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The (W)health of Nations: the Impact of Health Expenditure on the Number of Chronic Diseases

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Abstract

We investigate the impact of health expenditure on health outcomes on a large sample of Europeans aged above 50 using individual and regional-level data. We find a significant and negative effect of lagged health expenditure on later changes in the number of chronic diseases. This effect varies according to age, health behavior, gender, income and education, thereby supporting the hypothesis that the impact of health expenditure across different interest groups is heterogeneous. Our empirical findings are confirmed also when health expenditure is instrumented with parliament political composition.

Keywords: health satisfaction, education, life satisfaction, public health costs.

JEL codes: I12; I11 I18.

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1.1 Introduction and motivation to our research

We investigate the impact of domestic health expenditure on health outcomes as proxied for by the number of chronic diseases. The issue is of paramount importance in a historical phase in which low fertility rates, ageing population, endangered public debt sustainability and high costs of many new drugs which reduce mortality (e.g. new drugs to cure leukaemias) are among the factors contributing to an increase in health expenditure in a framework of shirking public resources.

The identification of the exact role of this important factor affecting health outcomes (and – more broadly speaking - active ageing) and of its heterogeneous impact on different population groups may be crucial to tackle the challenge of improving health outcomes without endangering government debt sustainability.

Public health expenditure represents one of the largest government expenditure items (6 percent of GDP in the OECD area, Joumard et al., 2010) and one of the most important drivers of health policies determined at country-level. Nixon and Ullman (2006) find a significant and positive effect of health expenditure on health outcomes in EU countries and show that, between 1980 and 1995, health care expenditure has added 2.6 years to male life expectancy and reduced by 0.63 percent the infant mortality rate. Along this line Or (2000) documents that a high share of public expenditure is associated with lower premature mortality and infant and perinatal mortality, even though not affecting life expectancy at 65 or heart diseases. Other authors (Hitiris and Posnett, 1992) find that mortality is negatively related to per capita health expenditure but its economic significance is limited (an elasticity between 0.08 and 0.06). The same authors find that per capita health care expenditure may explain more the variance in infant mortality than would per capita GDP and that it is inversely correlated to female premature mortality, while positively correlated to female life expectancy (Elola et al., 1995). Conversely, a lower number of physicians and cuts in health care expenditure are associated with increased infant mortality, reduced life expectancy at age 65 and lower heart diseases. In particular, a 10 percent cut in health care expenditure is associated with a 6 month reduction in life expectancy for men and 3 month reduction for women (Crémieux et al., 1999 and Or, 2000).

These mixed findings clearly imply that the driving factor is not just the magnitude of health expenditure but also its quality and efficiency. Concerning the latter, Joumard et al. (2010) estimate that life expectancy at birth could be raised by more than two years on average, holding health care spending constant, if all countries were to become as efficient as the best performers. On the other hand, a 10 percent increase in health care spending would increase life expectancy by only three to four months if the distance from the efficient frontier remains unchanged. The same literature generally finds that institutional variables for funding arrangements are often not significant, with some exceptions (e.g. countries with fee-for-service at the hospital level tend to have lower premature mortality but no longer life expectancy at 65, Or, 2000).

1.2 The specific contribution of our approach in the literature

The goal of this paper is to measure the impact of health expenditure to GDP and health expenditure per capita on health outcomes after controlling for standard socio-demographic factors, health styles and health quality on a large sample of Europeans aged above 50.

As shown above, the empirical literature often uses country-level data to test the impact of health expenditure on health outcomes such as mortality and longevity including, among others, life expectancy at a given age, premature mortality and infant mortality. This approach could be usefully complemented with an analysis on diseases' insurgence, especially in the economic perspective that is primarily concerned about the effects of health on human capital and National Health Service (NHS) expenditure. The latter effect is crucially determined by morbidity and not mortality. The point is clearly remarked by Nixon and Ullman (2006) who emphasize that the standard macroeconomic variables used as health outputs in the literature (infant mortality and life expectancy) have relevant limitations. First, they do not vary much in high income countries and second they are determined as well by factors unrelated to health care systems (such as the environment, car accidents or murders). Moreover, a disease-based approach is conceptually more attractive than generic mortality and longevity measures because it also accounts for health gains due to specific treatments (Joumard et al., 2008). These considerations led us to focus on the number of chronic diseases as synthetic health outcome indicator in our empirical research.

A second element of originality in our approach hinges on the use of individual data provided that, as is well known, beyond the quality of health care systems, mortality, longevity and various disease outcomes are affected by individual-level characteristics such as standard socio-demographic variables (gender, education, income, family status), health styles (diet, physical activity, alcohol and smoking) and the concurrent individual health conditions which need to be controlled for. According to Thornton (2002) the role of socioeconomic factors and life styles in preventing diseases and improving life expectancy is much more significant than medical care, even though we argue that national health care policies may also include prevention campaigns which are likely to affect individuals' lifestyles. In particular, smoking, sport activities and obesity explain why some countries achieve better health status than others while using comparable levels of health care resources (Afonso and St Aubyn, 2006). Another factor which has been acknowledged as having a crucial role on health is education. As is well known more educated individuals are modelled as having “higher productivity” in combining market and non market inputs to produce health outcomes (in the productive theory) and choose better combinations of inputs (especially health styles and doctor advice) to obtain such results (in the allocative theory) (Grossman, 2006; Feinstein et al., 2006). Joumard et al. (2010) calculate that education contributed to a gain of 0.5 years in life expectancy at birth for females out of a total improvement of 2.49 between 1991 and 2003, while health care expenditure contributes for 1.14. Similar results are found for males. Among other factors, occupation is also important for health status, not only in terms of exposure to specific workplace risks, but mainly due to its role in positioning people along a society's hierarchy (Blas and Kurup, 2010). In particular, it has been shown how work opportunities and work conditions for females affect socioeconomic status and, as a consequence, have an impact on behavioural and environmental risk factors for breast cancer in women (National Cancer Institute, 2011).

The use of individual-level data is therefore important not only for what considered above but also because it allows to consider properly that part of individual variability which is lost when looking at the country-level data only. Estimates based on the latter generally consider correlations across country mean values, thereby ignoring that other centiles of the distribution may have more relevance when dealing with health matters. For instance, more extreme percentiles in life styles such as intense drinking and smoking as well as extreme obesity would definitely have a stronger impact on health outcomes than their mean values. This is why matching inputs and outputs for each individual (and checking the effect of specific combinations of socio-demographic factors on health at individual level) may provide more accurate results than just considering average socio-demographic factors for each country.[1]

A third further advantage of our approach combining individual and country-level data is that it allows to test whether the health expenditure effect on health outcomes changes if we consider different population groups given that aggregate country-level time series on health outcomes for age, gender and health style groups are hardly available. By comparing the impact of health expenditure in different subsamples we may identify specific constituencies (i.e. based on gender, income, and education) which are more sensitive to health expenditure policies and specific health styles which can be improved (such as diet and physical activity) reducing health expenditure without negative effect on health outcomes. The three advantages in using individual data described above are not traded-off with any loss since, when starting from individual data of representative samples, it is always possible (as we do in our research) to aggregate observations to obtain data at regional level in order to check whether findings are significant also when aggregated.

The paper is divided into four sections. In the second section we illustrate descriptive statistics of our sample. In the third section we present our econometric findings for the overall sample and for specific (age, education, life style) subsamples while testing their robustness with IV estimates. We then provide robustness checks and

[1] Imagine a sample with two overweight individuals whose weight causes the insurgence of pathologies and two slightly underweight individuals with good health. Imagine to have similar samples for individuals in other countries and years. Individual data would clearly identify the link between obesity and health while aggregate country-level evidence would cancel out the effect. The inability to capture the overweight-health effect would as well make less clear the impact on health outcomes of country-level data such as health/GDP expenditure. The same could occur for drinking or smoking. While in some cases we may have some limited aggregate coverage on the share of individuals in distribution tails of life styles this is not always the case for panel data with many countries and repeated years.

control whether our main findings remain robust when re-estimated with data aggregated at regional level. The fourth section concludes.

2.1 Data and descriptive findings

We merge three sources of data. The first source is the cross-national panel data from the *Survey of Health, Ageing and Retirement in Europe* (SHARE). We use the first, second and fourth wave of SHARE implemented in 2004, 2006, and 2010 respectively. We exclude from our sample the third wave (SHARELIFE) since it is a retrospective survey of people life history and therefore not consistent with our study. The database contains information on health, socio-economic status, social and family networks of a sample of Europeans aged above 50. More specifically, the SHARE survey is composed by 19 country-level representative samples for the following countries: Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Israel, Czech Republic, Poland, Ireland, Hungary, Portugal, Slovenia and Estonia. The second source of data is the cross-national panel from OECD Statistics dataset, which collects information on the total health expenditure as a percentage of GDP and in per capita terms for all the 19 selected countries for the 2004-2012 period. The third source is the EuroStat cross-national panel data from which we extract our control variable for the quality of health care, namely avoidable CHF (congestive heart failure) hospital admission rate of people aged 15 and over per 100,000 inhabitants for the same 19 countries in the selected 2004-2012 period.

