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The influence of (public) health expenditure on longevity

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Abstract

Objectives We report new evidence on the contribution of health expenditure to increasing life expectancy in OECD countries, differentiating the effects of public and private health expenditures.

Methods A theoretical model is presented and estimated though a cross-country fixed effects multiple regression analysis for a sample of OECD countries over the period 1980–2000.

Results Although the effect of aggregate health expenditure is not conclusive, public health expenditure plays a significant role in enhancing longevity. However, its influence diminishes as the size of the public health sector on GDP expands, reaching a maximum around the 8 %.

Conclusions With the influence of public health expenditure being positive, the ambiguous effect of the aggregate expenditure suggests that the weight of public and private health sectors matters, the second having a lower impact on longevity. This might explain the poor evolution of the life expectancy in countries with a high amount of private resources devoted to health. In such cases, an extension of public services could give rise to a better outcome from the overall health investment.

Keywords Life expectancy · Private health expenditure · Public health expenditure

JEL Classification I11 · I18 · H51

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Introduction

A common topic on the agenda of politicians in western economies today is the revision of the so-called "welfare state", especially when discussing the convenience of reducing the presence of government in important fields like education and/or health. In this context, it is of interest to analyse the effects of public health expenditures on health in general, and on longevity in particular, with the objective of ascertaining the consequences of health policies.

Prior empirical papers have found ambiguous evidence. Recently, Thornton (2002), using US data from 1990 found that the contribution of total health expenditure to mortality is quite small. He suggests that this result is consistent with the notion that the health sector could be in the flat section of the medical curve, where additional resources destined for health barely increase longevity (Enthoven 1980). His estimations are made in a static context, making no distinction between private and public health spending. Lichtenberg (2004) analyses the annual time series behaviour of US longevity during the period 1960–2001. In addition to introducing a time series 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, and concludes that this is due to the greater variability of public health outlays, relative to the private sector. Self and Grabowski (2003) extend Thornton's study to a cross section of 191 countries, using data from 1997, concluding 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 expenditures are low and where, hence, diminishing returns do not appear. With respect to private expenditures, they have a positive effect when the whole sample is considered, but become non-significant when distinguishing between developed and developing 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 dynamic framework, since there is a time lag between the changes in certain explanatory variables and improvements in longevity.

Specifically, our paper contributes to this line of research by focusing on the OECD countries over the period 1960–2000, using 5-year averaged data. (We are not interested in the cyclical component of the economic activity). We carry out a panel data estimation procedure to analyse the impact of health expenditure on life expectancy across countries, being aware the influence of this factor on life expectancy is likely to occur with a certain delay (Ivaschenko 2005). Indeed, Byrne et al. (2007) find that the significant cross-sectional effect of funding levels on mortality, in their sample, disappears when longitudinal data are used. At this point, we should note that panel data analysis improves the efficiency of estimates (Hsiao et al. 1995), reduces the collinearity between current and lag variables (Pakes and Griliches 1984), and simplifies computation and inference (e.g. Hsiao 2007). Moreover, it allows us to specify fixed effects and improve identification by controlling for country-specific unobservable variables.

A better comprehension of the mechanisms linking longevity and health expenditures is necessary since it seems counter-intuitive to conclude that health outlays cannot explain improvements in life expectancy levels. Prior studies propose the existence of diminishing returns to medical care to justify its ineffectiveness, along with the importance given to socioeconomic factors, or pre-existing health conditions. We propose an alternative explanation. The intensity of health expenditure, measured as a percentage of GDP, mingles 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. To illustrate this, we present a very simple theoretical model to show that individuals choose the quantity of resources to devote to health depending on their income and the amount of public health resources assigned by authorities. Consequently, the consideration of both private and public health outlays, together with income in a regression analysis, would be redundant and would explain the irrelevance of private health expenditure in accounting for improvements in longevity. The same consideration could apply to total health expenditure.

