Cancer Mortality and Socioeconomic factors: The Spanish case

Authors: Jesús Clemente, Angelina Lazaro y Antonio Montañés
Affiliation: University of Zaragoza (Spain)

ABSTRACT

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1. Introduction

El análisis de la relación entre economía tiene una larga tradición en la literatura. Desde los trabajos seminales de Antonovsky (1967), y XXX es bien sabido que los niveles económicos de los individuos, en particular, y las decisiones adoptadas en materia económicas, en general, tienen su incidencia en la salud de la población. En este sentido, no es de extrañar que diversos autores hayan estudiado cómo afectan los ciclos económicos a la evolución de diversos indicadores de salud. Así, los resultados pioneros de Brenner (1973, 1975 and 1979) viene a corroborar esta relación, ya que este autor encuentra a countercyclical variation in admissions to mental hospitals, infant mortality rates, and deaths due to cardiovascular disease, cirrhosis, suicide, and homicide. Sin embargo, esto resultados han sido posteriormente cuestionados por otras investigaciones, como las de Ruhm (2000), cuyos resultados muestran una correlación negativa entre mortalidad y episodios de crisis económica. Recession might improve health at least in the short run, because it is associated with a reduction in road-traffic fatalities, a decrease in exposure to hazardous working conditions and other causes [12], [13], [14], [15]. Nevertheless, compared with wealthier groups, the health of population groups particularly hard hit in economic terms is likely to suffer potentially leading to wide health inequities. Economic shocks, whether positive or negative, have in the past often been associated with increased rates of common mental health problems as well as suicidal behaviour [15].

En este sentido, la reciente crisis de 2008, conocida como la Gran Recesión (GR), no ha sido una excepción y ha recibido bastante atención por parte de los economistas. Debemos recordar que esta crisis provocó fuertes caídas del GDP de los países y que en Europa fue superada por la toma de decisiones restrictivas de política económica. Es lo que se ha venido a llamar la Great Austerity (GA). Su efecto sobre la salud de la población Europea no ha tardado en aparecer, tal y como se deduce de los resultados de Quaglio et al (2013). However, the results are somewhat heterogenous, as can be deduced from the review of the literature made in Parmar et al (2016).

Un caso de especial interés es el español. La caídas del PIB fueron más drásticas que la media de los países europeos, por lo que las políticas de austeridad fueron especialmente severas, afectando al gasto público, en general, y el sanitario en particular. Afectando de manera especial a las inversiones. Diversos trabajos han analizado el posible efecto de estas políticas de austeridad sobre la evolución de la salud de la población española a partir de diversos indicadores de salud. Por solo citar algunos ejemplos, dentro de una extensa pléyade de excelentes trabajos, cabe destacar los artículos de Regidor et al. (2014) who find that Spanish health has continued its improvement after the Great Recession Márquez-Calderón et al. (2020) who conclude that La tendencia descendente de la mortalidad ha sufrido una ralentización o un estancamiento después del inicio de la crisis económica. Regidor et al (2019), using age adjusted data, find the opposite result and mortality in Spain continued to decline after the Great Recession, although there exists a slowdown in the decreasing rate. In these circumstances, it comes as no suprise that González López-Valcárcel and Barber (2017) conlude that the results on the effect of Great Recession on Spanish heath are unconclusive.

However, there seems to be a point where the results are coincident. The effect of the evolution of the mortality by neoplasms. Ferrando et al. (2019) conclude that since the onset of the economic crisis in Spain the rate of decline in cancer mortality has slowed significantly, and this situation could be exacerbated by the current austerity measures in healthcare.

Una de las posibles razones de esta ausencia de evidencia es el uso de técnicas no óptimas. Por ejemplo, los autores usan métodos que son sensibles al grado de perturbación de los shocks, de forma que cuando que cuando son muy persistentes, los métodos empleados no son correctos. Por tanto, parece apropiado utilizar mejores estadísticos que permitan contrastar la presencia de un cambio en la tendencia, en presencia de variables que puedan tener un alto grado de persistencia. Es el caso de los estadisticos propuesto por PErrn and Yabu(2008a, 2008b) y Kejriwal and Perron (2012).

Against this background, the aim of the paper is to test for the presence of broken trends in the mortality caused by neoplasm in Spain by using these statistics. These can estimate endogenously the period when the breaks appear. If we can associate these estimated periods with the ones when the Great Austerity measures were adopted, then we will conclude that the neoplasm mortality has been affected by the economic decisions taken in this period.

The rest of the paper is organized as follows. Section 2 presents the data and the methodology employed. Section 3 reflects the results, which are discussed in Section 4. The paper ends with a resume of the main conclusion we have obtained.

2. Data and Methods

2.1. Data

The data include the total neoplasm mortality by 100.000 inhabitants of Spain. We also disaggregate it according to the reduced list of neoplasm mortality offered by the Spanish Institute of Statistics (INE). The list of neoplasm and its equivalence to the International Classification of Diseases (ICD-10) appears in the Appendix.

All the data have been collected from INE, with the sample size covering the period 1980-2018.

2.2. Methodology

As we have mentioned, the aim of this paper is to test the possible presence of breaks in the trend function for several cancer mortality rates in Spain, paying special attention to the possible presence of a Great Austerity effect. If this exists, then we should appreciate an increase in the trend function in the second decade of the 2000s, as a consequence of the austerity measures adopted by the Spanish Governments since 2010. To capture changes in the trend function, we will employ the procedure developed in Kejriwal and Perron (2010), who extends the results of Yabu and Perron (2009a, 2009b) for the case of multiple breaks in the trend function, which are located in unknown periods of time. To that end, we should estimate the following equation:

$$y_t = \mu_o + \beta_o t + \sum_{i=1}^{m} \mu_i \, I(t > T_i) + \sum_{i=1}^{m} \beta_i \,(t - T_i) I(t > T_i) + u_t, \quad t = 1, 2, \dots, T \qquad (1)$$

With

$$u_t = \alpha \, u_{t-1} + v_t, \; t=2, \dots, T \qquad (2)$$

Where m is the unknown number of breaks, T_i (i=1,2,…, m) are the periods where these breaks appear, and μ and β are the parameters that measure the change in the intercept and in the slope of the trend function, respectively. The stochastic process $\{v_t\}$ is assumed to be stationary, so that a general error structure is permitted for the error term (u_t). Very importantly, u_t can either be integrated order 0, which is commonly denoted as I(0), such that $|\alpha| < 1$, or a first-order integrated process, denoted as $I(1)$, process where $|\alpha| = 1$.

