	0.090257	50.43451	0.0000
LOG(GDPPC)	-0.002375	0.010487	-0.226496	0.8211
R-squared	0.000279	Mean dependent var	4.531978	
Adjusted R-squared	-0.005155	S.D. dependent var	0.224674	
S.E. of regression	0.225252	Akaike info criterion	-0.132498	
Sum squared resid	9.335891	Schwarz criterion	-0.097813	
Log likelihood	14.32232	F-statistic	0.051301	
Durbin-Watson stat	2.016959	Prob(F-statistic)	0.821067	

We can notice this regression satisfies (8), which means that both variables have the same meaning as GDP pc.

Now, we make the same than in the men's case, we change the orientation of the variables included in regression (8) to prove the causality of them:

First, for Private Health Expenditure (PRE):

$$\text{Log (PRE)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \beta_3 * \text{Log(WOMEN_CANCER)} + \varepsilon_i \quad (10)$$

Table 2.11:

Dependent Variable: LOG(PRE)
Method: Least Squares
Date: 04/05/13 Time: 14:03
Sample: 1 186
Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.453276	0.797337	3.076838	0.0024
LOG(GDP)	0.014354	0.022716	0.631896	0.5282
LOG(POP)	0.007735	0.025746	0.300449	0.7642
LOG(WOMEN_CANCER)	0.302015	0.157316	1.919791	0.0564
R-squared	0.029737	Mean dependent var	4.285785	
Adjusted R-squared	0.013744	S.D. dependent var	0.484010	
S.E. of regression	0.480672	Akaike info criterion	1.394009	
Sum squared resid	42.05036	Schwarz criterion	1.463380	
Log likelihood	-125.6429	F-statistic	1.859348	
Durbin-Watson stat	1.859808	Prob(F-statistic)	0.138084	

In the second place, for Public Health Expenditure (PUE):

$$\text{Log (PUE)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \beta_3 * \text{Log(WOMEN_CANCER)} + \varepsilon_i \quad (11)$$

Table 2.12:

Dependent Variable: LOG(PUE)
Method: Least Squares
Date: 04/05/13 Time: 14:04
Sample: 1 186
Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.974992	0.588043	6.759701	0.0000
LOG(GDP)	0.127174	0.016753	7.590969	0.0000
LOG(POP)	-0.171766	0.018988	-9.046090	0.0000
LOG(WOMEN_CANCER)	-0.080860	0.116022	-0.696933	0.4867
R-squared	0.314307	Mean dependent var	3.993574	
Adjusted R-squared	0.303004	S.D. dependent var	0.424621	
S.E. of regression	0.354500	Akaike info criterion	0.785053	
Sum squared resid	22.87197	Schwarz criterion	0.854424	
Log likelihood	-69.00996	F-statistic	27.80830	
Durbin-Watson stat	1.858269	Prob(F-statistic)	0.000000	

Finally, we focus on Total health expenditure (THE):

$$\text{Log (THE)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \beta_3 * \text{Log(WOMEN_CANCER)} + \varepsilon_i \quad (12)$$

Table 2.13:

Dependent Variable: LOG(THE)
Method: Least Squares
Date: 04/05/13 Time: 14:05
Sample: 1 186
Included observations: 186

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.115206	0.692771	-0.166297	0.8681
LOG(GDP)	0.024949	0.019737	1.264070	0.2078
LOG(POP)	-0.040644	0.022370	-1.816956	0.0709
LOG(WOMEN_CANCER)	0.430186	0.136685	3.147268	0.0019
R-squared	0.067278	Mean dependent var	1.802257	
Adjusted R-squared	0.051903	S.D. dependent var	0.428914	
S.E. of regression	0.417635	Akaike info criterion	1.112854	
Sum squared resid	31.74428	Schwarz criterion	1.182225	
Log likelihood	-99.49539	F-statistic	4.375907	
Durbin-Watson stat	2.344690	Prob(F-statistic)	0.005307	

In this model that includes deaths by cancer in women, we observe the same outcome as in the men's model. So, we can see the influence of deaths by

cancer in women according to Public, Private and Total Health Expenditures. We notice that WOMEN_CANCER has much influence in Private Expenditure and Total Expenditure, whereas that it does not have influence in Public Expenditure, and the explanation of this issue would be the same as in men.

2.2.3. Analysis of the residuals:

In this section, we present some figures with the residuals of men and women. We use these graphics to observe the distribution of deaths by cancer in all the countries that we have chosen. We represent the standardized values of the residuals in the two next graphics and also the main countries that are located in two tails with a significance level of 5%.