Table 1 provides the legend of the variables used in our analysis, while Table 2a descriptive statistics for the socio-demographic variables. The sample is composed by 126,013 observations. The percentage of females is 56.1 and the mean age is 65.2

years. Around 70 percent of sample respondents are married or in a regular partnership, and almost 15 percent are widowed. The average number of children is 2.2 and the average number of grandchildren is 2.6. Retired people are 52.1 percent, employed are 28.4 percent, and homemakers are 11.6 percent. Table 2b provides descriptive statistics on respondents' lifestyles. The Body Mass Index is on average 26.7, with the percentage of overweight people being 41.7 and that of obese 19.9. The percentage of smokers is 19.1 and on average individuals consume alcohol 3.4 days per week. The percentage of people who practice sport or other physical activities once a week or more is 47.4. Descriptive statistics for objective and subjective health indicators are reported in Table 2c. The average of self-reported health satisfaction is 3.1, very close to the "good" level.[2] Around half of the respondents suffer from long-term diseases. The most common disease is hypertension (36.2 percent), followed by high blood cholesterol (22.1 percent), arthritis (21.9 percent), and diabetes (11.6).

2.2 Dynamics of the main variables of interest

In what follows we measure the impact of health expenditure on objective health measures by looking at the synthetic indicator of the reported number of chronic diseases. This variable is measured in the survey by asking respondents whether they received a doctor's diagnosis on a list of major chronic diseases presented on a show-card in which the following 17 chronic conditions are considered: 1) Heart attack; 2) High blood pressure or hypertension; 3) High blood cholesterol; 4) Stroke or cerebral vascular disease; 5) Diabetes or high blood sugar; 6) Chronic lung diseases; 7) Asthma; 8) Arthritis or rheumatism; 9) Osteoporosis; 10) Cancer or malignant tumor; 11) Stomach or duodenal ulcer, peptic ulcer; 12) Parkinson disease; 13) Cataracts; 14)

[2] The survey uses a standard 1-5 health satisfaction ladder whose values are in descending health order "excellent", "very good", "good", "fair" and "poor".

Hip fracture or femoral fracture; 15) Other fractures; 16) Alzheimer's; 17) Benign tumor.

Before performing and commenting our econometric estimates we provide a synthetic description of the two main variables of interest and of their correlation. Figure 1 (a) displays the dynamics of health care expenditure as percentage of GDP in the 19 surveyed countries over the 2004-2012 period, documenting significant cross-sectional and time series variability with varying rank across countries during the sample period. In particular, while some countries such as Hungary, Poland and Romania exhibit a quite stable share, other countries such as Denmark (from around 9 to 11 percent) and The Netherlands (from around 9 to 12 percent) have changed significantly their health expenditure share over the period 2004-2012. Figure 1 (a) documents that country-year values of our relevant indicator have enough variability and that ranking across countries displays as well reasonable variation around the sample period. In Figure 1 (b) we plot the dynamics of health expenditure per capita which documents a significant gap from the lowest (Estonia) to the highest (Switzerland) health per capita expenditure country and a relevant time trend, with health expenditure per capita reaching in the final sample year (2012) 1,446.6$ per capita in the former, against 6,080$ in the latter. Even though health per capita expenditure is calculated in the same currency and in PPP – and year dummies will capture time trend in our econometric estimates – it is interesting to use both indicators (health care expenditure as percentage of GDP and in per capita terms) to see whether our findings remain robust given that the former is much less affected than by time trends and imperfections in PPPs than the latter.

When looking at levels in the number of chronic diseases reported by respondents we find that more than two-thirds of the sample (67.5 percent) declare at least one chronic disease, while a sizeable share (18.9 percent) report at least three of them (Figure 2 (a)). When looking directly at the first difference of the above variable (the change in the number of chronic diseases that will be the dependent variable in the econometric analysis which follows) we find as expected a right skewed distribution given that health conditions get naturally worse with ageing. The modal value is around zero (almost half of the sample, 47.6 percent, report no changes in chronic diseases), while the number of those registering an additional disease (20 percent) is higher than that of those registering one disease less across two consecutive waves (Figure 2 (b)).

Figure 3a documents from a descriptive point of view an inverse relationship between health expenditure to GDP and the number of chronic diseases. For values of health/GDP expenditure below the 25th percentile the number of chronic diseases is 1.65, while falling to 1.19 for values above the 75th percentile. Note that, in case of reverse causality between health expenditure to GDP and the number of chronic diseases, we would expect a positive and not a negative nexus, with the former growing when the latter gets larger. The nexus between the two variables is negative also when we consider changes in the number of chronic diseases and not just levels. The value is around 0.22 for values of the health expenditure to GDP ratio below the 25th percentile, while around 0.14 for values above the 75th percentile (Figure 3c). Differences in means for our health outcome variable are significant at 95 percent since confidence intervals do not overlap for both levels and first differences. When considering health expenditure per capita, the inverse relationships with levels and first differences in the number of chronic diseases exhibit similar patterns as shown in Figures 3b and 3d respectively. The negative nexus between health expenditure and the change in the number of chronic diseases is also confirmed for the subsample of “healthy” individuals (i.e. individuals with no chronic diseases *ex ante*). The change in the number of chronic diseases is 0.80 for values of the health expenditure/GDP ratio below the 25th percentile, while 0.52 for values above the 75th percentile. Similar values for our health outcome variable (0.80 and 0.54) are shown when considering health expenditure per capita below the 25th percentile and above the 75th percentile respectively (Figure 3e and 3f).

3. Econometric analysis: baseline findings

Significance of descriptive evidence needs to be controlled for the concurring impact of other relevant factors. In the econometric analysis presented in this section we test the hypothesis that health expenditure affects changes in health status after controlling for a large set of concurring factors. In order to test our hypothesis we regress changes in the number of several chronic diseases on the lagged health expenditure share of GDP or, alternatively, on lagged health expenditure per capita.

More specifically, in order to investigate the effect of the health expenditure on health status, we estimate the following regression

$$\Delta HealthStatus_{i,t} = \alpha \cdot HealthExp_{t\text{-}1} + \sum_{k=1}^{8} \beta_k \cdot SocioDem_{i,k,t\text{-}1}$$

$$+ \sum_{k=1}^{4} \gamma_k \cdot HealthBehavior_{i,k,t\text{-}1} + \sum_{k=1}^{8} \delta \cdot \Delta changes_{i.k,t}$$

$$+ \sum_{k=1}^{8} \xi_k \cdot DIntYear_{i,k} + \mu \cdot HealthStatus_{i,t\text{-}1}$$

$$+ \phi \cdot HealthQuality_{i,t\text{-}1} + \varepsilon_{i,t}$$

where $\Delta HealthStatus_{i,t} = HealthStatus_{i,t} - HealthStatus_{i,t-1}$ is the first difference in the number of chronic diseases for the *i*-th country and $HealthExp_{t-1}$ is the national health care expenditure provided by all financial agents, measured as percentage of GDP or, alternatively, in per capita terms (US$, PPP) in $t - 1$. The $SocioDem_{i,k,t-1}$ includes socio-demographic information such as gender, age, years of schooling, marital status, job status, number of children and grandchildren, and income; $HealthBehavior_{i,g,t-1}$ includes life style variables such as dummies for drinking, smoking, frequency of vigorous physical activities and body mass index related variables such as the overweigh/obese status. $\Delta changes_{i,m,,t}$ is captures changes between current and previous interview waves in income, marital status, job status, life styles, and the number of grandchildren. The interview-year dummies are included in $DIntYear_{i,l}$ in order to control for asynchronous survey administration in each wave. $HealthQuality_{i,t-1}$ controls for quality of national health care systems using the rate of avoidable congestive heart failures in hospital, for people aged 15 and over, per 100,000 inhabitants (*avoidableCHF*), which is considered as one of the most reliable proxies for NHS quality (Joumard et al., 2010). The lagged health status level (the number of chronic diseases at time *t*-1) is finally introduced to take into account the obvious negative relationship between changes and levels of the outcome variable.

The main goal of our econometric analysis is evaluating the impact of α, that is the coefficient measuring the effect of the health expenditure share to GDP (health expenditure per capita) on the first difference in the number of chronic diseases. Standard errors are clustered at NUTS2 level in all estimates.