The algorithm starts by estimating the m break dates $T_1,\dots,T_m$ as global minimizers of the sum of squared residuals from the model with *l* breaks estimated by OLS

$$(\hat{T}_1, \dots, \hat{T}_m) = argmin_{(\hat{T}_1,\dots,\hat{T}_m)} SSR(T_1, \dots, T_m)$$

The breaks are estimated using the dynamic programming algorithm proposed by Bai and Perron (1998, 2003a, 2003b). Second, define the $l + 1$ intervals: $I_1=[0, \hat{T}_1]$, $I_2=[\hat{T}_1, \hat{T}_2]$,…,$I_{l+1}=[\hat{T}_l, \hat{T}]$. Then, the algorithm tests for the existence of a break at interval I_i. Consider the regression $y_t = x'^{(i)}_t \Psi^{(i)} + u_t^{(i)}$, for $I_i=[\hat{T}_{i-1}, \hat{T}_i]$, where $x_t^{(i)}$ is a set of dummy variables representing the structural breaks. We consider the case with includes a break in both the intercept and in the slope of the function, in such way that $x_t^{(i)} = (1, I(t > \tau)$, t-Tî-1, (t-tau) $I(t > \tau))$, where $I(t > \tau)$ is an indicator function that is equal to one for $t > \tau$ and zero otherwise. Denote by $\hat{u}_t^{(i)}$ the residuals of these regressions. Then, we compute the OLS regression for the following model:

$$\hat{u}_t^{(i)} = \alpha \hat{u}_{t-1}^{(i)} + \sum_{j=1}^{k} \varphi_j \, \Delta \hat{u}_{t-j}^{(i)} + \varepsilon_t$$

Denote by $\hat{\alpha}^{(i)}$ the OLS estimator of α in this regression, which it is used to build the super-efficient estimate of α, denoted by $\hat{\alpha}_S^{(i)}$. The number of lags, k, is chosen using the Bayesian Information Criterion, as recommended by Perron and Yabu (2009). Then, given the sample size $T^{(i)} = \hat{T}_{i-1} - \hat{T}_i$ and $\hat{\alpha}^{(i)}$, KP (2010) builds a super-efficient estimate of α. This estimator is defined as $\hat{\alpha}_s = \hat{\alpha}$, if $T^{\delta}|\hat{\alpha} - 1| > d$, and $\hat{\alpha}_s = 1$ otherwise.

Through extensive simulation, Perron and Yabu (2009) find that the values of $d = 1$ and $\alpha = 0.5$ lead to the best results in finite samples. Then, KP (2010) defines the transformed variables: $y_t^i = y_t - \hat{\alpha}_s y_{t-1}$ and $x_t^i = x_t - \hat{\alpha}_s x_{t-1}$ for every $t \in I_i$, and compute the feasible GLS regression

$$y_t^{(i)} = x'^{(i)}_t \Psi^{(i)} + u_t^{(i)}$$

Denote the Wald statistics for the null that $\Psi^{(i)} = 0$ as W_{FS}^{τ}, and repeat these steps for every permissible break date. Then, define the exp-functional

$$ExpW_{FS}^{i} = log\left[\left(\widehat{T}_{i-1} - \widehat{T}_{i}\right)^{-1} \sum_{\tau \in I_i} exp(W_{FS}^{\tau}/2)\right]$$

Given the exp-functionals $\{ExpW_{FS}^{i}\}_{i=1,\dots,l+1}$, KP (2010) defines the sequential test as follows:

$$F_T(l+1/l) = max_{1\leq i\leq l+1}\{ExpW_{FS}^{i}\}$$

We conclude in favor of a model with $l + 1$ breaks if $F_T(l+1/l)$ is sufficiently large, that is, greater that some critical values, see KP (2010). In the paper, we apply the test, first for $F_T(1|0)$ to determine if there is one break. Upon rejection, we apply it for $F_T(2|1)$ to determine if there are two breaks, and so on, until the test for $F_T(l + 1|l)$ fails to reject the existence of $l + 1$ breaks. The structural changes detected are on dates $\widehat{T}_1, \dots, \widehat{T}_l$.

3. Results

The obtained results are presented in Table 2. The average behavior is clearly summarized by the evolution of the total neoplasm mortality, which presents three changes in the trend function, located at 1994, 2002 and 2010. Then, the GR has not affected since its beginning. Rather, the changes began being noticeable since 2011. The changes in the trend coefficient in 1994 and 2002 are negative, which implies consecutive reductions of the upward trend observed at the beginning of the sample. Even, the situation in 2002 was that of slight reduction of the neoplasm rates of mortality. The effect of 2010 has the opposite sign and involves an increase in these mortality rates.

This pattern of behavior is shared for most of the mortality rates included in Table 2, in the sense that most of the series exhibit three breaks, located at mid 90s, beginning of the 2000s and after the GR, most of them appearing after 2010. The effects of the breaks on the trend coefficient are similar to those of the total neoplasm mortality previously analyzed, as could be expected.

However, we can find the existence of some deviations from this common pattern. First, we can observe that the mortality rate of the malignant neoplasm of liver and intrahepatic bile ducts does not present changes in the trend. Likewise, the mortality rates of cervix uteri just exhibits a break, whilst Larynx shows two breaks, none of them related to the GR. Furthermore, mortality rates of neoplasm of Lips, Bone, Breast, Ovary and Lymphoid present a third break after 2010. Finally, we should note that some the mortality rates of some neoplasm exhibit a break around 2010, but its effect is the opposite to the one founded for the total neoplasm mortality rates. This is the case of the mortality rates of malignant neoplasms of Colon, Uterus and Bladder. The cases of Kidney and Leukemia neoplasms also present a negative effect after 2010, although we cannot reject that the estimated trend parameter of the last break is statistically different to 0.

If we disaggregate the data by gender, the results are similar to the presented for the total case. The results of the total neoplasm mortality are similar and the series for both male (Table 3) and female (Table 4) present 3 breaks located at very similar periods of time (beginning 90s, mid 00s and around 2010). Exceptions are mortality rates of Breast and Leukemia neoplasm, for the male case, and Bone and Skin neoplasm, for female case. These cases present fewer number of breaks in the trend function. If we focus on the last break, we can see that most of the them are located after 2010. Exceptions are mortality rates of Lips, Stomach, Larynx, Bone and Lymphoid neoplasm (all of them in the 2006-2009 interval) for the male case, and Rectum, Liver, Larynx and Kidney neoplasms for the female case.