Figure 2.7: Residuals of men and women:

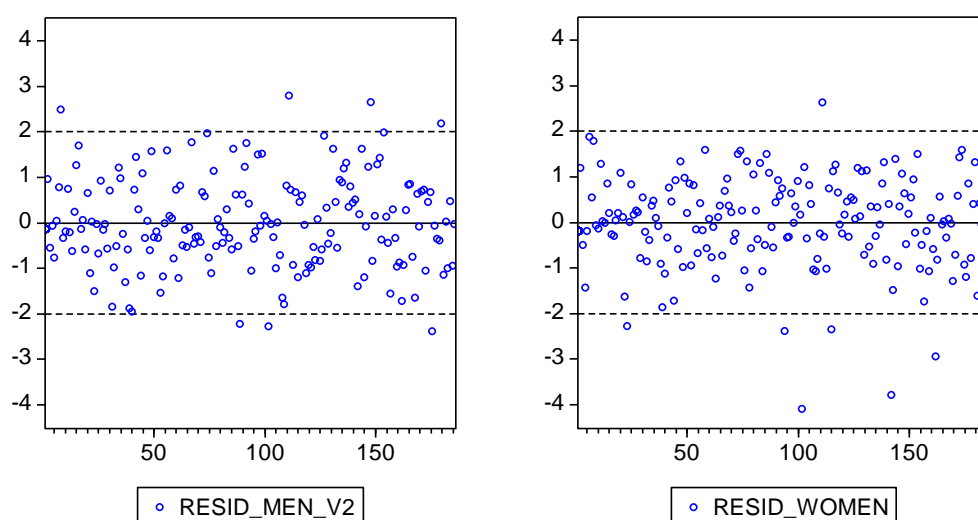


Table 2.14: Mean countries located in the left tail:

Left-tail			
Countries	Men	Countries	Women
United Arab Emirates	-2,3879183	Maldives	-4,09829381
Maldives	-2,27633871	Samoa	-3,79390628
Kuwait	-2,21436587	Syrian Arab Republic	-2,94802279
Costa Rica	-1,94659855	Lesotho	-2,38558284
Congo	-1,87636418	Namibia	-2,35214783
Canada	-1,84832526	Botswana	-2,27402146
Micronesia (Federated States)	-1,782979	Congo	-1,87144946
Syrian Arab Republic	-1,72357584	Sudan	-1,73313721
Tonga	-1,64361695	Cyprus	-1,72229819

Mexico	-1,64108667	Bosnia and Herzegovina	-1,63425767
Sudan	-1,56353638	Uzbekistan	-1,61285632
El Salvador	-1,54072392	San Marino	-1,49122826
Botswana	-1,50678071	Andorra	-1,43365132
Samoa	-1,39247474	Iran (Islamic Republic)	-1,42459651
Colombia	-1,31241875	Tunisia	-1,28565709
Gabon	-1,21851187	Georgia	-1,23146098
Namibia	-1,1981639	United Arab Emirates	-1,19262499
Saudi Arabia	-1,18808478	Costa Rica	-1,12717163

Table 2.15: Mean countries located in the right tail:

Right-tail			
Countries	Men	Countries	Women
Croatia	1,44797665	Netherlands	1,2762721
Lithuania	1,50642358	Azerbaijan	1,29397837
Madagascar	1,52316762	Jamaica	1,30249209
Dominica	1,57741484	Uruguay	1,31968744
Estonia	1,58937805	Saint Kitts y Nevis	1,32810721
Poland	1,62673272	Indonesia	1,33843889
Kazakhstan	1,63388596	Denmark	1,33891072
Sao Tome and Principe	1,63781924	Sao Tome and Principe	1,38773331
Belarus	1,7001904	Tuvalu	1,42400263
Latvia	1,75257497	South Africa	1,49999484
Grenada	1,76980422	Honduras	1,50393543
Papua New Guinea	1,91351466	Kazakhstan	1,50762514
Hungary	1,97729042	Hungary	1,58235734
South Africa	1,99772489	Uganda	1,59024631
Uruguay	2,1834833	Fiji	1,59828882
Armenia	2,49714984	Armenia	1,79643509
Seychelles	2,65463653	Antigua and Barbuda	1,8864434
Mongolia	2,79350064	Mongolia	2,62891895

Countries in red are outliers that are represented below or above the significance lines.

It is important to have in consideration if our residuals follow a normal distribution. To prove it we use the statistic by Jarque and Bera and we represent all the residuals with a histogram.