Table 3a shows that the effect of the health expenditure share of GDP on the first difference of the number of chronic diseases is significant since the null hypothesis of $\alpha = 0$ is rejected. The first specification (Table 3a, column 1) includes the basic set of controls, such as socio-demographic information and interview-year dummies. By assuming that the significant nexus implies causality (which we will test in what follows with IV estimates) we find that a one percent increase in the health expenditure/GDP ratio from its mean sample value reduces the change in the number of chronic diseases by 0.057. To provide an intuition about the economic significance (magnitude) of our effect consider that, if all respondents were not affected ex ante by any chronic illness, a one percent increase in health expenditure/GDP ratio would make 5.7 percent of the respondents not incur in the chronic illness they would have contracted otherwise in the next period. The ex ante situation is in reality much more heterogeneous, with some individuals with any chronic illness and others with one or more diseases with given probabilities of recovering from them. The real public expenditure effect is therefore a combination of different forces at work, such as, for instance, the reduced probability of getting one or additional chronic illnesses and the increased probability of recovering from them.

The significance of our main finding persists when we augment the benchmark specification with changes in socio-demographic indicators (Table 3a, column 2), health styles (alcohol consumption, smoking, vigorous physical activity, and BMI; Table 3a, column 3) and changes in health styles (Table 3a, column 4). Note that when we introduce health style controls the impact of health expenditure to GDP falls to 0.047 as part of the effect is absorbed by the other covariates.

Among the socio-economic variables, we find that the impact of age and education on the change in the number of chronic diseases is significant. The relationship between age and health status is as expected negative, while the negative impact of education is well supported by empirical evidence in the literature (see among others Grossman, 2006). Relational life also matters since being widowed has a positive effect on the change in the number of chronic diseases of around 0.17, while finding a partner accounts for a 0.25 negative impact on the change in the number of chronic diseases.

Health behavior is as well of foremost importance since individuals reporting the lowest level of physical activity have a 0.179 impact, more than twice as much the impact of those reporting even moderate physical activity. The overweight or obese status increases the number of chronic diseases in the next period by 0.16 as well. The effect of this factor is also confirmed when changes in lifestyles are included as regressors, with transition to the overweight/obese status producing a significant increase in the number of chronic diseases.

In columns 5-8 specifications (Table 3a) we repeat the first four estimates controlling for the quality of health systems through the introduction of the avoidable heart congestion failure indicator. While the number of observations falls, the health expenditure to GDP coefficient increases by around 0.03 indicating that the impact of health expenditure is even larger when quality adjusted.

3.1 Correction for attrition bias

In Table 3b we propose the same specifications of Table 3a corrected for attrition bias. This is because, as is well known, not all respondents participate to all waves and non responses may be due to death or decision not to respond due to reasons related or unrelated to health. Correlation between nonresponse and our health outcomes therefore cannot be in principle excluded. The standard approach followed to control for attrition is regressing non responses on lagged relevant variables and using the inverse of the non response probability score to weight our standard specification.

More specifically, in order to control for the attrition problem, we estimate the following logistic specification

$$A_{i,t} = \alpha + \sum_{k=1}^{K} \beta_k \; Sociodem_{i,t} + \gamma \; noconditions_{i,t} + \delta \; nosymptoms_{i,t}$$

$$+ \sum_{v=1}^{V-1} \chi_v \; DInt\_Year_{i,v} \; + \sum_{g=1}^{18} \; \kappa_g \; DCountry_{i,g} + \; \epsilon_{i,t}$$

where the dependent variable is the probability of not being present in two consecutive waves, *Sociodem* is a set socio-demographic and economic controls which includes gender, age, education years, employment and marital status, number of children and grandchildren, dummies for health styles (smoking, drinking and vigorous physical activities, overweight/obese condition), income, *nocondition* and *nosymptoms* which are dummy variables equal to one if the respondent reports not having specific illnesses or symptoms respectively. Results from this estimate show that (female) gender, number of grandchildren and the *nocondition* variable negatively correlate with attrition, while being divorced/separated and doing sport activities infrequently correlate positively with it. These findings suggest that worsening of health conditions may be one of the main causes of nonresponses.[3]

When correcting for attrition bias we find that the health expenditure to GDP coefficient remains significant with the same magnitude of around 0.1 according to the different considered specifications (Table 3b).

The magnitude of our final coefficient is not negligible. To give an intuition, assuming for simplicity that none of the respondents is ex-ante affected by chronic diseases, a drop of one percentage point in the health expenditure/GDP ratio would make one individual out of ten over the ageing population contract a new chronic

[3] For a similar approach on the attrition weighting procedure in the literature see, among others, Raab et al. (2005), Nicoletti and Peracchi (2005) and Vandecasteele and Debels (2007).

disease. In the reality part of the sample already has a chronic disease in *t-1* and therefore the coefficient is a combination of different transitions from and into illnesses which produce the combined 0.1 effect.

The replacement of the health expenditure/GDP variable with health expenditure per capita gives as well significant and similar results. The magnitude ranges from 0.09 for 1,000$ of per capita expenditure in column 1 (Table 4a) up to 0.15 in column 6 (Table 4a). When we correct our estimates for attrition we find that the impact rises to 0.12 in the first column of Table 4b to 0.15 in the last column of the Table 4b.

3.2 Subsample estimates

A question which has relevant policy implications in terms of potential support to health expenditure is whether the impact of health expenditure varies in different population groups. A first thing we expect is that it is higher for the elders. We split our sample of individuals aged above 50 into older and younger respondents and find that our hypothesis is supported by empirical evidence. The effect of health expenditure to GDP on our dependent variable is strongly significant for the older sample. The coefficient for individuals aged 65+ is -0.121 (against the overall sample coefficient of -0.095 in the corresponding specification) documenting as expected that the impact of health expenditure becomes stronger with ageing (Table 5).

Other relevant subsamples where we find a higher significant effect of health expenditure on health outcomes are those of women[4], the lower education group (individuals without a university degree), the low income group (individuals below

[4] Our findings are consistent on this point with those of Alemayehu and Warner (2004) showing that per capita lifetime expenditure is $316,600 is a third higher for females ($361,200) than males ($268,700). The same authors find that two-fifths of this difference is due to women's longer life expectancy.

the median income in their country) and the overweight or obese individuals vis-à-vis their complementary samples (Table 5).

This implies, on the one hand, that some population groups are more sensitive than others to policies aimed at increasing health expenditure. Our subsample results suggest, on the other hand, that improvements in lifestyles - by raising the number of individuals who require less medical treatment – could reduce health expenditure without negatively affecting health outcomes.

3.3 Instrumental variable results

Results shown above must be proven to be robust when controlling for endogeneity. As already discussed, the correlation observed in descriptive evidence and confirmed by econometric findings goes in a direction which is opposite from what reverse causality would predict. We nonetheless need to disentangle a possible direct causality nexus indicated by our findings from a potential concurring (even though weaker) reverse causality effect and from endogeneity caused by third unobserved drivers affecting both the variables of interest. The issue is of foremost importance since we can draw the policy conclusion that, coeteris paribus, increasing health expenditure is desirable in order to improve health outcomes only if we prove that our findings hide a direct causality link going from health expenditure to health outcomes. The almost insurmountable problem of finding proper instruments is related to their validity more than to their relevance. This is because, while it is not difficult to find third drivers which are correlated with the variable to be instrumented (relevance), it is not easy to postulate that such variables do not correlate directly with the dependent variable of the main estimate (validity). In order to address these concerns, in our specific case we propose an instrument drawn from the parliament political composition. On the one hand, the latter is expected to influence decisions on public and private expenditure but may be hardly suspected to affect directly health outcomes of the individuals in our sample. This is because it is hard to conceive that insurgence, persistence and/or recovery from illnesses ranging from cancer, Parkinson to arthritis may be affected by the share of seats of a given party in the parliaments. On the other hand, in terms of validity of our instrument, we expect the share of left wing party members to be significantly associated with health expenditure given the longstanding tradition of such party in supporting health expenditure in its political programs. What must be considered in this respect is that most health expenditure is public expenditure (around 74 percent in our sample) and political parties of the left are more likely to increase the budget on this point in order to improve wellbeing of the low income population (which is generally an important part of their constituencies) and due to their higher sensitivity for equity concerns (or at least to address equity concerns with public expenditure). Our assumption finds ample support in the literature. To quote just some examples Immergut (1992) describes how politicians implement different health policies and comes to the following conclusion: "National health insurance symbolizes the great divide between liberalism and socialism, between the free market and the planned economy [...] Political parties look to national health insurance programs as a vivid expression of their distinctive ideological profiles and as an effective means of getting votes National health insurance, in sum, is a highly politicized issue." De Donder and Hindricks (2007) examine the political economy of social insurance policy and demonstrate that in a two party model, the left wing party proposes more social insurance than the right wing party. Potrafke (2010) finds that the right wing party attracts the richer individuals and those with smaller health risks, while the left wing party attracts the poorer and those with higher health risks. From an empirical point of view, Herwartz and Theilen (2014) find confirmation that if governments are sufficiently long in power, right-wing governments spend less on public health than their left-wing counterparts.[5]

We build our instrument by collecting government data from the national Ministries of the Interior, Parliaments, and Senates datasets for the 19 selected countries in the period 1995-2014, available at their official websites. By considering the presence of some hysteresis in current health expenditure decisions we use the following three year moving average

$$Party_y = \frac{1}{3}(party_t + 0.9party_{t-1} + 0.8party_{t-2})$$

where *party* represents the share of left wing parliament members.[6] Moreover, since we are instrumenting health expenditure at time *t*-1, we lag the final year of our three-year moving average by two periods considering that current parliament decision affects the next year health expenditure.