Finally, the effect of the Great Austerity does not always involve an increase in the mortality rates. We can see that the mortality rates of the neoplasms of Colon and Bladder decrease after 2010 for the male case, whilst those of the neoplasms of Stomach, Colon and Bladder show a negative trend after 2010. Similarly, the cases of the neoplasms of Breast (2000) and Leukemia (2007), for the male case, exhibit negative trend in the last estimated segment of the sample.

4. Discussion

We can appreciate the presence of some differentiated periods in the Spanish neoplasm mortality rates. An initial sharp increase of the mortality rates, a moderate decline and a final change, mostly implying and increment, which is the one that can be related to the austerity measures. The initial increase is clearly related to the improvement of the life expectancy in Spain, which has moved from 75 years in 1980 to 84 year at the end of the sample. The next two segments (1994-2002 and 2003-2010) have involved serious reduction in the mortality rates, compensating the initial trend and describing a picture where the mortality rates exhibited negative growth rates. The advances made in the control the neoplasm mortality, especially those which implies analyses at the early stage of this illness, helped to arrive to this situation. This result is also seen in most of the developed countries, as Jemal et al. (2010) note.

The third period is the most interesting to our purpose, given that it coincides in time with the adoption of the austerity measures adopted by the Spanish Governments. In this regard, we should first note that our results offer overwhelmed evidence on the presence of a break in the trend function after 2010. If we take into account that this period is taken as the beginning of the austerity policies, we can conclude that the Great Austerity has affected the neoplasm mortality in Spain. This result qualifies some previous results of the literature, where scarce evidence in favor of this Great Austerity effect is found (if exists). For instance, Cirera et al (2020) cannot find a break related to the Great Austerity for the total Neoplasms data, even when these data are disaggregated by gender. Borra et al (2020) find a significant increase in the neoplasm mortality rates, although these authors do not estimate the period when the break appears and impose the presence of a break in 2008, which is not supported by the data.

However, we can observe that the evolution of all the neoplasm mortality has not been similar, with some of the considered types presenting clear reductions after 2010. This is the case of Colon and Bladder neoplasms, which exhibit remarkable reductions after 2010 for both male and female cases. We can also observe a good evolution of the Uterus, Ovary and Stomach neoplasms for the female case.

If we take into account the results of Teoh et al. (2020) and Richters et al. (2020), the mortality of bladder cancer is extremely related to tobacco consumption. Then, the decline in the estimated trend may be reflecting the impact of the Spanish Law 28/2005, later extended by Law 42/2010, which imposed serious restricctions to the tobacco consumption in Spain. Following Ferlay et al. (2008), Chavan et al. (2014) and Cai et al. (2020), other factors that may have generated this decline are educed occupational exposure to occupational carcinogens, a better control of urinary tract infections, the role of diet and other potential urinary tract carcinogens.

The declining in the trend of the mortality rates of the colon neoplasm, we should take into account the results of Darbá and Marsá (2020). These authors explain this evolution by taking into account the progressive use of screening, first introduced in Spain in 2001 and rapidly extended during the subsequent years. Following these authors, the increased early detection of these neoplasms as a consequence of the implementation of such screening programs may be played a crucial role in the reduction of the Colon mortality rates.

Lung, Pancreas, Breast (2005), Prostate, Stomach (hombres), Liver (hombres) and Ill defined son los mas freceuntes y crecen. ¿demandan más cuidados?

5. Conclusion

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Table 1. Testing for broken trends in neoplasm mortality rates. Total data.