In fact, taking into account a more suitable econometric specification, we find that public medical expenditures become effective in improving life expectancy, although the influence is not monotonic, reaching its maximum when the public health outlay is around 8 % of GDP. Furthermore, the weight of the public and private sectors in the total expenditure emerges as a relevant element, above all if there is no certain balance between the two sectors. Thus, an extension of the public health system can achieve important results in enlarging individual lifespans in countries with a relatively important presence of the private sector.

Methods

Theoretical framework

Individual welfare depends on consumption c, as usual, with a decreasing marginal utility of consumption. At a given level of consumption, a greater longevity h (in general, a better health status), also contributes to individual utility. Let the utility function be.

$$U = c^{\alpha} h^{\beta}, \tag{1}$$

with $0 < \alpha, \beta < 1$. Although the theoretical model we present is static, for the sake of simplicity, we consider that it captures the essence of our ideas about the influence of life expectancy on individual decisions. A standard dynamic model would consider an individual utility function resulting from aggregating instantaneous utility over the life of the individual, with the discount rate leading to a decreasing influence of the life span on welfare. This fact can be captured by our specification more simply, through the assumption $0 < \beta < 1$, reflecting the positive but decreasing influence of longevity on individual welfare.

Life expectancy h increases with effective health services according to the following expression:

$$h = \delta (s + \theta g)^{\rho}, \tag{2}$$

where $\delta > 0$ is a scale factor capturing the productivity of health technology. Individual health status is determined by the per capita amount devoted to health services, $x = s + g$, part being private (s) and the rest public (g). An element to take into account is θ, the ratio between the marginal productivity of public health expenditure and the marginal productivity of private health expenditure. This ratio measures the rate at which private and public health expenditure can be exchanged while maintaining a constant level of health. We consider that this rate depends on the size of the public sector, that is, $\theta = \theta(g)$. In particular, we assume that $\theta(g) > 1$, to capture the fact that, in general, public health expenditure is devoted, first and foremost, to finance actions that affect an important fraction of the population and involve significant positive external effects (i.e. what we could identify as basic health: vaccinations campaigns, prevention of disease, basic framework of health centres, etc.). But, once the basic programs are fulfilled, additional public expenditure is likely to be devoted to activities that the private sector also offers, so the productivities of the two sectors converge. To reflect this convergence, we assume $\theta'(g) < 0$. Finally, we consider $0 < \rho < 1$, implying that an increase in effective health services, either private or public, has a high impact on health status when there is a low level of services, but this impact decreases as the level of effective services increases (Wilkinson 1992; Heerink 1994; Van Zon and Muysken 2001).

Public health services are financed by taxes on individual income y (net of those taxes not linked to health) 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 good is considered as the numeraire). Private health services are purchased as an alternative of consumption goods. The individual budget constraint is given by

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

The consumers' problem consists of 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

$$U = \delta^\beta c^\alpha (s + \theta g)^{\rho\beta}. \tag{5}$$

The optimal allocation of resources between consumption and private health services on the part of individuals requires that the utility derived from the resources devoted to each of them must be equal at the margin: $\partial U/\partial c = (1/P_x)\partial U/\partial s$. That is to say,

$$\rho\beta c^* = \alpha P_x (s^* + \theta g). \tag{6}$$

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

$$s^* = \frac{\rho\beta}{\alpha + \rho\beta}\frac{y}{P_x} - \frac{\alpha\theta + \rho\beta}{\alpha + \rho\beta} g. \tag{7}$$

A 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:

$$x^* = s^* + g = \frac{\rho\beta}{\alpha + \rho\beta}\frac{y}{P_x} + \frac{\alpha(1-\theta)}{\alpha + \rho\beta} g. \tag{8}$$

