The influence of health expenditure on longevity: a reconsideration

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Abstract

This study reports some new evidence on the contribution of health expenditure to increasing life expectancy. We propose a theoretical model from which we deduce a consistent econometric specification. Using country-level data for OECD countries over the period 1960-2000, we find that public health expenditure plays a significant role in increasing longevity. Moreover, the influence of government expenditure is non-lineal and we show that the biggest effect on longevity is when public expenditure is around 7% of GDP and that a balanced relationship between the public and private health sectors is important.

Keywords: public and private health expenditure, longevity.

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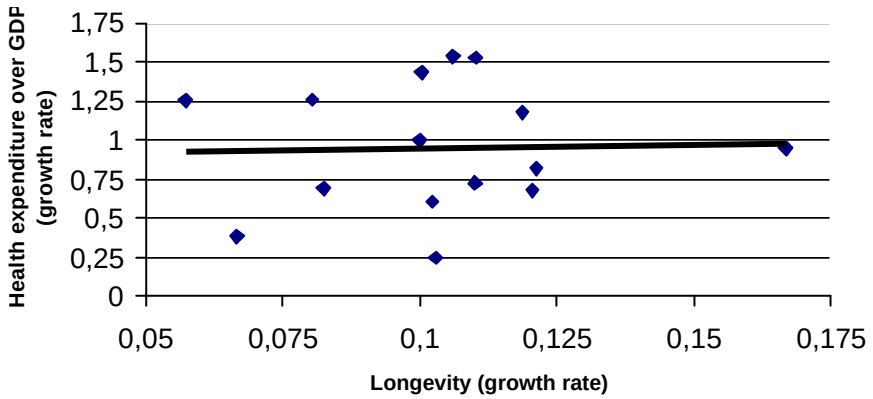
1. Introduction

Nowadays one of the main topics on the potical agendas of western economies is the revision of the so-called "welfare state", more precisely, the discussion about the convenience of reducing government presence in important fields like education or health. In this context, it is very interesting to analyse the effects of health expenditure on the sanitary status, in general, and on longevity, in particular, with the objective of checking the consequences of health policies. This task is not irrelevant because we do not observe a clear relationship between the intensity of the effort in health care and longevity in the period considered (see figure 1[1]).

Figure 1: Growth rates of longevity and total health expenditure (as percentaje of GDP), 1960-2000



Many previous empirical papers have been devoted to examining the repercussion of total health expenditure on longevity at the aggregate level and the empirical evidence is ambiguous. If we focus on the recent evidence, Thornton (2002) using U.S data form 1990, finds that the effect of total health expenditure on mortality is quite small. He suggests that this result is consistent with the possibility that the health sector could be in the flat section of

[1] The database used is explained in the section 3.

the medical curve, where additional resources destined to health barely increase longevity (Enthoven, 1980). His estimations are made in a static context where there is no distinction between the private or public character of health spending. Lichtenberg (2004) analyses the annual time series behaviour of U.S. longevity during the period 1960-2001. In addition to introducing a temporal dimension, he considers public and private health expenditure separately, finding that public health expenditure has a positive effect on longevity. He does not reject the null hypothesis that private health expenditure has no impact on life expectancy, giving as a reason a greater variability in the growth rate of public health expenditure compared to private health expenditure. Self and Grabowski (2003) extend Thornton's study to a cross-section of 191 countries using data from 1997. They conclude that public expenditure is not significant in developed countries whereas it is effective in improving health in developing economies. They justify government intervention in countries in which public health expenditure is low and, hence, diminishing returns do not appear. Private expenditure has a positive effect when the whole sample is considered, but becomes non-significant after distinguishing between developed and less developed countries. These authors conclude that the richest countries have better health mainly because health is persistent, although further research is called for to consider a dynamical framework because there is a time lag between changes in some explanatory variables and improvements in longevity, and because the period of time could be affecting to the empirical result. This paper contributes in this line. In particular, we focus on the OECD countries and, thus, we can assume homogeneous preferences and technologies. The sample covers the period 1960-2000. We use the data by 5 year averages because we are not interested in the cyclical component of the economic activity. Moreover, we use a panel data estimation procedure, a more adequate method than the usual cross-sectional analysis, which could be biased by a specific behaviour of the selected year. Our work also extends the study of Lichtenberg by including other developed countries as well as the U.S.