Figure 2.8: Histogram and statistics for men's residuals:

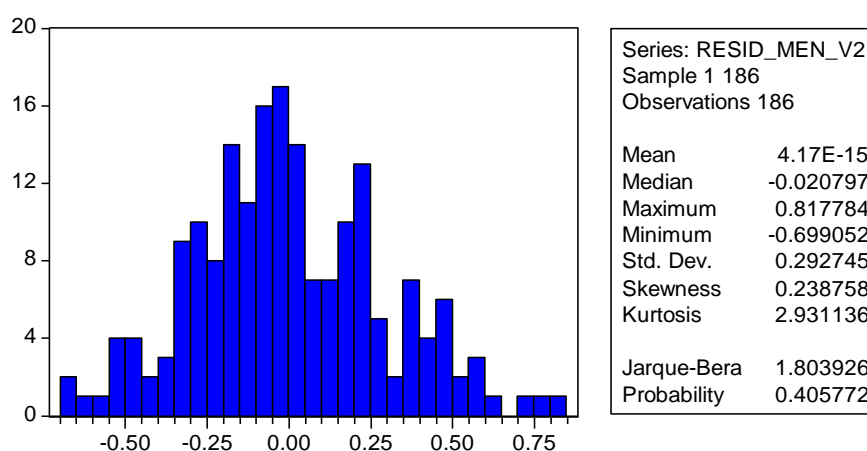
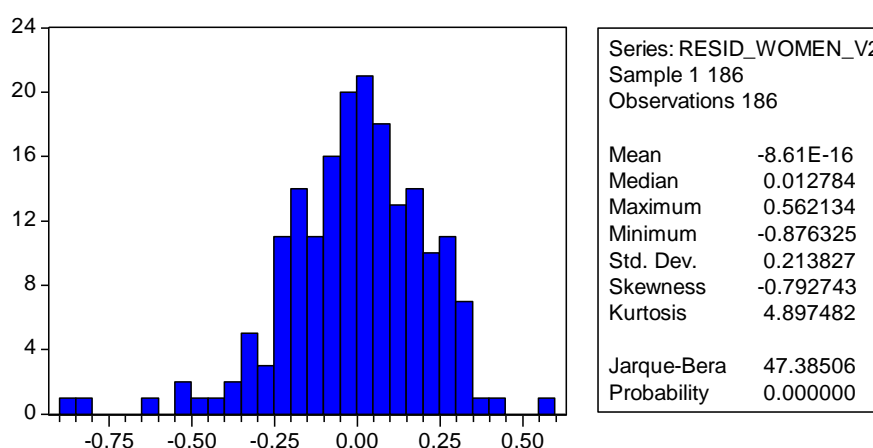


Figure 2.9: Histogram and statistics for women's residuals:



In the men's case, the p-value is equal to 0.4 with a statistic of Jarque&Bera of 1.8: We do not reject H_0 , so there is normality. On the other hand, in the women's case, the p-value is 0 with a statistic of Jarque&Bera of 47.38. So, we reject that there is normality in the residuals of the model.

All this information about residuals of our models explains the origin of the two following maps where the principal countries, which have more and less deaths by cancer per 100.000, are represented. So, in this section, we represent two important maps that we have obtained as residuals of our main models which we have analyzed in the previous section. In these maps the countries with highest and lowest cancer deaths are highlighted.

In this first map, we can see the countries that are in the least 10% of the residuals, that is, they are in the left tail. The red stars are for men and the black stars are for women. We notice that there is a big concentration in Central

America, in the south of Africa, a lot of countries from the west of Asia and some islands in the Pacific Ocean.

Figure 2.10: Countries with the lowest incidences:



Finally, in the opposite case, countries that are in the 10 per cent of the residuals are depicted. In this case, we can observe that the main areas where the residuals are located are: islands from the Caribbean Sea and Europe (although there are other areas like: some countries of Asia, Africa and Indonesia).

Figure 2.11: Countries with the highest incidences:



We observe that in women's case, there are more differences in the residuals than in men's case. For this reason, we want to do another study for women without the outliers to observe if something changes. So, we take the countries in red as the outliers in our model, because if we look at the figure of the residuals, we can see that these countries are outside of the two discontinuous lines that are for a significant of 5%.

The countries we select are: Maldives, Samoa, Syrian Arab Republic, Lesotho, Namibia, Botswana and Mongolia.