Then, the equilibrium life expectancy is described by the following expression:

$$h^* = \Omega[y + (\theta - 1)P_x g]^\rho = \Omega y^\rho \left[1 + (\theta - 1)\frac{P_x g}{y}\right]^\rho, \tag{9}$$

where $\Omega = \frac{\delta}{P_x}\left(\frac{\rho\beta}{\alpha+\rho\beta}\right)^\rho$ is a constant term. From (9), health status increases with income and is higher the higher the relative valuation of health in individual preferences (higher β or lower α), the more efficient the health technology (higher δ) and the lower the degree of decreasing marginal productivity of health resources (lower ρ). The influence of public health expenditure is also positive. Under the assumption that the effectiveness of the public health sector in improving health is greater than that of the private sector ($\theta > 1$), an increase in public services leads to a larger reduction in private demand, in such a way that the aggregate is also reduced. However, this does not imply a deterioration in health status, given that, as is easy to deduce, the amount of effective resources $s^* + \theta g$ increases and, therefore, in (9) longevity increases.

The above expressions highlight one element to consider in the determinants of health status: since the demand for private health is endogenous, the inclusion of private expenditure, together with public expenditure and income, in the same regression analysis is redundant. The expected result when these three are considered together is that one of the variables will appear to be non-significant in explaining health status—and this may be a plausible explanation for the conflicting empirical evidence. The same could apply when the aggregate expenditure is considered, since it includes one part that is determined by the government while the rest is influenced by government and by income (which, in turn, is usually considered to be an explanatory variable in the same regression).

Data

Figure 1 plots the unclear relationship between the intensity of health expenditure and the increase in life expectancy in our sample.

The countries in the sample are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the UK, and the USA. The sample period runs from 1960 to 2000. Since our objective is to determine the long-term influence of health expenditure on life expectancy, we have considered 8 stages of 5 years each that isolate cyclical elements, and we have taken average values for each stage. Thus, we have a data panel of 29 countries and 8 periods, although the available period is shorter for some countries.

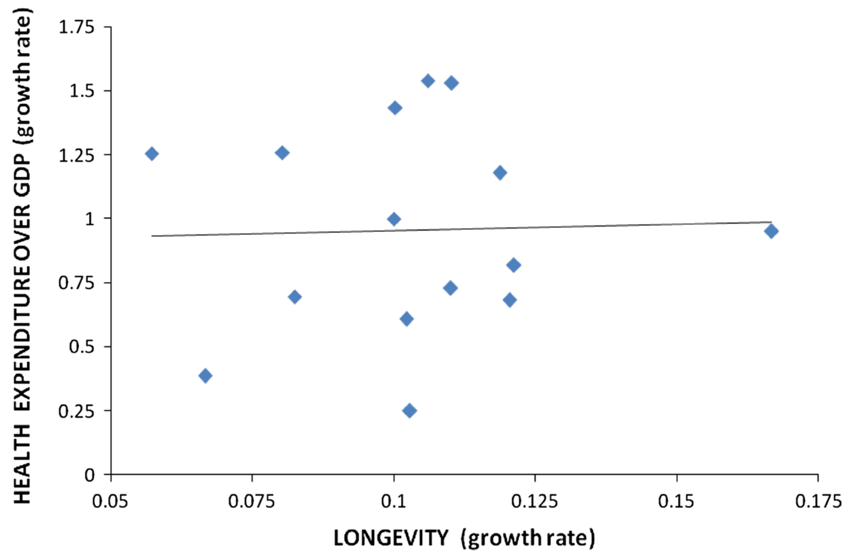

Fig. 1 Growth rates of longevity and total health expenditure (as a percentage of Gross Domestic Product). Organisation for Economic Co-operation and Development (OECD) countries, 1960–2000. *Source* OECD (2005), United Nations (2003)

GDP data have been collected from the Penn-World table (Heston et al. 2012). The 2005 OECD Health Data Base provides us with the data about health expenditures and calorie intake, and the longevity data come from the Population Division of the Department of Economic and Social Affairs of the United Nations (2003). All the economic data are measured in per capita terms and in USA$ PPP.