There is no doubt that a dynamic perspective allows a more adequate analysis of the influence of health expenditure on longevity. But we need a better comprehension of the reason why total health expenditure has limited effects on life expectancy levels, a conclusion that could seem counterintuitive at first glance. Previous studies propose the existence of diminishing returns to medical care to justify its ineffectiveness in improving longevity, along

with the importance given to socio-economic factors or pre-existing health conditions. We propose an alternative explanation to justify the apparently small impact of health expenditure on mortality. The intensity of health expenditure, measured as the percentage over GDP, usually mixes two different components that respond to heterogeneous motivations. While public expenditure is a political decision, private expenditure reflects the way individuals distribute their available income depending on their preferences. Indeed, while public expenditure is extensively used for cure services, private expenditure focuses on the quality of the medical services (care services) or on new health services not provided publicly (e.g.., cosmetic surgery)[2]. If such a distinction exists, it should be considered in order to avoid a misleading specification of the econometric model. To address this point, this paper explores the influence of health expenditure on longevity in a context where sanitary services are primarily provided by the government and in which individuals complement the public expenditure with additional (private) health expenditure. In particular, we present a theoretical model and a matched empirical specification that introduce this consideration.

We corroborate that an inappropriate specification could be a reason that explains the lack of relevance of health expenditure in improving the levels of longevity in developed countries and, hence, it could be the reason for the lack of unanimity in previous empirical studies. In this paper, we show that to consider both private and public health expenditure jointly with income in a regression analysis is excessive because individuals choose the quantity of resources that they devote to health depending on their income and the amount of public health resources assigned by authorities, that it is to say, private health expenditure is an endogenous variable in this context. The same is true of total health expenditure. In fact, taking into account a more suitable econometric specification, we find that public health expenditures become effective in improving life expectancy. To be more precise, the positive influence of public health expenditure on improvements of longevity is not monotonic, reaching its maximum level when the public health expenditure as a percentage of GDP is around 7%. Furthermore, the weight of the public and the private sectors in the total expenditure emerges as a relevant element, above all if there is not a certain "balance" between both sectors. In this sense, we find evidence according to a decreasing relationship

[2] See Newhouse (1977)

between relative composition, measured as the ratio of private to public health expenditure, and the effect of public health expenditure on increasing longevity.

The rest of paper is organized as follows. In the second section we present a theoretical model where the relationship between public and private expenditure is analysed, showing that the simultaneous consideration of both variables in the empirical work could lead to misleading results. Section 3 describes the data set and presents the econometric specification. In Section 4 we present the results of the estimations. In Section 5 we summarize the results and some recommendations of political economy are made.

2. A simple model of private and public health expenditures

Individuals' welfare depends on consumption *c*, as usual, with a decreasing marginal utility of consumption. Given a level of consumption, a greater longevity *h* (in general, a better health status) also contributes to individuals' utility. Let the utility function be

$$U = c^a h^b \text{ ,} \qquad (1)$$

with $0 < a, b < 1$. Although the theoretical model we present is static for the sake of simplicity, we think it captures the main ideas about the influence of life expectancy on individuals' decisions. Specifically, in this paper we are interested in longevity as a key dimension of health status. A standard dynamic model would consider a utility function resulting from aggregating instantaneous utility over the life of individuals, with the result that a longer life leads to a higher aggregate utility. However, the discount rate on future consumption leads to a decreasing influence of the life span on welfare. These facts can be captured by our specification through the assumption $0 < b < 1$, which reflects the positive but decreasing influence of longevity on individuals' welfare.