Now, we have a sample of 179 countries. We repeat the next two regressions to observe if something changes:

$$\text{Log (WOM_ATYP)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (THE)} + \beta_3 * \text{Log (PRE)} + \beta_4 * \text{Log(PUE)} + \beta_5 * \text{Log (POP)} + \varepsilon_i \quad (13)$$

Table 2.16:

Dependent Variable: LOG(WOM_ATYP)
 Method: Least Squares
 Date: 04/05/13 Time: 18:42
 Sample: 1 179
 Included observations: 179

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.490806	0.254452	17.64896	0.0000
LOG(GDP)	-0.011551	0.010376	-1.113236	0.2672
LOG(THE)	-0.012394	0.033491	-0.370054	0.7118
LOG(PRE)	0.030639	0.030084	1.018448	0.3099
LOG(PUE)	0.002992	0.039918	0.074957	0.9403
LOG(POP)	0.013962	0.012293	1.135823	0.2576
R-squared	0.019525	Mean dependent var	4.551003	
Adjusted R-squared	-0.008813	S.D. dependent var	0.186105	
S.E. of regression	0.186924	Akaike info criterion	-0.483288	
Sum squared resid	6.044699	Schwarz criterion	-0.376448	
Log likelihood	49.25428	F-statistic	0.689013	
Durbin-Watson stat	1.986440	Prob(F-statistic)	0.632388	

With this regression, using the countries without outliers, we observe that there are not important differences with the main model, that is, it has not improved. We have a similar situation. Using the second regression:

$$\text{Log (WOM_ATYP)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \varepsilon_i \quad (14)$$

Table 2.17:

Dependent Variable: LOG(WOM_ATYP)
 Method: Least Squares
 Date: 04/05/13 Time: 18:44
 Sample: 1 179
 Included observations: 179

Variable	Coefficient	Std. Error	t-Statistic	Prob.
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C	4.596303	0.136271	33.72902	0.0000
LOG(GDP)	-0.010986	0.008881	-1.237052	0.2177
LOG(POP)	0.014086	0.010118	1.392193	0.1656
R-squared	0.011256	Mean dependent var	4.551003	
Adjusted R-squared	0.000021	S.D. dependent var	0.186105	
S.E. of regression	0.186103	Akaike info criterion	-0.508410	
Sum squared resid	6.095674	Schwarz criterion	-0.454990	
Log likelihood	48.50268	F-statistic	1.001842	
Durbin-Watson stat	1.982059	Prob(F-statistic)	0.369286	

We can observe a big decrease of p-values in this case respect to the model with all the countries, but even so, they keep on being high and not significant.

So, it is not only because of the outliers that in the women's case there are more differences in residuals.

As we have already seen, women's case is different from men's case, because of the values that we get from the women's models. For this reason, we are going to try to prove if there is some difference between developed countries and developing countries as a new alternative to justify it. We take the countries from OCDE as developed countries and we see what happens.

We make the following regression to create a model that can estimate if there is some difference:

$$\text{Log (WOMEN_CANCER)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \varepsilon_i \quad (15)$$

Table 2.18:

Dependent Variable: LOG(WOMEN_CANCER)
Method: Least Squares
Date: 04/12/13 Time: 12:20
Sample: 1 34
Included observations: 34

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.207238	0.616632	8.444640	0.0000
LOG(GDP)	-0.001800	0.044544	-0.040412	0.9680
LOG(POP)	-0.034417	0.042888	-0.802475	0.4284
R-squared	0.126812	Mean dependent var	4.593590	
Adjusted R-squared	0.070477	S.D. dependent var	0.156514	
S.E. of regression	0.150898	Akaike info criterion	-0.860328	
Sum squared resid	0.705877	Schwarz criterion	-0.725649	
Log likelihood	17.62557	F-statistic	2.251041	
Durbin-Watson stat	1.890068	Prob(F-statistic)	0.122228	

All the variables are not significant, so they do not explain anything of our model. We could think that GDP and population in developed countries are not representative variables to explain deaths by cancer for women.

2.3. FINDINGS:

2.3.1. Especial case in women:

In women's case, there is a greater spread between some countries and others. The independent variables used in our model are not significant (with the exception of Total Health Expenditure and Private Health Expenditure). Moreover, residuals of women's models do not follow a normal distribution, as we have already observed. In men's case, these features do not happen, so we try to explain why it happens in women. We have used two kinds of solutions:

- Eliminate the outliers to observe if the situation is corrected, but we could see that it is not a good solution. However, we have to mention that respect to GDP and population, p-values have decreased largely, but they are still non-significant.
- Reduce our sample of countries, initially we had 186 countries and now we take only 34 countries, belonged to OCDE, to study if the same situation would happen when all countries have similar economic conditions and similar lifestyle. We can see that p-values of our new model are already very high, what indicates that our independent variables do not explain anything about our dependent variable (WOMEN_CANCER) because of they are not significant.