Econometric specification

The econometric specification comes from expression (9). Taking logs, we have:

$$\ln\ h^{*} = \ln \Omega + \rho \ln y + \rho \ln\left[1 + (\theta - 1)\frac{P_x g}{y}\right],$$

which, considering that the term in brackets is close to 1 and that (using the Mercator series) ln $(1 + x)$ can be approximated by x when x is close to 0, can be approximated by

$$\ln\ h^{*} \approx \ln \Omega + \rho \ln y + \rho(\theta - 1)\frac{P_x g}{y}.$$

That is to say, longevity depends on per capita income and on public health expenditure as a percentage of GDP. A positive (negative) value of the parameter associated with the latter variable means that public expenditure is more (less) effective than private. This approximation is adequate if the effectiveness of the public health sector is slightly greater than that of the private sector, a condition that can be fulfilled in developed countries, where both public and private health systems are well established.

Adopting a dynamic perspective, the above expressions can be considered as describing the long-run behaviour of longevity, with this variable adjusting in the short-run towards its long-run value. Thus, the short-run behaviour of longevity could be described as

$$\ln\ h_t - \ln\ h_{t-1} = \lambda(\ln\ h^{*} - \ln h_{t-1}),$$

with λ being the speed of adjustment. By substituting the long-run value of longevity, we have:

$$\Delta \ln h_t = \ln h_t - \ln h_{t-1}$$
$$= \lambda\left(\ln \Omega + \rho \ln y + \rho(\theta - 1)\frac{P_x g}{y} - \ln h_{t-1}\right).$$

Since y represents real GDP, we can use ln$y = \beta t$, where β is the long-term economic growth rate and t is a time variable. The short-term dynamics are captured by two additional variables: the output growth (gy) and the average calories consumed (cal), which is the usual way of capturing the different lifestyles between the countries in the sample:

$$\Delta \ln h_t = \lambda \ln \Omega + \lambda\rho\beta t + \lambda\rho(\theta - 1)\mathrm{he} + (-\lambda) \ln h_{t-1}$$
$$+ \mu_1 gy_t + \mu_2 \ln \mathrm{cal}.$$

Thus, we adopt the following econometric specification:

$$\Delta \ln h_t = \beta_0 + \beta_1 gy_t + \beta_2 \ln h_{t-1} + \beta_3 \mathrm{he}_t + \beta_4 t$$
$$+ \beta_5 \ln \mathrm{cal}_t + u_t, \qquad (10)$$

where he denotes health expenditure as a percentage of GDP, with three alternative measures: total expenditure (the), public expenditure (phe) or private expenditure (prhe). The time variable t should be considered as a proxy of technical progress (Cutler and McClellan 2001) and u_t is an error term, with $u_{\mathrm{r}} \sim N(0, \sigma^2)$. Following Self and Grawbosky (2003), the per capita calorie intake is also considered. Prior literature confirms that a higher intake of calories leads to obesity-related problems, especially in developed countries (Cutler et al. 2003; Loureiro and Nayga 2005). Since obesity is associated with an increased risk of death (Adams et al. 2006), we expect a negative effect of calorie intake on longevity (although too few calories could have a negative effect on longevity, especially in developing countries, the predominant nutritional problem in our developed countries sample is over-nutrition). The effect of income is difficult to predict, since the empirical evidence is not conclusive. The theoretical model presented above suggests that the consideration of total health expenditure as an independent variable together with GDP could lead to a miss-specification, due to the relationship between private health expenditure, income, and public health expenditure, represented by expression (7). Identical considerations should be taken into account when the empirical specification simultaneously includes public and private health expenditure and income as explanatory variables. In our analysis, we check whether the estimates corroborate this insight.