Life expectancy or longevity, *h*, increases with effective health services according to the following expression:

$$h = d(s + qg)^r \text{ ,} \qquad (2)$$

where $d > 0$ is a scale factor capturing the productivity of health technology. Individuals' health status is determined by private and public per capita health services, *s* and *g*

respectively, with $x = s + g$ being the total amount. q is the efficiency of public health services relative to private ones: $q > 1$ corresponds to a higher efficiency of public health services, and vice versa; thus, the effective aggregate per capita health services are given by $\hat{x} = s + qg$. Finally, we assume $0 < r < 1$, which implies that an increase in effective health services, either private or public, has a high impact on health status when the level of these services are low but the impact decreases as the quantity of effective services increases[3].

It is convenient to make some considerations about the degree to which public spending is able to create effective health services[4]. Although, in this section, we will treat the relative efficiency of public expenditure q as a constant for simplicity, it could change with several elements, in particular, with the level of public health expenditure or with the weight of public and private health expenditure in the aggregate. When public expenditure is low, increases in government expenditure have a relative higher productivity than clearly increases the longevity due to the fact that the priorities of public health programs are basic programs that affect an important fraction of the population and involve important positive external effects (vaccination campaigns, prevention of diseases, basic framework of health centres, etc.). Most public resources are devoted to "social" health services, that it is to say, public goods that the private sector does not cover. Additional public expenditure is likely to be devoted to activities that the private sector also offers (mainly "caring") and the total productivity of both sectors converges. This suggests that the effect of public services on health is high for low levels but decreases as the level grows.

Furthermore, if public and private health services cover (at least partially) different health needs, they can be considered, to some extent, as complementary inputs. In this case, the efficiency of public expenditure will also depend on the weight of the public and private sectors in the total expenditure, suggesting that the more balanced the composition of health expenditure, the higher the efficiency of public resources. We will introduce these considerations in the empirical analysis in Section 4.

[3] See Wilkinson (1992), Heerink (1994) and Van Zon and Muysken (2001).
[4] See, for example, Filmer and Pritchett (1999) and Self and Grabowski (2003).

Public health services are financed by taxes on individuals' income y at a rate t. Public expenditure is then given by

$$P_x g = ty, \tag{3}$$

with P_x being the (relative) price of health services (consumption goods are considered as the numeraire). In turn, private health services are purchased as an alternative to consumption goods. Individuals' budget constraint is given by

$$y(1-t) = c + P_x s\,. \tag{4}$$

The consumers' problem can be represented as the maximization of the utility function (1) subject to the budget constraint (4). Given the health technology in (2), the utility function can be expressed as

$$U = d^{b} c^{a} (s + qg)^{rb}\,. \tag{5}$$

The optimal allocation of resources between consumption and private health services on the part of individuals requires the value of the utility derived from both of them to be equal at the margin, that is to say,

$$rbc^{*} = aP_x (s^{*} + qg)\,. \tag{6}$$

This expression, together with the budget constraint (4), allows us to determine the private health services demand as

$$s^{*} = \frac{rb}{a + rb}\frac{y}{P_x} - \frac{aq + rb}{a + rb} g\,. \tag{7}$$

The positive relationship with income characterizes health services as a normal good. From the private demand in (7), the total amount of health services is given by:

$$x^{*} = s^{*} + g = \frac{rb}{a + rb}\frac{y}{P_x} + \frac{a(1-q)}{a + rb} g\,. \tag{8}$$

Then, the equilibrium health status can be characterized by the following expression:

$$h^* = \Delta\left[\frac{y}{P_x} + (q-1)g\right]^r, \qquad (9)$$

where $\Delta = d\left(\frac{rb}{a+rb}\right)^r$ is a constant term. From (9), health status clearly increases with income and decreases with the price of health services. It is higher, the higher the valuation of health in individuals' preferences (higher b or lower a), the more efficient the health technology (higher d) and the lower r is.