Empirical evidence documents that the relevance of our instrument is quite strong. Both health expenditure to GDP and health expenditure per capita are significantly and positively correlated with the share of left wing parliamentarian members. More specifically, we find in pairwise correlations that health expenditure to GDP has a correlation coefficient of 0.31 with the share of left wing members, while health per capita expenditure of 0.53. Correlation with other parliament groups is much weaker or in the opposite direction. In particular, the correlation coefficient of health

[5] Literature on how parliament composition affects health expenditure documents also a positive and significant correlation between health expenditure and election years, suggesting that parliaments increase health expenditure in such years in order to be re-elected. We therefore use alternatively as an instrument the years of elections finding very similar results in terms of impact of health expenditure on health outcomes with respect to those shown in what follows. Evidence is omitted and available upon request.

[6] We perform robustness check on the number of years considered in the moving average by adding one/two years and slightly finding weights. We find that our results are almost unaffected. Evidence is omitted and available upon request.

expenditure to GDP (health expenditure per capita) with the share of centre-left and centre-right members is respectively 0.08 (-0.04) and -0.22 (-0.39)..

The second-stage findings of the IV estimate which uses the above described instrument confirm the significance of the country health variables (Table 6). In terms of economic significance what is impressive is as well the stability of the health coefficients estimated with IV, which are quite similar to those found in non instrumented estimates. More specifically, a one percent increase in the health expenditure/GDP ratio produces an effect of 0.135 in terms of changes in the number of chronic diseases, while 1,000 US$ of health expenditure per capita have an effect of 0.19 (Table 6).

IV estimates performed on subsamples indicate that the impact of health expenditure on the number of chronic diseases remains significant only on the more vulnerable groups (Table 7). More specifically, we find a significant impact on the elders (0.185 on respondents aged above 65), on females (0.142), on the low educated group (0.15) and on those who do not practice physical activity. The pattern of the effects of health expenditure per capita exhibit similar variability (Table 7).

3.4 Robustness check with aggregated NUTS2 level data

As discussed in the introduction, the use of individual-level data enriches the analysis of the impact of health expenditure on health outcomes allowing us to take properly into account a large set of factors the variability of which would be sacrificed when averaging at aggregate level. We must wonder, however, whether the significance of our country-level variable of interest is overstated due to the higher number of individual-level observations (which multiply degrees of freedom for health/GDP values which vary only at regional level) and if it driven by some country-level outliers. Our robustness check in this respect consists in reducing drastically the number of observations by averaging our data at NUTS2[7] level and then re-estimating our main specifications. Even though we are aware of all the limitations of the aggregated data analysis discussed in section 1.2, robustness of our findings to this approach would reinforce the validity of our results (Table 8).

Empirical evidence on aggregated data shows that the health expenditure to GDP ratio is still negative and significant with a remarkably similar magnitude (Table 8). A similar result is found for the health expenditure per capita variable. More specifically, the health expenditure/GDP and the health per capita coefficients are respectively equal to 0.14 and 0.27 (per 1,000 US$) in the NUTS2 level estimates.

In a last robustness check we perform IV estimates using the instrument of the share of left wing parliamentarian members on our data aggregated at NUTS2 level. Again, the health variables are significant in the expected direction and coefficients are still slightly higher in magnitude for the health/GDP ratio (0.17), while smaller for the health per capita ratio (0.23). Note that 1,000 US$ per inhabitant are around three times one percent of the health/GDP ratios if we use Italy as a reference country. The value is higher (lower) for lower (higher) per capita income countries in the sample. It is therefore reasonable that the health per capita coefficient is higher than the health/GDP ratio coefficient. We finally repeat our aggregated analysis with (non IV and IV) estimates on those subsamples which provided significant IV estimates for our variable of interest on individual-level data in Table 7 and find that the patterns found in the individual-level estimates are substantially confirmed even though with different significance levels (Tables 8 and 9).

[7] The acronym NUTS derives from the French definition “nomenclature des unite ́s territoriales statistiques” and indicates regional units at European level.

4. Conclusion

If health expenditure to GDP affects mortality and longevity in country-level data, as postulated and tested by the current literature, a candidate channel for such an effect can be identified in the relationship between health expenditure to GDP and changes in the number of chronic diseases at individual level which can exhibit a certain degree of heterogeneity across different population subgroups. The analysis of the latter is the goal of our paper. Our original contribution to the literature stands as well in the combination of individual and regional-level data. We explain in the paper why such combination enriches the analysis and provides additional insights to the knowledge on the topic.

We provide evidence with both individual-level and regional-level data that health expenditure to GDP and health expenditure per capita have a negative and significant impact on changes in the number of chronic diseases. This result is remarkably stable also in terms of economic significance for the health expenditure/GDP ratio under the different estimation approaches adopted in the paper (IV and non-IV estimates, aggregated and individual-level data).

Our findings also show that health expenditure produces heterogeneous effects on health outcomes, being more relevant for the elders, females, the overweight/obese, the below-median income group and for the less-educated *vis-à-vis* their complementary samples. Two are the main implications of these subsample findings. First, these specific groups may be more interested in (and exert more political pressure for) higher health expenditure. Second, active ageing policies aimed at increasing education and reducing the population exposure to excess weight may allow to save health expenditure without adversely affecting health outcomes.

From a methodological point of view, our innovative content of our contribution hinges in the use of the political composition of the parliament as an instrument to mitigate endogeneity problems in the correlation between health expenditure and health outcomes. We finally document that our findings are robust when we aggregate our date at regional level, thereby documenting that our analysis can replicate and enrich the traditional aggregate country-year results provided by the related literature.

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Table 1. Variables Legend

Variable	Description
Age	Respondent's age
Ageclass	(0/1dummies for the following age groups) Age 55-59; Age 60-64; Age 65-69; Age 70-74; Age 75-79
AvoidableCHF	avoidable congestive heart failure hospital admission rate of people aged 15 and over per 100,000 inhabitants
Bmi_mod	Body mass index (easySHARE version)
Bmi2_mod	Dummy variables: underweight, normal, overwheit, obese.
Country	country identifier
Divorced	Dummy variable=1 if the respondent is divorced
Drinking Variables	Dummy variables: Drink 5or6days a week; Drink 3or4days a week; Drink 1or2 a week; Drink 1or2 a month; Drink <1 a month; Not Drink for 3 months
Eduyears	years of education
Employed	Dummy variable=1 if the respondent is employed
Female	Dummy variable = 1 if the respondent's gender is female and 0 otherwise. 0 otherwise
Gets_Divorced	Dummy variable=1 if the respondent got divorced
Gets_Grandchildren	Dummy variable=1 if the respondent got grandchildren
Gets_Partnership	Dummy variable=1 if the respondent got a new partner
Gets_Retired	Dummy variable=1 if the respondent got retired
Gets_Separated	Dummy variable=1 if the respondent got separated
Gets_Unemployed	Dummy variable=1 if the respondent got unemployed
Gets_Widowed	Dummy variable=1 if the respondent got widowed
Getshelpfromoutside	Dummy variable=1 if the respondent
Health_Satisfaction	Self-perceived health status: 1=excellent, 2=very good; 3=good;4=fair; 5=poor
Healthexpgdp	Share of health expenditure to GDP
Homemaker	
Improvesport	Dummy variable=1 if the respondent increased physical activity last year
Logincome	Ln of household total gross income. Its value is equal to the sum over all household members of the individual-level values of: annual net income from employment and self-employment (in the previous year); Annual public old age/early or pre-retirement/disability pension (or sickness benefits); Annual public unemployment benefit or insurance, public survivor pension from partner; Annual war pension, private (occupational) old age/early retirement/disability pension, private (occupational) survivor pension from partner's job, public old age supplementary pension/public old age/public disability second pension, secondary public survivor pension from spouse or partner, occupational old age pension from a second and third job; Annual public and private long-term insurance payments; Annual life insurance payment, private annuity or private personal pension, private health insurance payment, alimony, payments from charities received; Income from rent. Values of the following household level variables are added: Annual other hhd members' net income; Annual other hhd members' net income from other sources; Household bank accounts, government and corporate bonds, stocks/shares; mutual funds.
Married	Dummy variable=1 if the respondent is married
N_Children	number of children
N_Chronicdeseases	number of chronic diseases
N_Doctorvisits	how often seen or talked to medical doctor last 12 months
N_Grandchildren	number of grandchildren
None	Dummy variable=1 if the doctor told you had: none. 0 otherwise
Other_Job	Dummy variable=1 if the respondent has a second job
Overweight_Obese	Dummy variable=1 if the respondent is overweight (29.9<BMI<34.9) or obese (BMI>34.9). 0 otherwise
Reducedrinking	Dummy variable=1 if the respondent reduced drinking habits last year
Reg_Partnership	Dummy variable=1 if the respondent has a registered partnership
Retired	Dummy variable=1 if the respondent is retired
Separated	Dummy variable=1 if the respondent is separated
Vig_Activity	Frequency of sports or vigorous activities (0/1 dummies): *Min1week, Oneweek, OneorThreemonth, Hardly_ever_never*
Widowed	Dummy variable=1 if the respondent is widowed