Results

The methodology used is based on panel data analysis. Fixed effects are considered to take into account the differences in the amenities, the welfare state schedule, the specific geographical aspects, etc., of each country, as well as differences in the national health systems. We test for the presence of endogenous regressors, with the result that we cannot reject the exogeneity null hypothesis with the Durbin–Hu–Hausman test. To obtain this statistic, we have used as instruments the growth of the total population, the growth of the population older than 65, and the growth of the population younger than 15 (we cannot reject the null of the idoneity of these instruments: the values of the Sargan–Hansen tests are 0.52, 0.82 and 0.41 for the models estimated in Table 1). The selection of these instruments is based on Posnett and Hitiris (1992), Baltagi and Moscone (2010) and Panopoulou and Pantelidis (2012). Our conclusion remains the same when we use different combinations of such instruments or lagged values of the variables, as in Ivaschenko (2005). Thus, health expenditure appears to be an exogenous regressor in our estimated models. Hence, we have used panel estimation methods, in particular the fixed effects approach, and computed bootstrap standard errors.

We first explore the effect of total health expenditure on longevity, as is common in the literature. The results are presented in column 1 of Table 1. Additionally, we include information about the goodness of fit of the estimations and the test of fixed effects.

As mentioned above, prior papers find no definitive evidence of the effect of total health expenditure on life expectancy. From the theoretical model, we could expect certain problems in this specification, since the private and public components of total health expenditure are interrelated. Specifically, expression (7) establishes that private health expenditure depends positively on GDP and

Table 1 Effects of total and public health expenditure

	(1)	(2)	(3)
gy (GDP growth)	0.010 (3.7**)	0.010 (4.4**)	0.010 (3.4**)
ln*h* *t* – 1 (longevity delayed)	−0.210 (−13.3**)	−0.210 (−15.5**)	−0.217 (−11.0**)
the (total health expenditure/GDP)	0.0005 (0.81)		
phe (public health expenditure/GDP)		0.001 (1.8*)	0.001 (1.7*)
prhe (private health expenditure/GDP)			−0.001 (−1.1)
t (time)	0.004 (8.7**)	0.004 (9.6**)	0.004 (8.56**)
Lncal (ln of calories)	−0.050 (−2.8**)	−0.049 (−3.4**)	−0.0479 (−2.2**)
kor3	0.030 (14.3**)	0.030 (19.6**)	0.028 (9.4**)
tur7	0.019 (22.3**)	0.019 (26.9**)	0.018 (15.5**)
ice4	0.013 (7.5**)	0.013 (9.0**)	0.013 (6.7**)
R^2	0.74	0.73	0.71
Endogeneity test (the)	2.32		
Endogeneity test (phe)		1.79	
Endogeneity test (phe, prhe)			1.87
N	162	163	162

29 Organisation for Economic Co-operation and Development (OECD) countries, 1960–2000

t ratios between brackets

* And ** denote significance at 10 and 5 %, respectively. The variables *kor3*, *tur7* and *ice4* are dummies associated with the third period in Korea, the seventh in Turkey, and the fourth in Iceland, respectively. Endogeneity test reflects the Durbin–Wu–Hausman type statistic for testing whether the regressor rejects the exogeneity null hypothesis

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. Our results provide support for this idea: the aggregate health expenditure is not significant in explaining longevity growth.

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

Having verified that total health expenditure does not explain the behaviour of longevity in our sample, we adopt an alternative specification inspired by the theoretical model in which we only include public expenditure. The results are presented in column 2 of Table 1. The degree of adjustment is good, and similar to the previous estimation. Public health expenditure appears to be a significant variable at the 10 % level of significance. Interestingly, the influence of public expenditure on longevity growth is more than twice that of the total expenditure when fixed effects are considered. The parameters corresponding to the other variables maintain the expected sign. Therefore, these results confirm the notion that the information contained in total health expenditure is redundant. When public and private health expenditures are jointly included (column 3 of Table 1), the latter appears to be not significant.