	KP1	KP2	KP3	m	b	TB1	mu1	b1	TB2	mu2	b2	TB3	mu3	b3
Total	**34.6**	116.1	**116.1**	149.07	5.07	1994	2.14	-3.12	2002	-2.52	-3.32	2010	3.61	3.14
				0.88	0.10		1.45	0.26		1.58	0.34		1.52	0.31
Lips	**5.5**	294.2	**100.0**	2.64	0.21	1991	0.43	-0.20	1999	0.01	-0.09	2008	-0.30	0.15
				0.08	0.01		0.12	0.02		0.12	0.02		0.11	0.02
Oesophagus	0.2	45.3	**88.5**	3.97	0.04	1995	0.03	-0.08	2005	-0.25	0.03	2012	-0.04	0.04
				0.05	0.01		0.08	0.01		0.10	0.02		0.10	0.03
Stomach	**133.6**	75.4	**315.4**	20.08	-0.27	1987	0.70	0.00	2002	-0.71	0.01	2010	0.46	0.09
				0.20	0.05		0.21	0.05		0.22	0.04		0.23	0.05
Colon	**25.7**	212.8	**212.8**	5.32	0.84	1993	1.15	-0.30	2002	-0.60	-0.33	2011	1.64	-0.29
				0.20	0.03		0.31	0.05		0.33	0.06		0.34	0.07
Rectum	**67.1**	64.5	**51.7**	5.39	-0.01	1987	0.10	0.12	2003	-0.21	-0.12	2010	0.53	0.13
				0.15	0.03		0.15	0.04		0.17	0.04		0.18	0.04
Liver	1.9	2.7	27.8											
Pancreas	**430.5**		**248.1**	4.40	0.28	1995	-0.41	0.00	2002	-0.12	-0.12	2010	0.17	0.25
				0.08	0.01		0.15	0.03		0.16	0.04		0.15	0.03
Larynx	4.4	**43.0**	43.0	4.68	0.03	1994	-0.11	0.02	2004	-0.09	-0.44			
				0.06	0.01		0.01	0.01		0.09	0.08			
Lung	**34.8**			22.27	1.25	1994	0.45	-0.79	2002	-0.39	-0.42	2011	0.49	0.37
				0.23	0.03		0.38	0.07		0.40	0.08		0.41	0.08
Bone	2.1	3.6	**253.0**	2.08	-0.09	1990	-0.11	0.07	2000	-0.16	0.03	2007	-0.09	0.00
				0.06	0.01		0.09	0.01		0.10	0.02		0.09	0.02
Skin	**272.2**	**614.9**	**614.9**	0.39	0.07	1989	0.10	-0.01	1998	0.11	-0.05	2010	0.14	0.00
				0.05	0.01		0.07	0.01		0.06	0.01		0.07	0.01
Breast	**10.7**	343.8	**75.2**	18.10	0.73	1987	1.67	-0.12	1996	-1.53	-0.73	2005	-1.28	0.21
				0.31	0.07		0.36	0.08		0.34	0.07		0.30	0.05
Cervix uteri	**47.3**	36.8	36.8	1.51	0.08	1996	-0.08	-0.22						
				0.06	0.01		0.01	0.08						
Uterus	2.9	72.1	**63.9**	8.65	-0.20	1990	-0.10	0.15	2004	-0.34	0.14	2011	0.61	-0.09
				0.12	0.02		0.14	0.02		0.17	0.03		0.18	0.04
Ovary	**465.9**	250.5	**250.5**	3.01	0.21	1987	0.33	0.05	1995	0.51	-0.18	2004	-0.38	-0.05
				0.13	0.03		0.16	0.04		0.15	0.03		0.13	0.02
Prostate	**7.9**	178.8	**453.6**	15.91	0.60	1993	1.68	-0.06	2000	-0.13	-1.05	2010	1.81	0.46
				0.27	0.03		0.45	0.09		0.44	0.10		0.43	0.08
Kidney	**324.4**	78.7	**176.6**	1.57	0.10	1993	0.28	-0.04	2002	-0.19	-0.02	2012	0.25	-0.01
				0.05	0.01		0.08	0.01		0.08	0.01		0.09	0.02
Bladder	**5.6**		**318.5**	5.12	0.27	1995	-0.49	-0.10	2005	-0.54	-0.06	2012	0.75	-0.35
				0.09	0.01		0.14	0.02		0.17	0.04		0.18	0.04
Brain	**28.4**	29.9	**76.9**	5.83	-0.33	1987	-0.07	0.48	2003	-0.13	-0.15	2011	0.33	0.10
				0.25	0.06		0.26	0.06		0.28	0.05		0.30	0.07
ill-defined	**14.6**	40.1	**130.3**	11.21	0.52	1987	-0.53	-0.38	1999	2.03	-0.34	2010	-5.05	0.18
				0.33	0.07		0.36	0.08		0.33	0.05		0.36	0.06
Lymphoid	**231.0**	363.5	**540.5**	3.67	0.32	1994	0.42	-0.07	2001	0.24	-0.45	2008	0.11	0.32
				0.10	0.01		0.18	0.04		0.20	0.05		0.17	0.04
Leukaemia	**67.7**	206.6	**189.4**	4.83	0.13	1988	0.15	-0.06	2005	-0.42	-0.07	2012	0.61	-0.02
				0.12	0.02		0.13	0.03		0.15	0.03		0.17	0.04

Table 2. Total Neoplasms and its disaggregation by types. Male data

	KP1	KP2	KP3	m	b	TB1	mu1	b1	TB2	mu2	b2	TB3	mu3	b3
Total	34.45	79.79		176.52	7.20	1994	2.25	-4.20	2001	10.41	-6.09	2010	5.30	4.48
				1.05	0.12		1.83	0.37		1.85	0.43		1.77	0.34
Lips	6.70	206.88	206.88	4.50	0.38	1991	0.92	-0.40	2002	0.13	-0.26	2009	0.12	0.32
				0.13	0.02		0.18	0.03		0.21	0.04		0.20	0.04
Oesophagus	0.88	92.16	92.16	6.49	0.11	1997	-0.39	-0.14	2005	-0.54	-0.02	2012	0.04	0.06
				0.09	0.01		0.16	0.03		0.18	0.04		0.19	0.05
Stomach	116.10	90.88	330.79	24.14	-0.37	1987	0.99	0.11	2002	-0.52	-0.15	2009	0.37	0.21
				0.30	0.07		0.31	0.07		0.35	0.07		0.34	0.08
Colon	396.89	239.68	216.78	4.75	0.93	1993	1.59	-0.24	2005	-1.57	-0.18	2012	1.81	-0.70
				0.26	0.03		0.35	0.05		0.44	0.09		0.48	0.12
Rectum	3.17	103.65	79.67	5.90	-0.02	1987	-0.02	0.22	2003	-0.24	-0.18	2010	0.66	0.13
				0.18	0.04		0.19	0.04		0.21	0.04		0.22	0.05
Liver	28.17	3.01	203.27	11.48	0.07	1989	0.69	0.05	2003	-0.46	-0.26	2010	0.60	0.35
				0.18	0.03		0.21	0.04		0.25	0.05		0.25	0.06
Pancreas	443.01			4.87	0.32	1991	-0.21	-0.08	2001	0.64	-0.14	2010	0.13	0.32
				0.14	0.02		0.19	0.03		0.21	0.04		0.21	0.04
Larynx	4.74	61.70	63.18	9.12	0.07	1994	-0.39	-0.18	2001	0.18	-0.26	2008	0.19	0.24
				0.10	0.01		0.18	0.04		0.20	0.05		0.17	0.04
Lung	27.62			39.21	2.48	1994	0.84	-1.90	2001	3.11	-1.26	2011	1.28	0.59
				0.44	0.05		0.77	0.16		0.75	0.17		0.76	0.15
Bone	2.07	69.19	30.93	2.56	-0.10	1990	-0.19	0.06	2000	-0.22	0.06	2007	-0.15	0.00
				0.08	0.01		0.11	0.02		0.13	0.03		0.11	0.03
Skin	277.55		360.25	0.36	0.09	1990	0.05	-0.03	1998	0.18	-0.04	2010	0.24	-0.01
				0.07	0.01		0.10	0.02		0.09	0.02		0.09	0.02
Breast	5.74	19.79	15.36	0.14	0.01	2000	0.00	-0.07						
				0.02	0.00		0.00	0.03						
Kidney	176.85	22.32	67.61	1.99	0.14	1993	0.37	-0.05	2002	-0.19	-0.04	2012	0.46	0.00
				0.10	0.01		0.15	0.02		0.15	0.03		0.17	0.04
Bladder	5.69			8.46	0.46	1995	-0.88	-0.12	2005	-0.96	-0.23	2012	1.49	-0.59
				0.17	0.02		0.26	0.04		0.32	0.07		0.33	0.08
Brain	22.61	177.33	118.10	6.75	-0.35	1987	-0.20	0.50	2002	0.36	-0.21	2010	0.28	0.17
				0.31	0.07		0.32	0.07		0.34	0.06		0.36	0.07
ill-defined	13.62	19.45	403.52	11.13	0.73	1987	-0.34	-0.51	1999	3.22	-0.52	2010	-6.85	0.28
				0.46	0.10		0.50	0.11		0.46	0.07		0.50	0.09
Lymphoid	224.74	226.01	189.81	4.43	0.30	1989	0.57	-0.05	1999	0.94	-0.35	2006	-0.88	0.25
				0.19	0.03		0.24	0.04		0.26	0.06		0.23	0.05
Leukaemia	121.59	103.73	31.52	5.64	0.12	1994	-0.05	0.02	2007	0.21	-0.72			
				0.12	0.01		0.02	0.02		0.17	0.17			