We can conclude that our independent variables do not have a lot of influence over our dependent variable, but also we can see if we change the causality of the model, the variable WOMEN_CANCER has much influence in some of them such as Private Health Expenditure and Total Health Expenditure.

Deaths by cancer in men and women are not significant variables for Public Health Expenditure, what indicates that this spending does not depend on if there are more or less cases of cancer deaths. However, Private Health Expenditure and also Total Health Expenditure depend on the number of deaths by cancer there is in a country.

2.3.2. Mean cases of deaths by cancer:

In this section we are going to explain why there are some countries where there are more deaths by cancer per 100.000 and other countries with fewer deaths. We use all the information we have got of our models and we pay special attention to the information provided by residuals. We show the two mean maps where they are located the most affected countries and also the least affected by deaths by cancer and we will present some possibilities to explain it. So, some possible explanations for our results can be the followings incidents:

2.3.2.1. European countries:

Most of the countries that present the highest incidence of cancer deaths are located in the Northeast of Europe: Lithuania, Estonia, Poland, Latvia, Belarus, and also Netherlands, Denmark. Besides of them, we stress Croatia and Hungary in the South. What are the principal factors that can cause it? We could think in many factors:

First, we mention the nuclear testing and the consequences derived of it. So, we focus on nuclear testing along the history. Prior to 1950, only limited consideration was given to the health impacts of worldwide dispersion of radioactivity from nuclear testing. But in the following decade, humanity began to significantly change the global radiation environment by testing nuclear weapons in the atmosphere. By the early 1960s, there was no place on Earth where the signature of atmospheric nuclear testing could not be found in soil, water and even polar ice.

Cancer investigators who specialize in radiation effects have noticed an increase in cancer rates due to nuclear testing. And although it is difficult to investigate about it amid the large number of cancers arising from "natural" or "unknown" causes, it has found both direct and indirect evidence that radioactive debris dispersed in the atmosphere from testing has adversely affected public health. Frequently, however, there is misunderstanding about the type and magnitude of those effects. Thus today, with heightened fears about the possibilities of nuclear terrorism, it is worthwhile to review what we know about exposure to fallout and its associated cancer risks.

Some historical events such as World War II, have had numerous consequences in the following years. The main problem arising from this is the quantity of different types of radiation, which are of great harm to the population. The radioactive clouds, acid rains, strong winds scatter the radioactive particles, because the radioactive cloud usually takes the form of a mushroom, that familiar icon of the nuclear age. As the cloud reaches its stabilization height, it moves downwind, and dispersion causes vertical and lateral cloud movement. Because wind speeds and directions vary with altitude, radioactive materials spread over large areas. Large particles settle locally, whereas small particles and gases may travel around the world. Rainfall can cause localized concentrations far from the test site. Moreover, we have to mention the effect of external gamma radiation from fallout which is penetrating and affect all organs. Leukemia, which is believed to originate in the bone marrow, is generally considered a "sentinel" radiation effect because some types tend to appear relatively soon after exposure, especially in children, and to be noticed because of high rates relative to the unexposed.¹

¹ *Simon, S., Bouville, A., Land, C. (2006): Fallout from Nuclear Weapons Tests and Cancer Risks.*

Another important event is the reaction of Chernobyl, in Ukraine. The quantity of deaths by cancer has increased since this moment. Observations of thyroid cancer risk among children exposed to fallout from the Chernobyl reactor accident in 1986.

Finally, another possible explanation for cancer deaths in Europe could be the big part of Jewish who suffered the Holocaust. There is a study in the review: "Journal of the National Cancer Institute", where the equipment of Lital Keinan has used documents with a data of 300.000 Jewish born in European countries between 1920 and 1945. They divided them between the Jewish that could emigrate to Israel before the Second World War and the others that could not. The investigators observed that survivors from Holocaust had more risk of cancer than the judies that emigrated to Israel. In men, it is observed an increase of colon's cancer; however, in women it is observed an increase of breast cancer. The lack of food, the bad physical conditions, the cold and the infectious agents could explain this phenomenon.²