Table 2a. Descriptive statistics for socio-demographic variables

Variable		Obs	Mean	Std. Dev.	Min	Max
Female		126013	0.561	0.496	0	1
Age		125609	65.217	10.446	50	104.3
Ageclass						
	55-59	125609	0.178	0.382	0	1
	60-64	125609	0.175	0.380	0	1
	65-69	125609	0.153	0.360	0	1
	70-74	125609	0.130	0.336	0	1

	75-79	125609	0.100	0.300	0	1
	>80	125609	0.116	0.321	0	1
Eduyears		125609	7.640	9.019	0	25
Married		124674	0.699	0.459	0	1
Registered_partnershipp		124674	0.015	0.123	0	1
Separated		124674	0.012	0.108	0	1
Divorced		124674	0.074	0.262	0	1
Widowed		124674	0.146	0.354	0	1
Retired		124549	0.521	0.500	0	1
Employed		124549	0.284	0.451	0	1
Homemaker		124549	0.116	0.321	0	1
Other_job		124549	0.010	0.098	0	1
N_children		125149	2.223	1.460	0	17
N_grandchildren		124666	2.600	3.217	0	25
Income		122304	71,742.04	147421.90	0	4,865,798
ΔN_chronic_diseases		40029	0.124	1.167	-9	8
N_chronic_diseases		125314	1.358	1.371	0	10

Table 2b. Descriptive statistics for health behavior

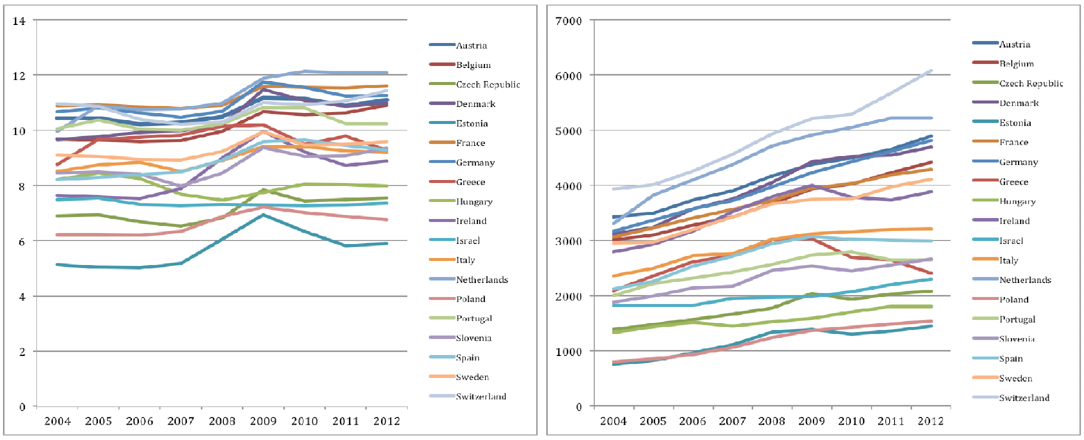
Variable		Obs	Mean	Std. Dev.	Min	Max
Drinking		124687	3.386	2.231	1	7
	Almost_every_day	124687	0.330	0.470	0	1
	5or6days_week	124687	0.099	0.299	0	1
	3or4days_week	124687	0.114	0.317	0	1
	1or2_week	124687	0.173	0.378	0	1
	1or2_month	124687	0.068	0.253	0	1
	<1_month	124687	0.027	0.161	0	1
	0_in_3months	124687	0.189	0.391	0	1
VigActivity		124676	2.615	1.335	1	4
	>1_week	124676	0.340	0.474	0	1
	1_week	124676	0.137	0.344	0	1
	1to3_month	124676	0.091	0.287	0	1
	Hardlyever_never	124676	0.432	0.495	0	1
Smoking		125014	0.191	0.393	0	1
BMI		121243	26.684	4.580	12	88
BMI_group		121243	2.801	0.764	1	4
	Underweight	121243	0.014	0.116	0	1
	Normal	121243	0.371	0.483	0	1
	Overweight	121243	0.417	0.493	0	1
	Obese	121243	0.199	0.399	0	1

Table 2c. Descriptive statistics for health variables

Variable		Obs	Mean	Std. Dev.	Min	Max
N_chronic_diseases						
	1	125314	0.299	0.458	0	1
	2	125314	0.191	0.393	0	1
	3	125314	0.105	0.307	0	1
	4	125314	0.049	0.215	0	1
	5	125314	0.020	0.142	0	1
	6	125314	0.007	0.085	0	1
	7	125314	0.002	0.048	0	1
	8	125314	0.001	0.025	0	1
	9	125314	0.001	0.012	0	1
	10	125314	7.98e-06	0.003	0	1
None		125314	0.248	0.432	0	1
Azheimer		94670	0.014	0.119	0	1
Arhritis		125314	0.219	0.413	0	1
Asthma		125314	0.029	0.169	0	1
Benign_tumor		94670	0.012	0.109	0	1
Cancer		125314	0.049	0.216	0	1
Cataracts		125314	0.079	0.27	0	1
Chronic_lung_disease		125314	0.057	0.232	0	1

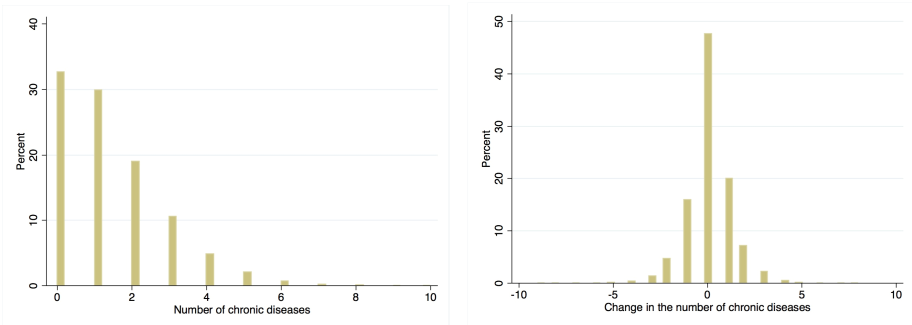
Diabetes_or_highbloodsugar	125314	0.116	0.32	0	1
Heart_attack	125314	0.131	0.337	0	1
Highblood_cholesterol	125314	0.221	0.415	0	1
Highbloodpressure_hypertension	125314	0.362	0.481	0	1
Hiporfemoral_fracture	125314	0.022	0.146	0	1
Osteoporosis	125314	0.049	0.216	0	1
Other_conditions	125314	0.155	0.362	0	1
Other_fractures	94670	0.065	0.246	0	1
Parkinson	125314	0.007	0.084	0	1
Stomachorduodenalorpeptic_ulcer	125314	0.055	0.228	0	1
Stroke	125314	0.040	0.196	0	1
Health satisfaction	125369	3.132	1.095	1	5

Figure 1. Dynamics of health expenditure to GDP (a) and health expenditure per capita (b) in SHARE countries.



(a) (b)

Figures 2. The distribution of the number of chronic diseases (a) and of changes in the number of chronic diseases across two consecutive waves (b)



(a) (b)

Figures 3a – 3f. Levels and first differences of the number of chronic diseases for the lowest and highest quartile of the health expenditure distribution

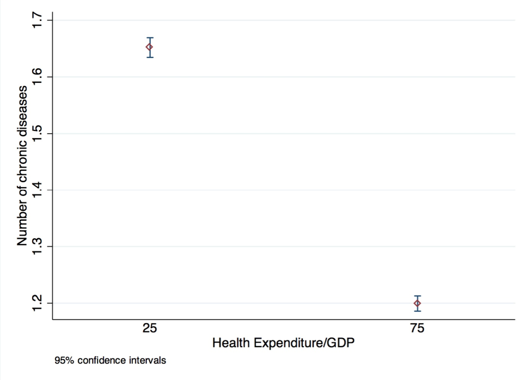


Figure 3a. Number of chronic diseases for the lowest and highest quartile of the health expenditure/GDP distribution.