Table 3. Total Neoplasms and its disaggregation by types. Female data

	KP1	KP2	KP3	m	b	TB1	mu1	b1	TB2	mu2	b2	TB3	mu3	b3
Total	18.09	61.49	61.49	122.82	2.96	1996	-3.69	-1.63	2004	-5.24	-1.15	2011	4.59	1.20
				0.77	0.08		1.34	0.24		1.55	0.36		1.51	0.36
Lips	137.43	317.04	370.26	0.86	0.06	1995	0.02	-0.06	2002	0.22	0.01	2010	0.18	0.06
				0.04	0.00		0.07	0.01		0.07	0.02		0.07	0.01
Oesophagus	27.52	51.97	51.97	1.53	-0.02	1991	-0.19	0.02	2005	-0.06	0.02	2012	-0.10	0.02
				0.05	0.01		0.06	0.01		0.07	0.01		0.08	0.02
Stomach	9.05	653.49	138.83	16.20	-0.20	1987	0.40	-0.08	2005	-0.40	0.20	2012	0.34	-0.12
				0.20	0.04		0.20	0.05		0.22	0.05		0.25	0.06
Colon	14.88	126.03	126.03	5.80	0.76	1995	-0.14	-0.38	2002	-0.33	-0.33	2011	1.27	-0.21
				0.21	0.02		0.37	0.07		0.38	0.09		0.37	0.08
Rectum	45.30	13.58	116.47	4.91	0.00	1987	0.43	-0.04	1994	0.37	0.07	2005	-0.66	0.06
				0.16	0.03		0.20	0.05		0.17	0.04		0.15	0.02
Liver	54.46	66.08	86.68	10.79	-0.31	1987	0.19	0.15	1994	0.06	0.08	2009	0.36	0.05
				0.17	0.04		0.22	0.06		0.18	0.04		0.17	0.03
Pancreas		383.73	525.53	3.89	0.25	1993	0.33	-0.13	2000	0.61	0.04	2010	0.39	0.20
				0.12	0.02		0.21	0.04		0.20	0.05		0.20	0.04
Larynx	11.80	12.86	27.53	0.39	-0.01	1992	-0.06	0.01	2002	0.13	-0.02	2009	0.02	0.03
				0.03	0.00		0.04	0.01		0.05	0.01		0.04	0.01
Lung	67.84			5.94	0.08	1988	-0.62	0.15	2000	-0.09	0.25	2010	0.30	0.32
				0.16	0.03		0.19	0.04		0.18	0.03		0.20	0.04
Bone	20.60	40.89	38.50	1.68	-0.10	1988	0.08	0.03	2003	0.00	-0.04			
				0.07	0.01		0.01	0.01		0.07	0.06			
Skin	162.99	142.53	41.22	0.37	0.06	1994	-0.03	-0.01	2007	0.10	-0.13			
				0.06	0.01		0.01	0.01		0.08	0.08			
Kidney	419.07	80.94	54.57	1.25	0.04	1987	0.11	0.02	1995	0.26	-0.06	2003	0.07	0.03
				0.09	0.02		0.11	0.03		0.11	0.02		0.09	0.02
Bladder	1.52	39.26	49.28	1.89	0.09	1995	-0.43	0.01	2002	-0.24	-0.04	2012	0.14	-0.10
				0.07	0.01		0.12	0.02		0.12	0.03		0.13	0.03
Brain	4.66	2.09	188.55	4.96	-0.32	1987	0.05	0.46	2003	-0.07	-0.16	2011	0.39	0.07
				0.22	0.05		0.23	0.05		0.24	0.04		0.27	0.06
Lymphoid	307.57	407.03	407.03	2.98	0.32	1994	0.42	-0.03	2002	-0.42	-0.38	2011	0.69	0.12
				0.11	0.01		0.19	0.03		0.20	0.04		0.20	0.04
Leukaemia	39.72	122.27	108.43	4.20	0.11	1988	0.19	-0.06	2003	0.26	-0.17	2010	0.73	0.10
				0.15	0.03		0.16	0.03		0.18	0.04		0.19	0.04

EXTENDIDAS

Table 1. Testing for broken trends. Both genders.