Moreover, health status is favored by a high (relative) efficiency of public resources. However, the influence of public services can be positive or negative depending on this efficiency. An increase in public services has an impact on the aggregate amount of health services that depends on the relative efficiency of the public and private sectors. With more efficient public sector ($q > 1$), an increase in public health services leads to a larger reduction in private demand of health goods in such a way that the aggregate also gets reduced. However, this does not imply a deterioration in health status given that, as is easy to deduce, the amount of effective resources $\hat{x}^* = s^* + qg$ increases and, therefore, in (9) life expectancy grows. The opposite holds for $q < 1$.

The above expressions highlight a first element to take into consideration about the determinants of health status: with private demand for health being endogenous, the inclusion of private expenditure along with public expenditure and income in a regression analysis is redundant. The expected result when the three variables are considered together is that some of them will appear to be non-significant in explaining health status and this may be one reason why there has been conflicting empirical evidence. The same could apply when the aggregate expenditure is considered, since it includes a fraction that is determined by the government whereas another fraction is influenced by public expenditure as well as by income (which, in turn, is usually considered as another explanatory variable in the same regression).

The proposed framework will help us to explore some of the findings reported in the next section.

3. Data and econometric specification.

In this section we present empirical evidence related to the effect of health expenditure on increasinf longevity. As our objective is to determine the long-term influence of health expenditure on the lengthening of life expectancy, we have grouped the sample period, 1960-2000 into 8 stages of five years that isolate cyclical elements. The sample is made of developed countries, which allows us to maintain the habitual assumption of a common (constant) long-run technological progress rate. The countries in the sample are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, UK and USA. Thus, we have a data panel of 29 countries and 8 periods, although for some countries the available period is shorter.

The econometric specification corresponds to the following expression:

$$\Delta lon_t = b_0 + b_1 g_t + b_2 lon_{t-1} + b_3 he_t + b_4 t + b_5 cal_t + e_t , \qquad (10)$$

where the endogenous variable, *lon*, is the logarithm of longevity, and the exogenous variables are g, the GDP growth rate, *he*, health expenditure as a percentage of GDP, either the total (*the*) or the public (*phe*), *t* is a time variable that can be considered as a proxy of technical progress (capturing facts like convergence processes, technological progress[5], etc.) and *cal* is the logarithm of calories consumed. Following Self and Grawbosky (2003), we include the quantity of calories consumed, whose relationship with the level of health has been extensively investigated. Since in the sample economies the consumption of calories is above the recommended level, given the sedentary way of life in western countries, the expected effect on longevity is negative. With respect to the expected influence of income and health, it is difficult to make an a priori forecast because the empirical evidence is not conclusive. The theoretical model presented above suggests that the consideration of total health expenditure as non depending on GDP could originate a wrong empirical specification

[5] See Cutler, Deaton and Lleras-Muney (2006)

due to the relationship between private health expenditure, income and public health expenditure, represented by expression (7). Identical considerations apply when the empirical specification simultaneously includes public and private health expenditure and income as explanatory variables. In the next section we check if the empirical results corroborate the theoretical findings.

The data related to income have been collected form the Penn-World table (Heston, et al., 2002) in its most recent update, from which it is possible to obtain a sample that covers the period 1980-2000 for the considered countries, although available data start later than 1980 for some of them. Finally, the longevity data come from the Population Division of the Department of Economic and Social Affairs of the United Nations (2003). Finally, the data of calories and health expenditures in constant prices are been taken from the OECD Health Database of 2002.

4. Empirical results

The methodology used is based on panel data analysis including the estimation of the case in which all the parameters are the same for every year and every country (plain estimation or OLSQ estimation), as well as those that allow the presence of fixed effects or random effects. The tests lead us to select the fixed effects specification. No problems of heteroscedasticity and endogenity are detected.

4.1. First step: the effect of total health expenditure

We first explore the effect of total health expenditure on longevity, as is usually done in the literature. The results are presented in columns 1 and 2 of Table 1. Additionally, we include information about the goodness of fit of the estimations, the LM test for checking the existence of heteroscedasticity, and the test of fixed effects that verify the hypothesis that the constant term coincides for all countries. We find a good degree of explanation and the hypothesis of homoscedasticity is accepted.