Now that a more suitable econometric specification of the longevity equation is available, we concentrate on another interesting insight derived from the theoretical framework, suggesting that public services enhance health in two ways: possible changes in the relative rate of substitution between private and health inputs (θ), and the presence of diminishing returns ($\rho < 1$). It is interesting to explore whether these elements are working. In this section, we show empirical evidence in favour of both.

As a first approach to a possible non-linearity in the relationship between public expenditure and longevity, we have considered that the effect of government health expenditure could depend on its weight in GDP. As Fig. 2 shows, there are important differences among the countries in our sample. For example, in 2000, while public expenditure in Korea is around 2 % of GDP, in Germany it exceeds 8 %.

Given this situation, we allow for a non-monotonic relationship, introducing the square of the ratio of government health expenditure on GDP (phe2) in the empirical

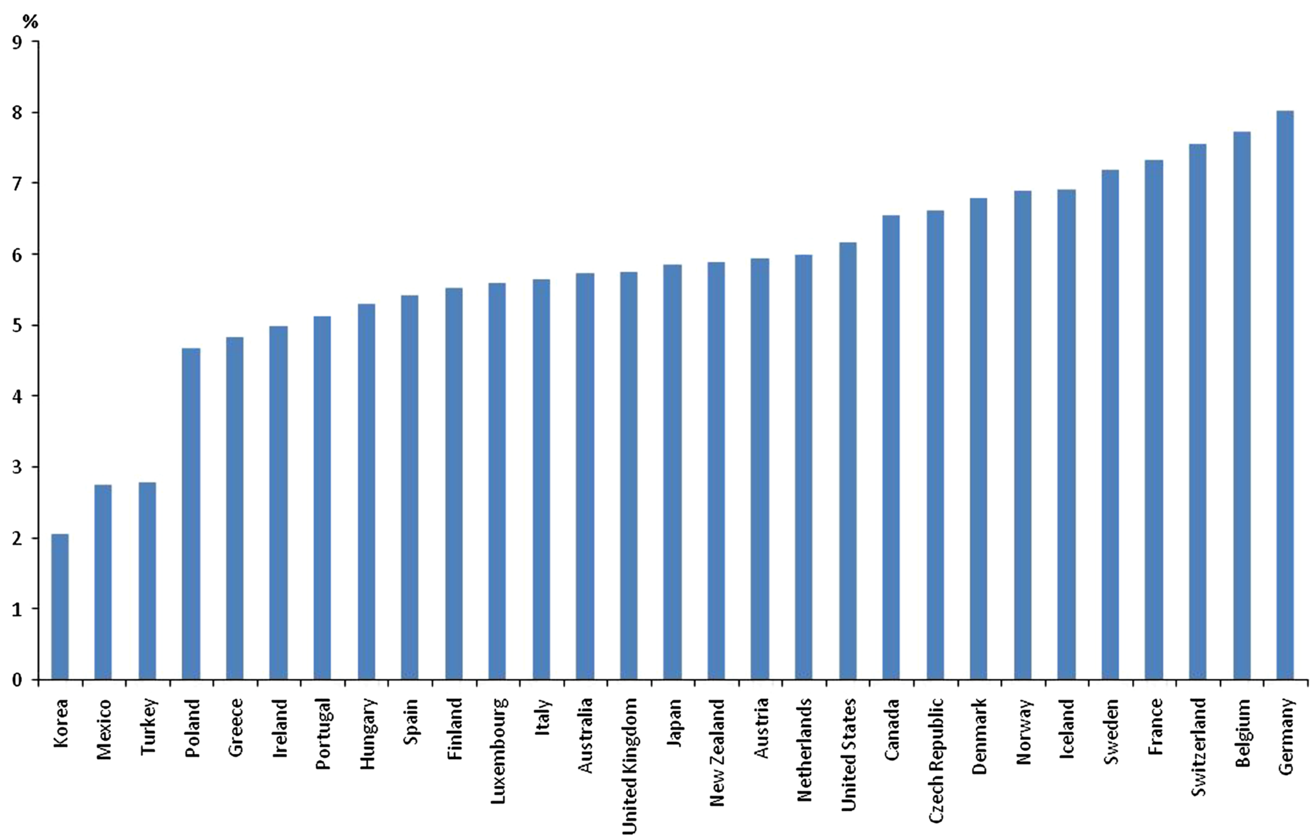

Fig. 2 Public health expenditure as a percentage of Gross Domestic Product. 29 Organisation for Economic Co-operation and Development (OECD) countries, 2000. *Source* OECD (2005)

Table 2 Non-linear effects of public health expenditure

	(1)	(2)
gy (GDP growth)	0.010 (2.7**)	0.008 (2.81**)
ln*h t* − 1 (longevity delayed)	−0.23 (−11.4**)	−0.004 (−10.8**)
phe (public health expenditure/GDP)	0.004 (2.4**)	0.002 (2.51**)
phe2 (phe squared)	−0.0003 (1.8*)	
Nordic		−0.002 (−1.92*)
Latin		−0.001 (−0.7)
Conservative		−0.001 (−0.9)
t (time)	0.004 (9.0**)	0.005 (8.87**)
lncal	−0.053 (−3.7**)	−0.05 (−3.7**)
kor3	0.030 (17.4**)	0.030 (7.87**)
tur7	0.018 (17.0**)	0.017 (13.19**)
ice4	0.013 (7.8**)	0.013 (6.49**)
R-sq	0.73	0.68

29 Organisation for Economic Co-operation and Development (OECD) countries, 1960–2000

t ratios between brackets

* And ** denote significance at 10 and 5 %, respectively. The variables *kor3*, *tur7* and *ice4* are dummies associated with the third period in Korea, the seventh in Turkey, and the fourth in Iceland, respectively

specification. The results appear in column 1 of Table 2, showing a concave relationship.