	KP1	KP2	KP3	m	b	TB1	mu1	b1	TB2	mu2	b2	TB3	mu3	b3
Total	**34.6**	116.1	**116.1**	149.07	5.07	1994	2.14	-3.12	2002	-2.52	-3.32	2010	3.61	3.14
				0.88	0.10		1.45	0.26		1.58	0.34		1.52	0.31
Lips	**5.5**	294.2	**100.0**	2.64	0.21	1991	0.43	-0.20	1999	0.01	-0.09	2008	-0.30	0.15
				0.08	0.01		0.12	0.02		0.12	0.02		0.11	0.02
Oesophagus	0.2	45.3	**88.5**	3.97	0.04	1995	0.03	-0.08	2005	-0.25	0.03	2012	-0.04	0.04
				0.05	0.01		0.08	0.01		0.10	0.02		0.10	0.03
Stomach	**133.6**	75.4	**315.4**	20.08	-0.27	1987	0.70	0.00	2002	-0.71	0.01	2010	0.46	0.09
				0.20	0.05		0.21	0.05		0.22	0.04		0.23	0.05
Colon	**25.7**	212.8	**212.8**	5.32	0.84	1993	1.15	-0.30	2002	-0.60	-0.33	2011	1.64	-0.29
				0.20	0.03		0.31	0.05		0.33	0.06		0.34	0.07
Rectum	**67.1**	64.5	**51.7**	5.39	-0.01	1987	0.10	0.12	2003	-0.21	-0.12	2010	0.53	0.13
				0.15	0.03		0.15	0.04		0.17	0.04		0.18	0.04
Liver	1.9	2.7	27.8											
Pancreas	**430.5**		**248.1**	4.40	0.28	1995	-0.41	0.00	2002	-0.12	-0.12	2010	0.17	0.25
				0.08	0.01		0.15	0.03		0.16	0.04		0.15	0.03
O. digestive	0.5	190.0		7.59	-0.10	1989	0.28	0.10	1996	-0.14	-0.13	2009	-0.33	0.20
				0.15	0.03		0.21	0.05		0.18	0.04		0.17	0.03
Larynx	4.4	**43.0**	43.0	4.68	0.03	1994	-0.11	0.02	2004	-0.09	-0.44			
				0.06	0.01		0.01	0.01		0.09	0.08		0.09	0.02
Lung	**34.8**			22.27	1.25	1994	0.45	-0.79	2002	-0.39	-0.42	2011	0.49	0.37
				0.23	0.03		0.38	0.07		0.40	0.08		0.41	0.08
O. respiratory	1.0	3.5	6.6											
Bone	2.1	3.6	**253.0**	2.08	-0.09	1990	-0.11	0.07	2000	-0.16	0.03	2007	-0.09	0.00
				0.06	0.01		0.09	0.01		0.10	0.02		0.09	0.02
Skin	**272.2**	**614.9**	**614.9**	0.39	0.07	1989	0.10	-0.01	1998	0.11	-0.05	2010	0.14	0.00
				0.05	0.01		0.07	0.01		0.06	0.01		0.07	0.01
O. skin	3.8	63.2	**63.2**	1.25	0.15	1987	-0.20	-0.13	2003	-0.22	0.03	2011	0.07	0.03
				0.12	0.03		0.12	0.03		0.13	0.02		0.15	0.03
Breast	**10.7**	343.8	**75.2**	18.10	0.73	1987	1.67	-0.12	1996	-1.53	-0.73	2005	-1.28	0.21
				0.31	0.07		0.36	0.08		0.34	0.07		0.30	0.05
Cervix uteri	**47.3**	36.8	36.8	1.51	0.08	1996	-0.08	-0.22						
				0.06	0.01		0.01	0.08						
Uterus	2.9	72.1	**63.9**	8.65	-0.20	1990	-0.10	0.15	2004	-0.34	0.14	2011	0.61	-0.09
				0.12	0.02		0.14	0.02		0.17	0.03		0.18	0.04
Ovary	**465.9**	250.5	**250.5**	3.01	0.21	1987	0.33	0.05	1995	0.51	-0.18	2004	-0.38	-0.05
				0.13	0.03		0.16	0.04		0.15	0.03		0.13	0.02
Female genital	**16.9**	60.3	**62.6**	1.84	0.03	1995	-0.24	0.01	2004	-0.25	-0.05	2011	0.16	0.04
				0.05	0.01		0.08	0.01		0.10	0.02		0.09	0.02
Prostate	**7.9**	178.8	**453.6**	15.91	0.60	1993	1.68	-0.06	2000	-0.13	-1.05	2010	1.81	0.46
				0.27	0.03		0.45	0.09		0.44	0.10		0.43	0.08
Male genital	**5.7**	3.6	**104.9**	0.68	0.00	1992	0.18	-0.04	2000	0.15	0.02	2010	0.09	0.02
				0.04	0.01		0.06	0.01		0.06	0.01		0.06	0.01
Kidney	**324.4**	78.7	**176.6**	1.57	0.10	1993	0.28	-0.04	2002	-0.19	-0.02	2012	0.25	-0.01
				0.05	0.01		0.08	0.01		0.08	0.01		0.09	0.02
Bladder	**5.6**		**318.5**	5.12	0.27	1995	-0.49	-0.10	2005	-0.54	-0.06	2012	0.75	-0.35
				0.09	0.01		0.14	0.02		0.17	0.04		0.18	0.04
Urinary organs	**171.5**	165.9	**395.1**	0.10	0.02	1995	0.14	-0.03	2005	-0.05	0.12	2012	-0.23	0.26

				0.04	0.00		0.06	0.01		0.08	0.02		0.08	0.02
Brain	**28.4**	29.9	**76.9**	5.83	-0.33	1987	-0.07	0.48	2003	-0.13	-0.15	2011	0.33	0.10
				0.25	0.06		0.26	0.06		0.28	0.05		0.30	0.07
O. neurological	**26.3**	5.3	**25.0**	1.02	0.00	1989	0.18	0.01	1998	0.13	-0.01	2011	0.11	-0.02
				0.03	0.01		0.04	0.01		0.04	0.01		0.04	0.01
ill-defined	**14.6**	40.1	**130.3**	11.21	0.52	1987	-0.53	-0.38	1999	2.03	-0.34	2010	-5.05	0.18
				0.33	0.07		0.36	0.08		0.33	0.05		0.36	0.06
Lymphoid	**231.0**	363.5	**540.5**	3.67	0.32	1994	0.42	-0.07	2001	0.24	-0.45	2008	0.11	0.32
				0.10	0.01		0.18	0.04		0.20	0.05		0.17	0.04
Leukaemia	**67.7**	206.6	**189.4**	4.83	0.13	1988	0.15	-0.06	2005	-0.42	-0.07	2012	0.61	-0.02
				0.12	0.02		0.13	0.03		0.15	0.03		0.17	0.04
In situ	**18.6**	43.4	**43.4**	0.00	0.00	1987	-0.01	-0.01	1996	0.01	0.00	2007	0.01	0.00
				0.00	0.00		0.01	0.00		0.00	0.00		0.00	0.00
Benign	**40.2**	159.4	**259.6**	0.24	0.03	1987	0.13	-0.01	1999	0.06	-0.01	2010	0.23	0.01
				0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01
Myelodysplastic	**7.6**	236.1	**128.4**	0.08	0.01	1987	-0.15	0.10	1999	0.36	-0.10	2008	-0.12	0.08
				0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01
Other	**51.9**	11.0	19.4	-2.16	1.06	1988	-1.10	-0.21						
				0.49	0.10		0.10	0.47						