The estimated coefficients present the signs, and fall into the range of values, usually found in the literature. As mentioned above, previous papers show no definitive evidence about the effect of total health expenditure on increasing life expectancy. We again find that this effect is non-significant when fixed effects are considered, although it is significant at 15% when random effects are considered. We think that the fixed effect specification is better because the differences between countries could be due to their technological levels (different parameters in (2)). However, as the Haussman test leads us to reject the null hypothesis, we include both models in our empirical results.

As we mentioned above, from the theoretical model we could expect some problems in this specification because the private and public components of total health expenditure are interrelated. Specifically, expression (7) establishes that private health expenditure depends positively on GDP and negatively on public health expenditure; thus, an important percentage of total expenditure is related to GDP and its effect is indirectly considered by this variable. The results in columns 1 and 2 of Table 1 provide support for this idea: total health expenditure appears to be non-significant (or not very significant) to explain longevity increase.

The other variables present the expected sign: the lagged longevity and the calories consumed negatively affect longevity growth, while GDP growth and technical progress positively affect it. All in all, these preliminary results show that the usual results in the literature prevail[6] in our database.

4.2. Second step: the effect of public health expenditure and the composition effect

Having verified that total health expenditure does not explain the behaviour of longevity in developed countries in the period considered, we adopt a specification inspired by the theoretical model in which we only include public expenditure. The results are presented in columns 3 and 4 of Table 1. The degree of adjustment is similar to previous estimations, there are not problems of heteroscedasticity and the fixed effects model is again selected, although

[6] We should point out the necessity of including some dummy variables that reflect the particular behaviours of some countries (Turkey, Korea and Iceland) in certain periods.

the Hausman test indicates that the fixed and the random effects are not equal. Public health expenditure appears to be a significant variable at the 10% or the 15% significance level. Interestingly, the influence of public expenditure on longevity increase is more than twice that of the total expenditure when fixed effects are considered. The parameters corresponding to other variables maintain the expected sign. Therefore, these results are consistent with the idea suggested by the theoretical model that the information contained in total health expenditure is excessive, indicating that it is more adequate to consider only public expenditure when GDP is also used to explain longevity behaviour.

4.3. Non-linear effects

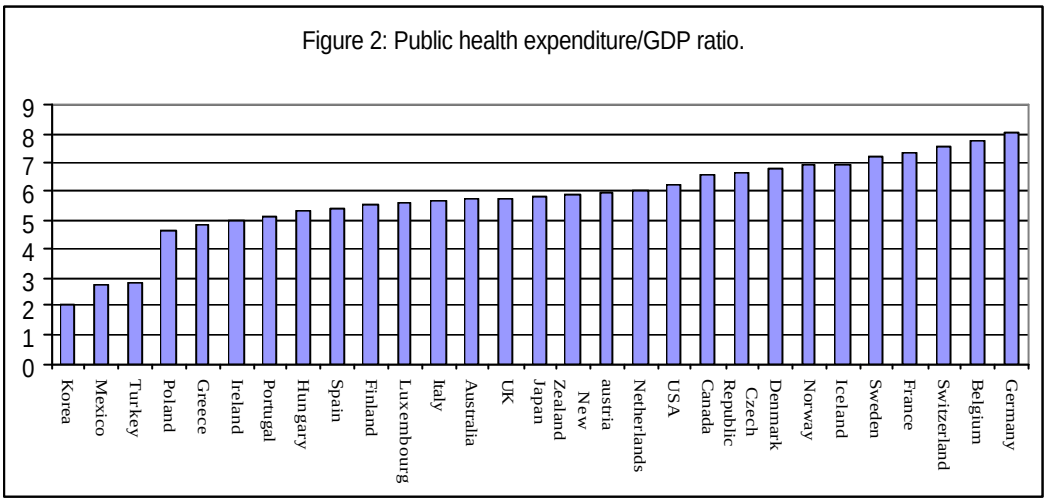
To interpret the results, it is important to bear in mind that when presenting the theoretical framework we have suggested the possibility that the influence of public health expenditure on longevity could be modified by two elements: changes in the relative efficiency of public health services with respect to private ones (q); and the presence of diminishing returns to scale ($r<1$). In this section we show empirical evidence in favor of this idea.