Figure 3 represents the influence of government health expenditure on longevity growth for the range of values of the ratio of public health expenditure on GDP. The maximum influence corresponds to a percentage of public health services of around 8 % of GDP. Thus, although public expenditure always has a positive influence on the growth of longevity in the sample, its influence is great when the size of this sector is around 8 % of GDP and, for a larger public health system, the effect of additional public health expenditure is still positive, although lower.

Discussion

Going further, we take the heterogeneity in health systems into account, choosing a specific typology of welfare states as a proxy. Esping-Andersen (1990) and Ferrera (1996) propose a classification into four different welfare systems: a Nordic or social-democratic regime (Nordic countries and the Netherlands); a liberal regime (Anglo-Saxon countries); a conservative–corporatist regime (France, Germany, Belgium, Luxembourg, Austria, Switzerland) and a Latin regime (Italy, Spain, Greece, Portugal).The social-democratic welfare system is based on the principle of universalism, granting access to services based on citizenship, and limiting the reliance on the market and the family. The liberal regime is based on market dominance and private provision of services, with a very limited role for the public sector. The conservative–corporatist regime is based on the principle of subsidiarity and the dominance of social insurance schemes. The Latin regime is close to the latter, but with a lower development of the welfare state and a greater importance of social and family structures. Arts and Gelissen (2002) include an interesting survey regarding the debate on this typology of welfare states.

Taking the liberal regime (as well as the countries not included in any of the four categories) as the baseline, we have introduced three dummies affecting public health expenditure for Nordic, Latin, and conservative–corporatist regimes, respectively. Looking at column 2 in Table 2, we can see that only the Nordic system has a significantly different behaviour. The values estimated show that the effectiveness of public health expenditures in this group of countries is lower than in the others. Since this is the group that, on average, exhibits the highest ratio of public health expenditure to GDP, approaching the threshold of 8 % found above, this constitutes further evidence of the existence of decreasing effectiveness of public expenditure on extending life expectancy.