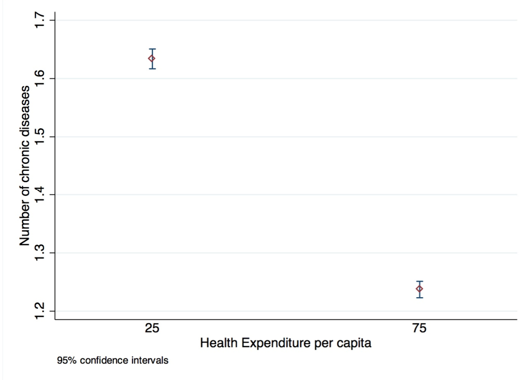


Figure 3b. Number of chronic diseases for the lowest and highest quartile ofthe health expenditure per capita distribution.

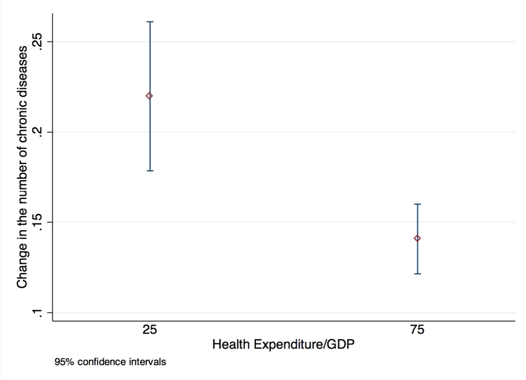


Figure 3c. Change in the number of chronic diseases for the extremes of the health expenditure/GDP distribution.

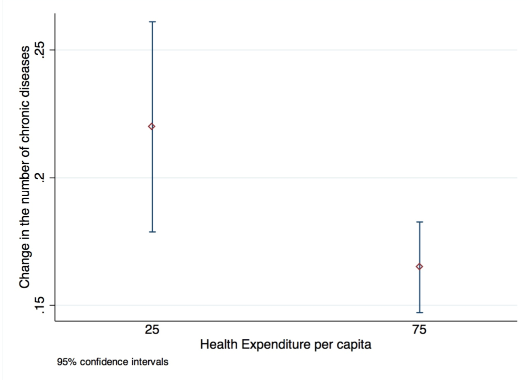


Figure 3d. Change in the number of chronic diseases for the extremes of the health expenditure per capita distribution.

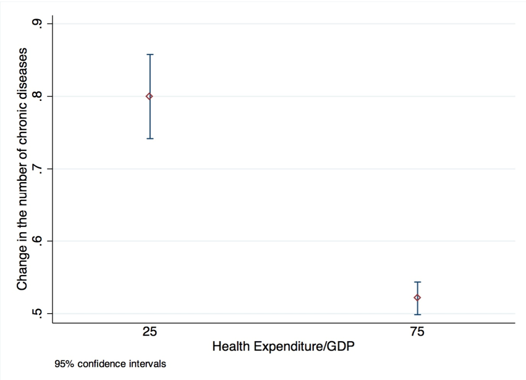


Figure 3e. Change in the number of chronic diseases for the lowest and highest quartile of the health expenditure/GDP distribution (individuals with no chronic diseases ex ante).

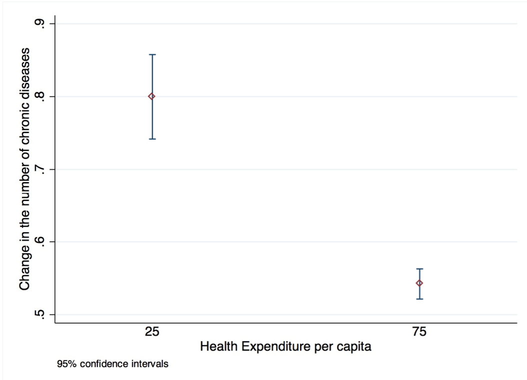


Figure 3f. Change in the number of chronic diseases the lowest and highest quartile of of the health expenditure per capita distribution (individuals with no chronic diseases ex ante).

Table 3a. The effect of health expenditure to GDP on changes in the number of chronic diseases

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HealthExp/GDP $_{t-1}$	-0.0572***	-0.0596***	-0.0478**	-0.0470**	-0.0831***	-0.0889***	-0.0728***	-0.0738***
	(0.0195)	(0.0197)	(0.0191)	(0.0189)	(0.0241)	(0.0243)	(0.0233)	(0.0229)
Female $_{t-1}$	0.0209	0.0245	0.0285*	0.0245	0.0180	0.0274	0.0295	0.0310
	(0.0162)	(0.0166)	(0.0166)	(0.0168)	(0.0195)	(0.0197)	(0.0201)	(0.0200)
Age55-59 $_{t-1}$	0.0953***	0.0934***	0.0913***	0.0867***	0.0849***	0.0851***	0.0847***	0.0817***
	(0.0211)	(0.0215)	(0.0214)	(0.0214)	(0.0250)	(0.0264)	(0.0261)	(0.0271)
Age60-64 $_{t-1}$	0.145***	0.139***	0.140***	0.130***	0.150***	0.146***	0.152***	0.143***
	(0.0275)	(0.0296)	(0.0269)	(0.0280)	(0.0358)	(0.0388)	(0.0350)	(0.0371)
Age65-69 $_{t-1}$	0.202***	0.191***	0.201***	0.186***	0.195***	0.183***	0.199***	0.182***
	(0.0325)	(0.0334)	(0.0331)	(0.0343)	(0.0455)	(0.0451)	(0.0462)	(0.0466)
Age70-74 $_{t-1}$	0.267***	0.250***	0.266***	0.237***	0.309***	0.290***	0.312***	0.280***
	(0.0412)	(0.0414)	(0.0424)	(0.0428)	(0.0432)	(0.0439)	(0.0452)	(0.0463)
Age75-79 $_{t-1}$	0.322***	0.294***	0.325***	0.287***	0.334***	0.303***	0.343***	0.299***
	(0.0494)	(0.0487)	(0.0508)	(0.0512)	(0.0646)	(0.0638)	(0.0666)	(0.0676)
Age_above 80 $_{t-1}$	0.295***	0.274***	0.286***	0.249***	0.283***	0.260***	0.294***	0.249***
	(0.0490)	(0.0488)	(0.0502)	(0.0504)	(0.0671)	(0.0660)	(0.0701)	(0.0699)
Eduyears $_{t-1}$	-0.0124***	-0.0121***	-0.00992***	-0.00951***	-0.0113***	-0.0105***	-0.00843***	-0.00760***
	(0.00219)	(0.00216)	(0.00213)	(0.00207)	(0.00302)	(0.00292)	(0.00294)	(0.00274)
N_children $_{t-1}$	-0.0178**	-0.0158**	-0.0203**	-0.0186**	-0.0187**	-0.0149*	-0.0228**	-0.0193**
	(0.00751)	(0.00775)	(0.00791)	(0.00844)	(0.00882)	(0.00874)	(0.00918)	(0.00938)
N_grandchildren $_{t-1}$	0.00178	0.00200	0.00112	0.00126	0.00559	0.00585	0.00573	0.00532
	(0.00442)	(0.00442)	(0.00461)	(0.00483)	(0.00455)	(0.00451)	(0.00463)	(0.00467)
Retired $_{t-1}$	-0.0243	-0.0114	-0.0141	0.00250	-0.0198	-0.00335	-0.0122	0.0150
	(0.0450)	(0.0494)	(0.0442)	(0.0484)	(0.0604)	(0.0644)	(0.0602)	(0.0633)
Employed $_{t-1}$	-0.152***	-0.149***	-0.132***	-0.125***	-0.175***	-0.170***	-0.160***	-0.145***
	(0.0358)	(0.0390)	(0.0349)	(0.0380)	(0.0422)	(0.0464)	(0.0414)	(0.0457)
Homemaker $_{t-1}$	-0.0429	-0.0426	-0.0379	-0.0403	-0.0409	-0.0452	-0.0410	-0.0468
	(0.0441)	(0.0468)	(0.0414)	(0.0442)	(0.0534)	(0.0566)	(0.0496)	(0.0530)
Other_job $_{t-1}$	-0.480***	-0.342**	-0.466***	-0.357**	-0.519**	-0.337*	-0.494**	-0.314
	(0.163)	(0.156)	(0.160)	(0.161)	(0.205)	(0.200)	(0.203)	(0.203)
Divorced $_{t-1}$	0.140***	0.142***	0.146***	0.154***	0.165***	0.167**	0.167**	0.176***
	(0.0491)	(0.0490)	(0.0516)	(0.0518)	(0.0625)	(0.0633)	(0.0645)	(0.0648)
Married $_{t-1}$	0.0530*	0.0514*	0.0580*	0.0637**	0.0404	0.0408	0.0413	0.0516
	(0.0288)	(0.0298)	(0.0307)	(0.0318)	(0.0397)	(0.0411)	(0.0414)	(0.0423)