As a first approach to a possible non-linearity of the relationship between public expenditure and longevity, we have analysed the effect of government health expenditure in three blocks of countries, depending on the weight of this expenditure on GDP. As Figure 2 shows, there are important differences among the countries in our sample. For example, in 2000, while in Korea the public expenditure is below 5% of GDP, in Germany it exceeds 8%. We choose the following distribution: a first group (G1) of countries that have a ratio below 5%, (that is to say, Korea, Mexico, Turkey, Poland, Greece and Ireland); a second group, the reference one, where the ratio is from 5% to 6.5% (Portugal, Hungary, Spain, Finland, Luxembourg, Italy, Australia, UK, Japan, Canada, New Zealand, Austria, Netherlands, and USA); and a third group (G3) composed by the countries that exceed 6.5% (Czech Republic, Denmark, Norway, Iceland, Sweden, France, Switzerland, Belgium and Germany).

We show the results of the estimation in columns 1 and 2 of Table 2, in which the estimation of parameters associated to variables phe(G1) and phe(G3) capture the difference

I’’’¿¿¿¿¿¿??????????largest ratio of public health expenditure over GDP, respectively, taking the intermediate group (G2) as the baseline. Although the level of explanation does not improve significantly, in qualitative terms we obtain relevant results. Firstly, public expenditure is again significant in explaining longevity growth. Secondly, the results in column 1 provide support for the presence of a non-lineal relationship between public health expenditure and the ability of further resources to lengthen life expectancy, with a significant reduction in the effects of public health expenditure in the countries with the highest percentages of this expenditure on GDP. This result corroborates the idea of a decreasing productivity of public resources in lengthening life.

Figure 2: Public health expenditure/GDP ratio.



Since the above results could be biased by the way the groups have been formed, we follow a second approach in which we allow for a non-monotonic relationship by introducing the square of the ratio of government health expenditure on GDP (phe2) into the empirical specification. The results appear in the third column of Table 2 and show a concave relationship. Figure 2 represents the influence of government health expenditure on longevity growth for the range of values of the ratio of public health expenditure on GDP observed in the sample considered (that is to say, from 0 to 9%). The maximum influence corresponds to a weight of public health services around 7% of the GDP. Thus, public effort always has a positive influence on the increase of longevity in the countries considered, but this influence has an upper limit.

4.4. The composition effect

Another idea suggested in Section 3 is that the composition of health expenditure could be important; that is to say, the effects of total health expenditure on longevity growth could depend, for a given total health expenditure, on the weight of government and private expenditures, as suggested in Section 2, because the motivations of both components are very different and may not be perfect substitutes. This point is interesting because the composition of the health system is very different in the countries in our sample, with the ratio of private to public expenditures ranging from 0 to 3.

In this context, we propose the following empirical specification, in which we include the product of public health expenditure and the ratio of private to public expenditures (*relat*) and also the product with the square of this ratio ($relat^2$):

$$\Delta lon_t = b_0 + b_1 g_t + b_2 lon_{t-1} + b_3 phe_t + b^1{}_3 phe_t relat_t + b^2{}_3 phe_t relat^2{}_t + b_4 t + b_5 cal + e_t$$

Table 3 shows the results. Again, we confirm the presence of non-linear effects: the influence of government health expenditure depends on the composition of the aggregate expenditure. Figure 3 depicts this influence using the estimation of the random effects model. In general, it shows a decreasing relationship between composition (private over public expenditures, *relat*) and the influence of public expenditure on longevity. However, when the ratio is below 0.5, the effect could be considered as constant. From 0.5 to 1 the relationship is clearly decreasing. For values of the ratio over 1 we find an increase in the constant but the decreasing pattern prevails. The latter behaviour could be indicating that these countries have a different health system that promotes the private health system, a question that it is not considered in this work.