2.3.2.2. Kazakhstan and other nuclear information (Japan):

There were other nuclear problems in the world. Here, we present the most known events, stressing Kazakhstan and Japan; being this last a country that is not included as a outlier, but it has been very affected by nuclear actions. The first test explosion of a nuclear weapon, Trinity, was on a steel tower in south-central New Mexico on July 16, 1945. Following that test, nuclear bombs were dropped on Hiroshima and Nagasaki, Japan, in August of 1945. In 1949, the Soviet Union conducted its first test at a site near Semipalatinsk, Kazakhstan. The U.S., the Soviet Union and the United Kingdom continued testing nuclear weapons in the atmosphere until 1963, when a limited test ban treaty was signed. France and China, countries that were not signatories to the 1963 treaty, undertook atmospheric testing from 1960 through 1974 and 1964 through 1980, respectively. Altogether, 504 devices were exploded at 13 primary testing sites, yielding the equivalent explosive power of 440 megatons of TNT. The earliest concern about health effects from exposure to fallout focused on possible genetic alterations among offspring of the exposed. However, heritable effects of radiation exposure have not been observed from decades of follow-up studies of populations exposed either to medical x rays or to the direct gamma radiation received by survivors of the Hiroshima and Nagasaki bombs. Rather, such studies have demonstrated radiation-related risks of leukemia and thyroid cancer within a decade after exposure, followed by increased risks of other solid tumors in later years. Studies of populations exposed to radioactive fallout also point to increased cancer risk as the primary

² Valerio, M. (2009), *Los judíos que sufrieron el Holocausto tienen más riesgo de cáncer.*

late health effect of exposure. As studies of biological samples (including bone, thyroid glands and other tissues) have been undertaken, it has become increasingly clear that specific radionuclides in fallout are implicated in fallout-related cancers and other late effects.

Increased cancer risk is the main long-term hazard associated with exposure to ionizing radiation. The relationship between radiation exposure and subsequent cancer risk is perhaps the best understood, and certainly the most highly quantified, dose-response relationship for any common environmental human carcinogen. Our understanding is based on studies of populations exposed to radiation from medical, occupational and environmental sources (including the atomic bombings of Hiroshima and Nagasaki, Japan), and from experimental studies involving irradiation of animals and cells. Numerous comprehensive reports from expert committees summarize information on radiation-related cancer risk using statistical models that express risk as a mathematical function of radiation dose, sex, exposure age, age at observation and other factors. Using such models, lifetime radiation-related risk can be calculated by summing estimated age-specific risks over the remaining lifetime following exposure, adjusted for the statistical likelihood of dying from some unrelated cause before any radiation-related cancer is diagnosed.

2.3.2.3. French case: Polynesia.

There is a lot of information that indicates and confirms that there is a high relation between the nuclear testing made by France, in Polynesia between 1960 and 1996, and the cancer of many militaries who worked in the facilities focused on the atomic experimentation. We stress above all these countries: Papua New Guinea, Indonesia and Fiji, which are very close to Polynesia.³

2.3.2.4. Caribbean Islands:

Respect to the Caribbean Islands, we highlight Dominica, Jamaica, Saint Kitts and Nevis and Antigua and Barbuda, where we have observed there are high levels of cancer deaths. We have to comment that in these islands there are a high proportion of people that have prostate cancer. In many countries in the northeast region of Europe is also very common. This kind of cancer is the more common and it is the second cancer that causes more deaths. Additionally, we stress that in Asia, Africa, Central American and South American is not very common.

³ Quiñonero. J-P. (2012), *Las pruebas nucleares francesas podrían estar detrás de numerosos casos de cáncer entre sus militares.*

This cancer can be genetic, for this reason, the risk is higher in men who have some affected familiar than others who do not. However, it is strange that cancer deaths are very abundant in women's case in these islands, so we suppose that must be due to other kind of cancer.⁴

We have to do a special mention for cancer deaths in islands, because if we focus on our map of cancer incidence, we can observe that there are plenty of islands which suffer from this illness and die because of it. We stress the next: Madagascar, Sao Tomas and Principe, Papua New Guinea, Seychelles, Indonesia and Fiji.

2.3.2.5. Mongolia:

Mongolia is a special case because it is the country that has more deaths by cancer as much in men as women with a lot of difference. Thanks to an investigation included in NCBI, we can know what the main cancers that cause these deaths are. The five leading primary sites in males were liver, stomach, lung, esophagus, and colon/rectum; whereas in females they were liver, cervix, stomach, esophagus and breast; being liver cancer the most common cause of death in each gender. On the other hand, in males, the most common death by cancer is due to stomach and lung cancer, whereas in females, it is the stomach and esophagus.⁵

2.3.2.6. General factors:

2.3.2.6.1. Pollution:

In general terms, ambient factors are responsible of a very important part of cancers. The International Agency to Research of Cancer (IARC), from the World Health Organization (WHO) evaluates systematically chemical substances or physics and biological aspects that can cause cancer.