Table 2. Total Neoplasms and its disaggregation by types. Male data

	KP1	KP2	KP3	m	b	TB1	mu1	b1	TB2	mu2	b2	TB3	mu3	b3
Total	34.45	79.79		176.52	7.20	1994	2.25	-4.20	2001	10.41	-6.09	2010	5.30	4.48
				1.05	0.12		1.83	0.37		1.85	0.43		1.77	0.34
Lips	6.70	206.88	206.88	4.50	0.38	1991	0.92	-0.40	2002	0.13	-0.26	2009	0.12	0.32
				0.13	0.02		0.18	0.03		0.21	0.04		0.20	0.04
Oesophagus	0.88	92.16	92.16	6.49	0.11	1997	-0.39	-0.14	2005	-0.54	-0.02	2012	0.04	0.06
				0.09	0.01		0.16	0.03		0.18	0.04		0.19	0.05
Stomach	116.10	90.88	330.79	24.14	-0.37	1987	0.99	0.11	2002	-0.52	-0.15	2009	0.37	0.21
				0.30	0.07		0.31	0.07		0.35	0.07		0.34	0.08
Colon	396.89	239.68	216.78	4.75	0.93	1993	1.59	-0.24	2005	-1.57	-0.18	2012	1.81	-0.70
				0.26	0.03		0.35	0.05		0.44	0.09		0.48	0.12
Rectum	3.17	103.65	79.67	5.90	-0.02	1987	-0.02	0.22	2003	-0.24	-0.18	2010	0.66	0.13
				0.18	0.04		0.19	0.04		0.21	0.04		0.22	0.05
Liver	28.17	3.01	203.27	11.48	0.07	1989	0.69	0.05	2003	-0.46	-0.26	2010	0.60	0.35
				0.18	0.03		0.21	0.04		0.25	0.05		0.25	0.06
Pancreas	443.01			4.87	0.32	1991	-0.21	-0.08	2001	0.64	-0.14	2010	0.13	0.32
				0.14	0.02		0.19	0.03		0.21	0.04		0.21	0.04
O. digestive	1.54	41.99	109.07	5.89	-0.08	1989	0.56	0.04	2004	-0.20	-0.02	2012	0.30	0.15
				0.15	0.03		0.17	0.03		0.19	0.03		0.22	0.05
Larynx	4.74	61.70	63.18	9.12	0.07	1994	-0.39	-0.18	2001	0.18	-0.26	2008	0.19	0.24
				0.10	0.01		0.18	0.04		0.20	0.05		0.17	0.04
Lung	27.62			39.21	2.48	1994	0.84	-1.90	2001	3.11	-1.26	2011	1.28	0.59
				0.44	0.05		0.77	0.16		0.75	0.17		0.76	0.15
O. respiratory	0.34	5.38	14.68											
Bone	2.07	69.19	30.93	2.56	-0.10	1990	-0.19	0.06	2000	-0.22	0.06	2007	-0.15	0.00
				0.08	0.01		0.11	0.02		0.13	0.03		0.11	0.03
Skin	277.55		360.25	0.36	0.09	1990	0.05	-0.03	1998	0.18	-0.04	2010	0.24	-0.01
				0.07	0.01		0.10	0.02		0.09	0.02		0.09	0.02
O. skin	10.93	228.11	558.13	1.44	0.19	1987	-0.44	-0.17	2001	0.22	-0.01	2009	0.13	0.11
				0.17	0.04		0.18	0.04		0.19	0.03		0.19	0.04
Breast	5.74	19.79	15.36	0.14	0.01	2000	0.00	-0.07						
				0.02	0.00		0.00	0.03						
Kidney	176.85	22.32	67.61	1.99	0.14	1993	0.37	-0.05	2002	-0.19	-0.04	2012	0.46	0.00
				0.10	0.01		0.15	0.02		0.15	0.03		0.17	0.04
Bladder	5.69			8.46	0.46	1995	-0.88	-0.12	2005	-0.96	-0.23	2012	1.49	-0.59
				0.17	0.02		0.26	0.04		0.32	0.07		0.33	0.08
Urinary organs	131.69	192.79	458.21	0.12	0.03	1995	0.34	-0.08	2004	-0.13	0.20	2012	-0.34	0.44
				0.07	0.01		0.11	0.02		0.12	0.02		0.13	0.03
Brain	22.61	177.33	118.10	6.75	-0.35	1987	-0.20	0.50	2002	0.36	-0.21	2010	0.28	0.17
				0.31	0.07		0.32	0.07		0.34	0.06		0.36	0.07
O. neurological	13.47	109.30	109.30	1.02	-0.04	1987	0.22	0.06	2000	0.12	-0.01	2011	0.20	-0.04
				0.06	0.01		0.06	0.01		0.06	0.01		0.06	0.01
ill-defined	13.62	19.45	403.52	11.13	0.73	1987	-0.34	-0.51	1999	3.22	-0.52	2010	-6.85	0.28
				0.46	0.10		0.50	0.11		0.46	0.07		0.50	0.09
Lymphoid	224.74	226.01	189.81	4.43	0.30	1989	0.57	-0.05	1999	0.94	-0.35	2006	-0.88	0.25
				0.19	0.03		0.24	0.04		0.26	0.06		0.23	0.05
Leukaemia	121.59	103.73	31.52	5.64	0.12	1994	-0.05	0.02	2007	0.21	-0.72			
				0.12	0.01		0.02	0.02		0.17	0.17			
In situ	15.25	12.46	46.24	0.00	0.00	1988	0.00	-0.03						
				0.01	0.00		0.00	0.01						
Benign	48.43	58.76	30.43	0.16	0.04	1995	-0.02	-0.01	2010	-0.06	0.41			

				0.04	0.00		0.01	0.01		0.05	0.06			
Myelodysplastic	5.28	75.87	60.32	0.11	0.01	1989	0.11	0.11	1999	0.37	-0.10	2007	-0.36	0.07
				0.06	0.01		0.08	0.02		0.09	0.02		0.08	0.02
Other	41.10	51.63	38.10	-2.44	1.21	1988	-1.28	0.13	2007	-0.05	-0.42			
				0.54	0.11		0.11	0.06		0.55	0.52			