5. Conclusions

There are studies both in favour and against increasing government's role in the health sector. This paper adds to the debate about the contribution of the public health sector in

OECD countries by providing a possible explanation of the contradictory results of the previous literature and finding some new evidence on its role in lengthening longevity. The consideration of a dynamic perspective, through the use of panel data, allows us to reflect that the key element is the distinction between public and private health expenditure. Whereas public expenditure is basically a political decision, the private expenditure reflects the way individuals distribute their available income according to their preferences. Furthermore, public and private health expenditures have, at least to some extent, alternative uses in terms of health. As a consequence, the inclusion of total health expenditure together with GDP in a regression analysis implies a misleading specification of the econometric model. The cause is that private health expenditure is endogenous and depends positively on GDP and negatively on public health expenditure.

The findings reported above suggest that increases in the percentage of the GDP devoted to public health services always have the desired effect of lengthening life expectancy, but our estimates indicate that the effectiveness of these public resources is not homogeneous. The influence of public health expenditure on longevity growth is higher when it is around 7% of GDP. This evidence could be consistent with the combination of two mechanisms. One is that the public provision of "basic" health services needs a certain minimum amount of resources to be successful. Another is the expected activation of diminishing returns once a certain level of expenditure is surpassed. Consequently, increasing government health expenditure in countries with a significant size of public sector may not achieve fruitful improvements in health.

Another point to highlight is that the composition of health expenditure is relevant. We find a decreasing relationship between the private/public health expenditure ratio and the effect of public health expenditure on increasing longevity. The public sanitary effort is most effective in terms of longevity when the private/public health expenditure ratio is lower than 0.5. Therefore, for countries in which the private-public ratio is higher than 0.5, a policy recommendation could be that an expansion of the public sector would be desirable in terms of longevity if it is accompanied by a reduction, or at least a stagnation, of the private sector.

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Table 1. Effects of total and public health expenditure.

	Fixed Effect	tratios	Random Effect	tratios	Fixed Effect	tratios	Random Effect	tratios
g	0,007*	2,41	0,010*	3,42	0,007*	2,47	0,010*	3,50
Lon_{t-1}	-0,004*	-8,61	-0,002*	-10,86	-0,004*	-8,87	-0,002*	-10,50
the	0,054	0,94	0,063***	1,52				
phe					0,125**	1,77	0,074***	1,54
time	0,005*	7,97	0,003*	9,69	0,005*	8,06	0,003*	10,27
cal	-0,050*	-4,05	-0,046*	-5,08	-0,050*	-4,11	-0,045*	-5,05
Kor75	0,031*	5,33	0,039*	7,59	0,030*	5,31	0,038*	7,48
Tur7	0,018*	3,48	0,014*	2,92	0,017*	3,44	0,014*	2,87
Ice92	0,014*	2,70	0,013*	2,54	0,014*	2,72	0,013*	2,50
constant								
Number of obs.	162		162		162		162	
R^2	0.86		0.76		0.87		0.75	
Adj. R^2	0.83		0.74		0.83		0.74	
Lm test	1.12		1.02		1.15		0.72	
F test fixed effects	3.6				3.83			
Haussman test			27,26*				29,68*	

*, ** and *** indicate significance at 5%, 10% and 15%, respectively.