The first idea to explain why there are more cases of cancer in some countries and less in others is the level of pollution. We have to consider two kinds of pollution: outdoor (ambient pollution) and indoor (domestic pollution).

Outdoor pollution:

We consider four common air pollutants: Particulate matter (PM), Ozone, Nitrogen dioxide, Sulfur dioxide, being the first the most important to cause cancer.

⁴ American Cancer Society, (2013), *¿Cuáles son los factores de riesgo del cáncer de próstata?*

⁵ Sandaogdorj, T., Tudev. U., Ochir, C., *between others.* (2010), *Cancer incidence and mortality in Mongolia.*

The evidence on airborne particulate matter (PM) and its public health impact is consistent in showing adverse health effects at exposures that are currently experienced by urban populations in both developed and developing countries. The range of health effects is broad, but is predominantly to the respiratory and cardiovascular systems.

OBS: According to Air Quality Guideline of WHO, these are the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to long-term exposure to PM2.5.

The data we have used to study the relation between pollution and GDP pc explains the following: The database contains results of urban outdoor air pollution monitoring from almost 1100 cities in 91 countries. Air quality is represented by annual mean concentration of fine particulate matter (PM10 and PM2.5, i.e. particles smaller than 10 or 2.5 microns).

The database covers the period from 2003 to 2010, with the majority of values for the years 2008 and 2009. The primary sources of data include publicly available national/subnational reports and web sites, regional networks such as the Asian Clean Air Initiative and the European Airbase, and selected publications. The database aims to be representative for human exposure, and therefore primarily captures measurements from monitoring stations located in urban background, urban traffic, residential, commercial and mixed areas.

The world's average PM10 levels by region range from 21 to 142 ug/m³, with a world's average of 71 ug/m³.

UV radiation also causes cancer; it has been shown by studies in numerous countries.⁶

As we want to study the relation between pollution and GDP per capita, we use a new variable called Pollution from WHO. This new variable is a measure of the annual mean of PM10 concentration for 90 countries that are included in our study, as we have already explained. We use the following regression to observe what happens. We use logarithms in all variables:

$$\text{Log (POLLUTION)} = \beta_0 + \beta_1 * \text{Log (GDP)} + \beta_2 * \text{Log (POP)} + \varepsilon_i \quad (16)$$

⁶ Information taken from World Health Organization (WHO).

Table 2.19:

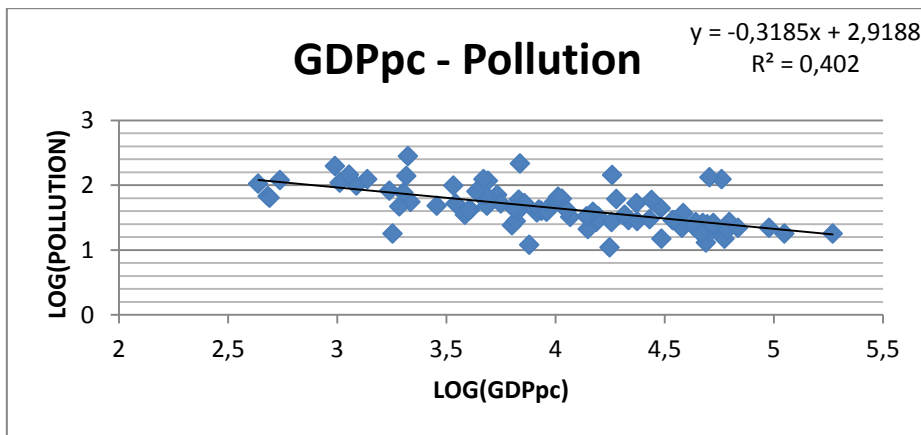
Dependent Variable: LOG(POLLUTION)
 Method: Least Squares
 Date: 04/11/13 Time: 12:38
 Sample: 1 90
 Included observations: 90

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.007315	0.799469	7.514132	0.0000
LOG(GDP)	-0.301664	0.044743	-6.742157	0.0000
LOG(POP)	0.335787	0.044443	7.555481	0.0000
R-squared	0.410091	Mean dependent var	3.771271	
Adjusted R-squared	0.396530	S.D. dependent var	0.704125	
S.E. of regression	0.546988	Akaike info criterion	1.663986	
Sum squared resid	26.03006	Schwarz criterion	1.747313	
Log likelihood	-71.87937	F-statistic	30.24018	
Durbin-Watson stat	1.950292	Prob(F-statistic)	0.000000	

There is a negative correlation between Pollution and GDP per capita. (approx.: -0.363359)

Now, we present the figure 2.13, where we observe that the trend is negative, what it means that the higher GDP pc is, the smaller POLLUTION is.