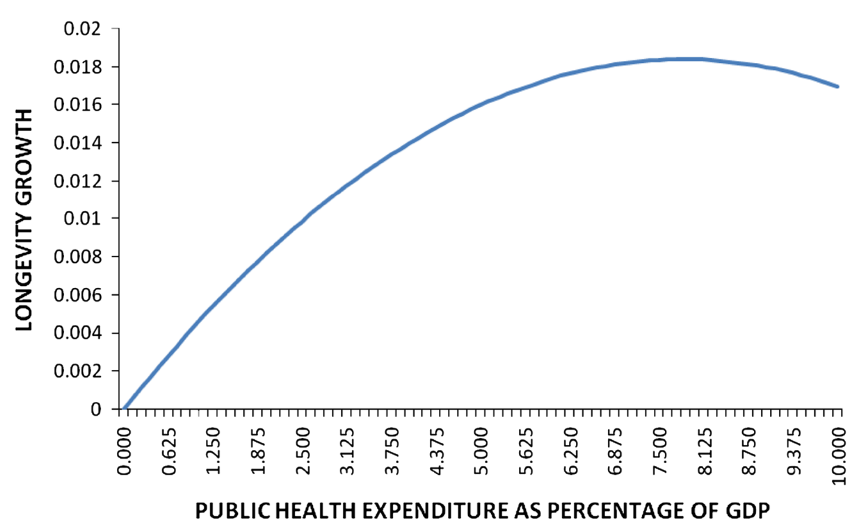

Fig. 3 Influence of public health expenditure on longevity growth. *Source*: own elaboration. 29 OECD countries, 2000

This suggests a role for the composition of health services, that is to say, to the relative weight of public and private health expenditure. They vary greatly across the countries in our sample, with the weight of the public sector ranging from <50 % to more than 90 % of the aggregate.

For example, the group of Nordic countries appears on the right side of the range, indicating that these countries are not only those with the highest relative size of public health systems, but those with a lower development of the private health sector. On the opposite side of the ranking, in the United States (together with Korea), the weight of the private sector is significantly larger than in the rest of the sample: private expenditure in the USA amounts to more than the 50 % of the total, while in the rest the average is around 25 %. That is to say, there is no correlation neither between the size of the supply of public and private health services nor between any of these and total health outlays.

In particular, the above results offer a plausible explanation for the apparently paradoxical data for the USA. While this is the country that devotes the largest amount of resources to health (over 13 % of GDP, close to twice the average value in the sample), life expectancy was 76.2 years in 2000, below the average. The key element that enables us to understand this puzzle is precisely the composition of health expenditure. The average value in the sample shows a ratio of public to private expenditures of 3.72. In contrast, this ratio is only 0.82 for the USA. That is to say, the public health system in the USA is responsible for only 45 % of the resources devoted to health, compared with the almost 80 % average in the OECD countries. The above results show the need for a redesign of the health system through an intensive promotion of the public health system. In any case, the relationship between longevity and health expenditure is complex, and is further influenced by other factors, namely the specific characteristics of the lifestyle of the population (obesity, chronic diseases—Habibov 2009, medication misuse—Cheaito et al. 2014), the ways in which public resources are used (Liu et al. 2012; Wu et al. 2013), and the quality of health services. In fact, empirical evidence about health efficiency is not conclusive. For instance, ranks of health efficiency given by Evans et al. (2001) and Or et al. (2005) do not coincide, due to the use of different estimation methods and the use of different health efficiency definitions, suggesting that the countries with a better health performance are not always those with the most efficient health systems. Apart from health efficiency, the financing schedule (insurance vs. tax mechanisms) or even cultural differences may also be important (Clemente et al. 2004; Maziak et al. 2013).

Anyway, our results suggest that any public decision about increasing the quantity of resources devoted to lengthening individual lifespans should take into account the current size of the public sector and try to adequately encompass the evolution of the public and private sectors, to obtain the best outcome.

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