Table 2. Nonlineal effects of public health expenditure:

	Fixed Effect	tratios	Random Effect	tratios	Fixed Effect	tratios
g	0,008*	2,63	0,010*	3,55	0,007*	2,35
Lon $_{t-1}$	-0,004*	-8,62	-0,002*	-10,59	-0,004*	-8,76
phe (G1)	-0,008	-0,06	-0,056	-1,13	0,485*	2,40
phe	0,208*	2,34	0,099*	1,69		
phe (G3)	-0,138**	-1,60	-0,030	-1,04		
phe2					-3,443**	-1,90
time	0,005*	7,92	0,003*	10,17	0,005*	8,31
cal	-0,055*	-4,38	-0,043*	-4,64	-0,054*	-4,43
Kor75	0,029*	5,21	0,038*	7,33	0,030*	5,42
Tur7	0,017*	3,39	0,014*	2,96	0,016*	3,22
Ice92	0,013*	2,57	0,013*	2,51	0,013*	2,61
Constant			0,180*	12,13		
Number of obs.	162		162		162	
R^2	0.87		0.76		0.87	
Adj. R^2	0.83		0.74		0.84	
Lm test	1.33		0.8		1.78	
F test fixed effects	3.8				4.05	
Haussman test			31.2			

*, ** and *** indicate significance at 5%, 10% and 15%, respectively.

Table 3. Nonlineal effects of public health expenditure: the composition effect:

	Fixed Effect	tratios	Random Effect	tratios
g	0,008*	2,68	3,72*	3,72
Lon $_{t-1}$	-0,004*	-9,46	-10,59*	-10,59
phe	0,107***	1,53	1,38****	1,38
Phe relat	0,052	0,43	1,71**	1,71
Phe relat2	-0,162*	-2,78	-1,68**	-1,68
time	0,005*	8,56	10,03*	10,03
cal	-0,044*	-3,61	-5,27*	-5,27
Kor75	0,036*	5,65	7,41*	7,41
Tur7	0,015*	3,00	2,86*	2,86
Ice92	0,013*	2,62	2,59*	2,59
Constant			0,18*	12,07
Number of obs.	162		162	
R^2	0.87		0.76	
Adj. R^2	0.84		0.44	
Lm test	1.33		0.46	
F test fixed effects	4,11			
Haussman test			37,37*	

*, ** and *** indicate significance at 5%, 10% and 15%, respectively.

Figure 2: Influence of Public Health Expenditure on longevity

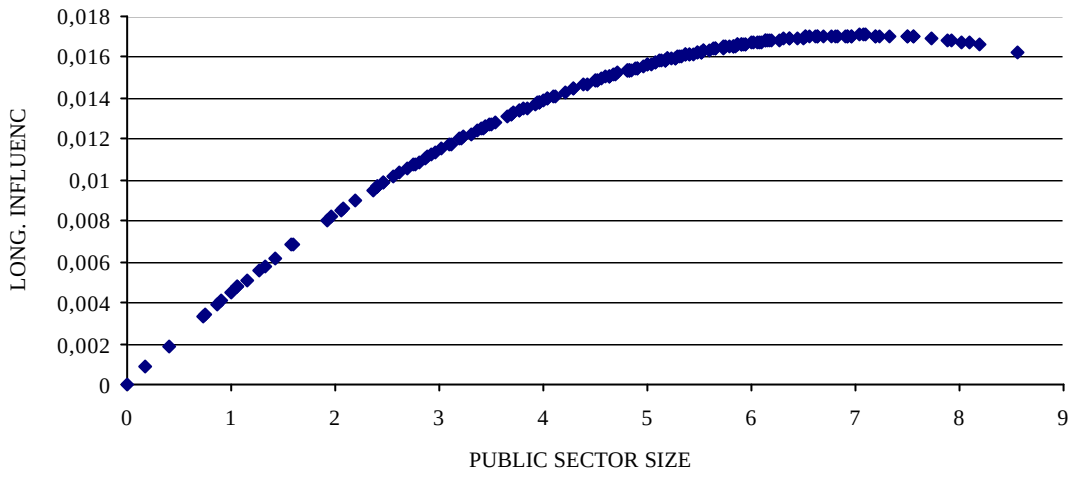

Figure 3: Private/Public health expenditure ratio and influence on longevity