Table 3. Total Neoplasms and its disaggregation by types. Female data

	KP1	KP2	KP3	m	b	TB1	mu1	b1	TB2	mu2	b2	TB3	mu3	b3
Total	18.09	61.49	61.49	122.82	2.96	1996	-3.69	-1.63	2004	-5.24	-1.15	2011	4.59	1.20
				0.77	0.08		1.34	0.24		1.55	0.36		1.51	0.36
Lips	137.43	317.04	370.26	0.86	0.06	1995	0.02	-0.06	2002	0.22	0.01	2010	0.18	0.06
				0.04	0.00		0.07	0.01		0.07	0.02		0.07	0.01
Oesophagus	27.52	51.97	51.97	1.53	-0.02	1991	-0.19	0.02	2005	-0.06	0.02	2012	-0.10	0.02
				0.05	0.01		0.06	0.01		0.07	0.01		0.08	0.02
Stomach	9.05	653.49	138.83	16.20	-0.20	1987	0.40	-0.08	2005	-0.40	0.20	2012	0.34	-0.12
				0.20	0.04		0.20	0.05		0.22	0.05		0.25	0.06
Colon	14.88	126.03	126.03	5.80	0.76	1995	-0.14	-0.38	2002	-0.33	-0.33	2011	1.27	-0.21
				0.21	0.02		0.37	0.07		0.38	0.09		0.37	0.08
Rectum	45.30	13.58	116.47	4.91	0.00	1987	0.43	-0.04	1994	0.37	0.07	2005	-0.66	0.06
				0.16	0.03		0.20	0.05		0.17	0.04		0.15	0.02
Liver	54.46	66.08	86.68	10.79	-0.31	1987	0.19	0.15	1994	0.06	0.08	2009	0.36	0.05
				0.17	0.04		0.22	0.06		0.18	0.04		0.17	0.03
Pancreas		383.73	525.53	3.89	0.25	1993	0.33	-0.13	2000	0.61	0.04	2010	0.39	0.20
				0.12	0.02		0.21	0.04		0.20	0.05		0.20	0.04
O. digestive	17.71	102.34	137.61	9.09	-0.09	1993	0.59	-0.09	2001	0.36	-0.07	2010	0.15	0.26
				0.15	0.02		0.23	0.04		0.24	0.05		0.24	0.05
Larynx	11.80	12.86	27.53	0.39	-0.01	1992	-0.06	0.01	2002	0.13	-0.02	2009	0.02	0.03
				0.03	0.00		0.04	0.01		0.05	0.01		0.04	0.01
Lung	67.84			5.94	0.08	1988	-0.62	0.15	2000	-0.09	0.25	2010	0.30	0.32
				0.16	0.03		0.19	0.04		0.18	0.03		0.20	0.04
O. respiratory	8.90	1.59	16.91	2.81	0.28	1995	-0.25	0.75						
				0.10	0.01		0.01	0.12						
Bone	20.60	40.89	38.50	1.68	-0.10	1988	0.08	0.03	2003	0.00	-0.04			
				0.07	0.01		0.01	0.01		0.07	0.06			
Skin	162.99	142.53	41.22	0.37	0.06	1994	-0.03	-0.01	2007	0.10	-0.13			
				0.06	0.01		0.01	0.01		0.08	0.08			
O. skin	12.79	73.80	48.79	1.16	0.08	1990	-0.07	0.03	2003	0.09	-0.27			
				0.08	0.01		0.02	0.01		0.10	0.09			
Kidney	419.07	80.94	54.57	1.25	0.04	1987	0.11	0.02	1995	0.26	-0.06	2003	0.07	0.03
				0.09	0.02		0.11	0.03		0.11	0.02		0.09	0.02
Bladder	1.52	39.26	49.28	1.89	0.09	1995	-0.43	0.01	2002	-0.24	-0.04	2012	0.14	-0.10
				0.07	0.01		0.12	0.02		0.12	0.03		0.13	0.03
Urinary organs	106.80	169.24	183.15	0.10	0.00	1987	0.05	0.01	2005	-0.06	0.05	2012	-0.11	0.10
				0.04	0.01		0.04	0.01		0.05	0.01		0.06	0.01
Brain	4.66	2.09	188.55	4.96	-0.32	1987	0.05	0.46	2003	-0.07	-0.16	2011	0.39	0.07
				0.22	0.05		0.23	0.05		0.24	0.04		0.27	0.06
O. neurological	36.58	5.18		1.04	0.02	1994	-0.16	0.03	2002	-0.18	-0.05	2012	0.05	-0.02
				0.03	0.00		0.05	0.01		0.05	0.01		0.05	0.01
ill-defined	14.85	28.73	193.70	11.32	0.30	1987	-0.82	-0.22	2002	1.33	-0.35	2010	-3.09	0.20
				0.31	0.07		0.32	0.07		0.33	0.06		0.35	0.07
Lymphoid	307.57	407.03	407.03	2.98	0.32	1994	0.42	-0.03	2002	-0.42	-0.38	2011	0.69	0.12
				0.11	0.01		0.19	0.03		0.20	0.04		0.20	0.04
Leukaemia	39.72	122.27	108.43	4.20	0.11	1988	0.19	-0.06	2003	0.26	-0.17	2010	0.73	0.10
				0.15	0.03		0.16	0.03		0.18	0.04		0.19	0.04
In situ	21.94	23.65	23.65	0.00	0.00	1988	0.00	0.00	2007	-0.02	0.01			
				0.01	0.00		0.00	0.00		0.01	0.00			
Benign	175.17	115.66	389.12	0.25	0.04	1992	-0.10	-0.01	2004	-0.08	-0.02	2012	0.16	0.00
				0.04	0.01		0.05	0.01		0.06	0.01		0.07	0.02
Myelodysplastic	4.51	175.86	75.86	0.05	0.01	1989	-0.02	0.08	1999	0.28	-0.07	2006	-0.22	0.05

				0.05	0.01		0.06	0.01		0.07	0.02	0.06	0.01
Other	76.08	34.02	34.02	-1.88	0.92	1988	-0.94	0.03	2002	-0.06	-0.43		
				0.43	0.09		0.09	0.05		0.48	0.40		

Related to cancer early detection and mass screening in Spain, only breast cancer is detected by an almost nationwide screening implemented at the regional level, although there is controversy with regard to mammographic screening and therapies in the substantial decreases in breast cancer mortality.[29] While the opportunistic and individual detection of prostate cancer by prostatic antigen began to be applied in 1991.[30] Furthermore, an initial coverage for colorectal cancer screening started in 2006.