Separated $_{t-1}$	0.0354	0.0695	0.0520	0.0574	0.0448	0.0726	0.0475	0.0340
	(0.0909)	(0.0886)	(0.0900)	(0.0905)	(0.111)	(0.109)	(0.110)	(0.110)
Reg_partnership $_{t-1}$	0.00781	0.0118	0.0169	0.0353	-0.0394	-0.0321	-0.0331	-0.00102
	(0.0549)	(0.0566)	(0.0553)	(0.0564)	(0.0649)	(0.0676)	(0.0661)	(0.0659)
Widowed $_{t-1}$	0.132***	0.130***	0.131***	0.134***	0.140***	0.138***	0.131***	0.134***
	(0.0357)	(0.0370)	(0.0371)	(0.0380)	(0.0487)	(0.0498)	(0.0493)	(0.0493)
Ln(Income) $_{t-1}$	0.0160	0.0141	0.0255*	0.0254*	0.0317*	0.0288	0.0416**	0.0396**
	(0.0147)	(0.0143)	(0.0153)	(0.0147)	(0.0189)	(0.0183)	(0.0193)	(0.0184)
Δ Ln(Income)	0.0143	0.0154*	0.0160*	0.0171*	0.0264**	0.0266**	0.0271**	0.0270**
	(0.00898)	(0.00917)	(0.00920)	(0.00929)	(0.0110)	(0.0111)	(0.0113)	(0.0113)
Drinking5or6days_a_week $_{t-1}$			-0.0215	-0.0342			-0.0291	-0.0429
			(0.0285)	(0.0283)			(0.0391)	(0.0389)
Drinking3or4days_a_week $_{t-1}$			-0.00445	-0.0233			0.00240	-0.0143
			(0.0278)	(0.0294)			(0.0402)	(0.0417)
Drinking1or2_a_week $_{t-1}$			-0.0572**	-0.0708**			-0.0750**	-0.0919**
			(0.0258)	(0.0281)			(0.0335)	(0.0352)
Drinking1or2_a_month $_{t-1}$			-0.0390	-0.0511			-0.0303	-0.0459
			(0.0290)	(0.0313)			(0.0367)	(0.0378)
Drinking<1_a_month $_{t-1}$			-0.0635	-0.0848*			-0.0249	-0.0460
			(0.0493)	(0.0493)			(0.0604)	(0.0575)
NotDrinking_for_3_months $_{t-1}$			-0.0402	-0.0501*			-0.0493	-0.0642*
			(0.0254)	(0.0265)			(0.0332)	(0.0329)
VigActivity1_week $_{t-1}$			0.0309	0.0711***			0.0229	0.0787***
			(0.0201)	(0.0215)			(0.0279)	(0.0265)
VigActivity1to3_a_month $_{t-1}$			0.0517*	0.105***			0.0275	0.110***
			(0.0280)	(0.0351)			(0.0325)	(0.0346)
VigActivity_hardlyever_or_never $_{t-1}$			0.125***	0.179***			0.115***	0.189***
			(0.0201)	(0.0215)			(0.0273)	(0.0279)
Smoking $_{t-1}$			0.00327	-0.00715			0.0227	0.0102
			(0.0202)	(0.0229)			(0.0246)	(0.0295)
Overweight_or_obese $_{t-1}$			0.156***	0.157***			0.171***	0.172***
			(0.0186)	(0.0183)			(0.0239)	(0.0240)
ReduceDrinking		0.0378**		0.0482**		0.0408		0.0467*
		(0.0186)		(0.0191)		(0.0255)		(0.0240)
ImproveSport		-0.0929***		-0.156***		-0.114***		-0.184***
		(0.0221)		(0.0262)		(0.0237)		(0.0246)
Δ smoking				-0.0271				-0.0199
				(0.0319)				(0.0491)
ΔBmi_mod				0.0132***				0.0116**
				(0.00463)				(0.00496)
GetsSeparated		-0.0720		-0.0759		-0.144		-0.141

		(0.222)		(0.239)		(0.328)		(0.371)
GetsWidowed		0.174***		0.196***		0.154**		0.175**
		(0.0568)		(0.0642)		(0.0703)		(0.0765)
GetsDivorced		-0.0550		-0.0744		-0.0930		-0.124
		(0.107)		(0.115)		(0.121)		(0.126)
GetsPartnership		-0.254**		-0.226		-0.394**		-0.360*
		(0.119)		(0.148)		(0.150)		(0.187)
ΔHelpFromOutside		0.0498*		0.0406		0.0573*		0.0481
		(0.0284)		(0.0295)		(0.0313)		(0.0331)
GetsRetired		0.0255		0.0225		0.0238		0.0286
		(0.0310)		(0.0316)		(0.0389)		(0.0395)
GetsUnemployed		-0.00797		0.0121		0.0223		0.0505
		(0.0707)		(0.0711)		(0.0913)		(0.0907)
GetsGrandchildren		-0.0231		-0.0212		-0.0390		-0.0378
		(0.0205)		(0.0208)		(0.0235)		(0.0239)
N_ChronicDeseases $_{t-1}$	-0.397***	-0.398***	-0.413***	-0.415***	-0.433***	-0.435***	-0.450***	-0.453***
	(0.0168)	(0.0171)	(0.0173)	(0.0179)	(0.0160)	(0.0161)	(0.0160)	(0.0163)
AvoidableCHF					0.000384	0.000345	0.000380	0.000286
					(0.000382)	(0.000373)	(0.000378)	(0.000360)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,294	15,980	15,927	15,507	10,853	10,650	10,551	10,266
R-squared	0.198	0.200	0.208	0.210	0.216	0.220	0.226	0.231

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3b. The effect of health expenditure to GDP on changes in the number of chronic diseases (correction for attrition bias)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$HealthExp/GDP_{t-1}$	-0.0532**	-0.0563**	-0.0452*	-0.0450**	-0.0985***	-0.106***	-0.0927***	-0.0945***
	(0.0229)	(0.0228)	(0.0232)	(0.0225)	(0.0277)	(0.0277)	(0.0266)	(0.0259)
AvoidableCHF	No	No	No	No	Yes	Yes	Yes	Yes
Observations	15,722	15,578	15,647	15,507	10,406	10,318	10,351	10,266
R-squared	0.183	0.186	0.193	0.199	0.206	0.211	0.216	0.224

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Each column displays the health expenditure/GDP coefficient estimated in a specification which corresponds to that of the same Table 1A column

Table 4a. The effect of per capita health expenditure on changes in the number of chronic diseases

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$HealthExpPerCapita_{t-1}$	-9.25e-05***	-9.42e-05***	-8.10e-05**	-7.21e-05**	-0.000140***	-0.000149***	-0.000123***	-0.000122***
	(3.46e-05)	(3.49e-05)	(3.34e-05)	(3.29e-05)	(4.25e-05)	(4.29e-05)	(4.14e-05)	(4.04e-05)
AvoidableCHF	No	No	No	No	Yes	Yes	Yes	Yes
Observations	16,294	15,980	15,927	15,507	10,853	10,650	10,551	10,266
R-squared	0.198	0.200	0.208	0.210	0.216	0.219	0.226	0.230

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Each column displays the health expenditure per capita coefficient estimated in a specification which corresponds to that of the same Table 1A column (with the exception of the health per capita coefficient which replaces health expenditure/GDP coefficient).

Table 4b. The effect of per capita health expenditure on changes in the number of chronic diseases (correction for attrition bias)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

HealthExpPerCapita $_{t-1}$	-0.000117***	-0.000121***	-0.000108***	-0.000101***	-0.000163***	-0.000174***	-0.000155***	-0.000155***
	(3.89e-05)	(3.87e-05)	(3.87e-05)	(3.77e-05)	(4.77e-05)	(4.76e-05)	(4.63e-05)	(4.49e-05)
AvoidableCHF	No	No	No	No	Yes	Yes	Yes	Yes
Observations	15,722	15,578	15,647	15,507	10,406	10,318	10,351	10,266
R-squared	0.184	0.187	0.193	0.200	0.206	0.211	0.217	0.224

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Each column displays the health expenditure per capita coefficient estimated in a specification which corresponds to that of the same Table 1A column (with the exception of the health per capita coefficient which replaces health expenditure/GDP coefficient).

Table 5. The effect of health expenditure on changes in the number of chronic diseases (for subsamples).