Figure 2.13: Relation between Pollution and GDP per capita in logs:



Indoor pollution:

According to WHO, carcinogens from indoor air pollution cause approximately 1.5% of annual lung cancer deaths. As with bronchitis, the risk for women is higher, due to their role in food preparation as well as their comparatively lower rates of smoking. Women exposed to indoor smoke thus have double the risk of lung cancer in comparison with those not exposed.

The principal indoor pollutant is: smoking. Lung cancer is mainly caused by smoking, but the quantitative relations between smoking and histologic subtypes of lung cancer remain inconclusive.⁷

2.3.2.6.2. *Nutrition:*

Diet, nutrition, metabolic/hormonal imbalances, energy excess consumption, obesity, and physical inactivity are thought to be important contributors to increasing cancer incidence rates worldwide. However, the mechanisms of action of these factors remain poorly understood. In addition, the contributing influence of dietary transitions from traditional to Western type diets, which is taking place in low- and middle-income countries (e.g. Latin America), are not well studied.

Cancers of primary interest include those of the breast, particularly premenopausal breast cancer, endometrium, colon and rectum, liver, pancreas and thyroid. Methodological tools developed in the DEX and BMA groups are widely used in these epidemiological studies.⁸

⁷ Pesch, B., Kendzia, B. *between others*, (2012), *Cigarette smoking and lung cancer--relative risk estimates for the major histological types from a pooled analysis of case-control studies*.

⁸ *Information taken from World Health Organization (WHO).*

3. CONCLUSIONS:

In this paper, we create some models using different kind of variables to prove the possible relation between them. We also present the results that we get of these models. These results are very important to locate the principal regions and countries which have the highest and the lowest incidence of cancer deaths. We include plenty of the different kinds of cancer (prostate cancer, lung cancer, bladder cancer, etc.) that inhabitants can suffer. During the research process, we have obtained several results which have been interpreted with the help of some extra information.

The main contribution of this paper is to analyze the relation between deaths by cancer per 100.000 inhabitants and some macroeconomic variables such as GDP, health expenditure and population. With the residuals obtained from the previous models we locate the main regions where there is greater or fewer proportion of deaths by cancer conditional to the variables we include in our models.

Studying our models and taking in consideration men and women, it can be concluded that any expenditure does not affect the number of cancer deaths. However, cancer deaths have influence on Private and Total Health Expenditure. Public Health Expenditure is a variable that it is not significant to know if there is greater or least number of deaths by cancer in a country. Besides, cancer deaths do not have influence on Public Health Expenditure. The interpretation of this could be that cancer is better treated by private health services, because they reduce the number of deaths by cancer as the attention and treatments are more specialized.

One important result is to know that deaths by cancer in men are more significant than in women in almost the entire world, although the difference between one and the other is not very high. In the case of women, it has not found a big relation between the macroeconomic variables used and deaths by cancer, as most of the parameters in our regression models have not been statistically significant. A tentative explanation could be that women did not suffer work stress or smoke in the past as the men did. However, nowadays, this aspect has totally changed, what is causing that women have the same problems as men when it is time to be able to contract new diseases like cancer. Moreover, in women's case, it has to be considered the high number of cases of women who have breast cancer. Fortunately, medicine is improving very fast and in many countries it has reduced the number of deaths by this kind of cancer greatly. Another important difference between men and women is that in women's case there is a greater disparity, unlike men who present more homogeneous results between the different proposed countries to our study. These differences are taken into account in relation to some parameters such

as GDP, Health expenditure or population. If it is only considered the variable “deaths by cancer per 100.000”, it is observed women have a normalized distribution. Moreover, there are not so many differences between the difference regions of our sample of 186 countries. However, it is observed that men present a greater concentration of cases in Europe and fewer in Eastern Mediterranean.

Finally, if we wonder what countries are more or less affected by deaths of cancer in relation with our economic variables, we stand out two groups. On the one hand, the countries or regions with fewer deaths would be: Central America, Eastern-Mediterranean (United Arab Emirates, Kuwait, Syrian Arab Republic, Sudan, Iran ...) and some countries in South America (Botswana, Lesotho ...). On the other hand, the countries and regions with more deaths would be: Mongolia that is the country with more impact of deaths by cancer in the world, Caribbean Islands, some countries in Europe (Lithuania, Latvia, Estonia, Hungary, Croatia...) and Micronesia. It is important to observe the effect of deaths by cancer in islands, because they are very important locations affected.

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