	Health exp to GDP	St. Dev.	R-squared	Health exp per capita	St. Dev.	R-squared	Observations
All sample	-0.0945***	(0.0259)	0.224	-0.000155***	(4.49e-05)	0.224	10,266
Elder 65+	-0.121***	(0.0314)	0.232	-0.000200***	(5.47e-05)	0.232	5,355
Female	-0.0968***	(0.0306)	0.226	-0.000149***	(5.14e-05)	0.225	5,650
Physical activity	-0.115***	(0.0255)	0.238	-0.000189***	(4.08e-05)	0.238	5,120
Lack of physical activity	-0.0666*	(0.0396)	0.225	-0.000102	(7.24e-05)	0.225	4,260
High income	-0.0533*	(0.0278)	0.227	-9.26e-05*	(4.79e-05)	0.227	4,642
Low income	-0.124***	(0.0283)	0.232	-0.000201***	(5.03e-05)	0.232	5,622
No overweight	-0.0754**	(0.0324)	0.221	-0.000128**	(6.03e-05)	0.221	4,144
Overweight	-0.106***	(0.0293)	0.232	-0.000172***	(4.91e-05)	0.232	6,122
Low education	-0.0971***	(0.0285)	0.218	-0.000157***	(4.89e-05)	0.218	7,990
High education	-0.0915**	(0.0356)	0.279	-0.000150**	(6.57e-05)	0.279	2,276

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Each column displays the health expenditure per capita coefficient estimated in a specification which corresponds to that of the same Table 1.A column (with the exception of the health per capita coefficient which replaces health expenditure/GDP coefficient). Elder 60+: individuals aged above 60; high income: individuals with income above country median; Low income: individuals with income below country median; Low education: individuals without graduate degree; High education: individuals with graduate degree.

Table 6. Instrumental variable estimates

Variables	(1)	(2)
HealthExp/GDP $_{t-1}$	-0.135**	
	(0.0669)	
HealthExpPerCapita$_{t-1}$		-0.000186**
		(8.52e-05)
Female $_{t-1}$	0.0451*	0.0446*
	(0.0242)	(0.0242)
Age55-59 $_{t-1}$	0.0576**	0.0608**
	(0.0270)	(0.0274)
Age60-64 $_{t-1}$	0.131***	0.137***
	(0.0320)	(0.0323)
Age65-69 $_{t-1}$	0.161***	0.168***
	(0.0443)	(0.0439)
Age70-74 $_{t-1}$	0.254***	0.262***
	(0.0462)	(0.0450)
Age75-79 $_{t-1}$	0.256***	0.265***
	(0.0675)	(0.0666)
Age_above 80 $_{t-1}$	0.201***	0.211***
	(0.0648)	(0.0646)
Eduyears $_{t-1}$	-0.00594*	-0.00665**
	(0.00329)	(0.00323)
N_children $_{t-1}$	-0.0208*	-0.0201*
	(0.0110)	(0.0108)
N_grandchildren $_{t-1}$	0.00577	0.00570
	(0.00539)	(0.00533)
Retired $_{t-1}$	0.0947	0.0873
	(0.0712)	(0.0704)
Employed $_{t-1}$	-0.0886	-0.0914
	(0.0561)	(0.0563)
Homemaker $_{t-1}$	-0.00669	-0.0107
	(0.0584)	(0.0584)
Other_job $_{t-1}$	-0.185	-0.184
	(0.183)	(0.184)
Divorced $_{t-1}$	0.244***	0.243***
	(0.0767)	(0.0760)
Married $_{t-1}$	0.0594	0.0557
	(0.0491)	(0.0492)
Separated $_{t-1}$	0.0877	0.0825
	(0.131)	(0.132)
Reg_partnership $_{t-1}$	-0.0457	-0.0375
	(0.0627)	(0.0623)
Widowed $_{t-1}$	0.174***	0.167***
	(0.0545)	(0.0542)
Ln(Income)$_{t-1}$	0.0434***	0.0511***
	(0.0163)	(0.0162)
Δ Ln(Income)	0.0293**	0.0316***
	(0.0118)	(0.0120)
Drinking5or6days_a_week $_{t-1}$	-0.0187	-0.0197
	(0.0487)	(0.0482)
Drinking3or4days_a_week $_{t-1}$	0.0547	0.0526
	(0.0513)	(0.0511)
Drinking1or2_a_week $_{t-1}$	-0.0587	-0.0606
	(0.0405)	(0.0405)
Drinking 1or2_a_month $_{t-1}$	0.0139	0.0104
	(0.0570)	(0.0564)
Drinking <1_a_month $_{t-1}$	-0.0626	-0.0682
	(0.0857)	(0.0850)
NotDrinking_for_3_months $_{t-1}$	-0.0414	-0.0464
	(0.0350)	(0.0345)
VigActivity1_week $_{t-1}$	0.0677**	0.0673**
	(0.0276)	(0.0274)
VigActivity 1or3_a_month $_{t-1}$	0.110***	0.110***
	(0.0356)	(0.0354)
VigActivity hardlyever_or_never $_{t-1}$	0.210***	0.210***
	(0.0278)	(0.0277)

Smoking $_{t-1}$	-0.00982	-0.0116
	(0.0363)	(0.0356)
OverweightOrObese $_{t-1}$	0.177***	0.176***
	(0.0240)	(0.0241)
ReduceDrinking	0.0516*	0.0516*
	(0.0277)	(0.0276)
ImproveSport	-0.201***	-0.200***
	(0.0299)	(0.0300)
Δ smoking	-0.0579	-0.0592
	(0.0528)	(0.0526)
ΔBmi_mod	0.0130**	0.0129**
	(0.00582)	(0.00582)
GetsSeparated	-0.132	-0.142
	(0.283)	(0.284)
GetsWidowed	0.159**	0.155**
	(0.0749)	(0.0747)
GetsDivorced	-0.101	-0.0988
	(0.122)	(0.124)
GetsPartnership	-0.468***	-0.450***
	(0.170)	(0.167)
ΔHelpFromOutside	0.0500	0.0487
	(0.0435)	(0.0431)
GetsRetired	0.0398	0.0366
	(0.0493)	(0.0499)
GetsUnemployed	0.0108	0.00870
	(0.0899)	(0.0879)
GetsGrandchildren	-0.0249	-0.0253
	(0.0243)	(0.0242)
N_ChronicDeseases $_{t-1}$	-0.442***	-0.442***
	(0.0176)	(0.0176)
AvoidableCHF	-0.000168	-1.48e-05
	(0.000645)	(0.000528)
Year dummies	Yes	Yes
Observations	10,266	10,266
R-squared	0.224	0.224

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7. Instrumental variable estimates for subsamples

	Health exp/GDP		R-squared	Health exp per capita		R-squared	Obs
Elder 65+	-0.185**	(0.0845)	0.231	-0.000261**	(0.000110)	0.231	5,355
Female	-0.142*	(0.0807)	0.225	-0.000194*	(0.000106)	0.225	5,650
Physical activity	-0.108*	(0.0570)	0.238	-0.000144*	(7.34e-05)	0.238	5,120
Lack of physical activity	-0.427*	(0.241)	0.195	-0.000566**	(0.000284)	0.207	4,260
High income	-0.115	(0.0726)	0.226	-0.000155*	(9.02e-05)	0.226	4,642
Low income	-0.144**	(0.0714)	0.232	-0.000209**	(9.85e-05)	0.232	5,622
No overweight	-0.132	(0.0924)	0.220	-0.000177	(0.000116)	0.221	4,144
Overweight	-0.137**	(0.0605)	0.232	-0.000192**	(7.96e-05)	0.232	6,122
Low education	-0.151**	(0.0713)	0.217	-0.000210**	(9.28e-05)	0.218	7,990
High education	-0.0831	(0.0931)	0.279	-0.000106	(0.000119)	0.279	2,276

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Subgroup legend: see Table 5.

Table 8. The impact of health expenditure to GDP and health expenditure per capita on NUTS2 level aggregated data (subsample)

	Health exp/GDP	St. Dev.	R-squared	Health exp per capita	St. Dev.	R-squared
All	-0.135***	(0.0471)	0.742	-0.000269***	(8.48e-05)	0.749
Female	-0.182***	(0.0551)	0.764	-0.000343***	(0.000101)	0.767
Elder 65+	-0.158**	(0.0681)	0.553	-0.000286**	(0.000123)	0.553
Lack of physical activity	-0.119*	(0.0647)	0.621	-0.000176	(0.000120)	0.612
Low income	-0.0520	(0.0518)	0.712	-0.000136	(9.02e-05)	0.718
Overweight	-0.120**	(0.0576)	0.672	-0.000272***	(9.55e-05)	0.692
Low Education	-0.154**	(0.0639)	0.710	-0.000250**	(0.000116)	0.704

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Subgroup legend: see Table 5.

Table 9. The impact of health expenditure to GDP and health expenditure per capita on NUTS2 level aggregated data – IV estimates

	Health exp/GDP		R-squared	Health exp per capita		R-squared
All	-0.170**	(0.0738)	0.649	-0.000229**	(0.000101)	0.642
Female	-0.233***	(0.0724)	0.749	-0.000326***	(9.98e-05)	0.755
Elder 65+	-0.174**	(0.0704)	0.551	-0.000262**	(0.000106)	0.552
Lack of physical activity	-0.148*	(0.0865)	0.615	-0.000217*	(0.000128)	0.606
Low income	-0.127*	(0.0688)	0.675	-0.000180*	(9.57e-05)	0.684
Overweight	-0.181***	(0.0694)	0.634	-0.000250***	(9.51e-05)	0.651
Low Education	-0.204**	(0.0964)	0.637	-0.000247**	(0.000120)	0.622

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Subgroup legend: see Table 5.