2849A

Part IIA PAPER 3 PROJECT

1. Cross-country Variations in Health Outcomes in the European Union 2018

Health care outcomes show wide variation across the Member States of the European Union (OECD 2018, 2019).
Using the OECD Health database and related publications, together with any other data and information that you wish to introduce:
a) Identify and explain the critical factors affecting health status outcomes across Europe. Health status can be taken to include:

- Life expectancy.
- Avoidable mortality.
- Chronic disease morbidity.
- Self-rated health.

b) On the basis of your analysis, evaluate and examine the contribution to cross-national variations in health status of:

- Risk factors.
- Access to care.
- Quality of care.
- Health resources.

c) In the light of your findings for Parts a) and b), consider critically what policies are appropriate for:

- An overall improvement in health status in the EU.
- Reducing cross-country inequalities in healthcare outcomes in the EU.

1998 Words, 6 Tables, 1 Graph

Introduction

This paper investigates the critical determinants of health status in the EU region, the drivers of gains in life expectancy over the past couple of decades, the sources of cross-country disparities in health and aims to propose feasible and cost-efficient policy alternatives to improve overall health in the region and lower health inequality between the nations.

Literature review

The present literature on the macro-level analysis of health outcomes is predominantly based on the production function approach attributed to Auster, Leveson, and Sarachek (1969), with modifications by Grossman (1972), which follows the concept that health status is the output of numerous interacting input variables. These papers introduced the use of additional explanatory variables categorised as lifestyle factors (such as tobacco, alcohol, sugar and Vegetable consumption), socio-economic circumstances (like education, income level, public goods consumption) or healthcare measures (like expenditure), which were argued to enable the estimation of the actual effect of medical care utilisation (Thornton, 2002). There were several ways of applying the production function framework, some using panel data with typically Fixed Effects and GLS Random Effects (Bichaka and Gutema, 2008; OECD, 2017) while others used pooled cross-sectional analysis (Shaw et al., 2005). Simultaneity issues (Fuchs, 2004), different treatments of lag effects (Backhouse et al., 1987) and choice of appropriate variables (life expectancy at birth vs. at 40 vs. avoidable mortality vs. self-rated health) are main topics of methodological discussions. The results differ quite significantly, with some studies finding that lifestyle factors like smoking are not significant determinants (French and Miller, 1999) while many others dispute this (Shaw et al. 2005). Initial differences were likely due to different methodology and theory, however with the evolution of regression techniques there is a convergence in the literature towards an emphasis on lifestyle and socio-economic factors (Taylor et al., 2016; OECD, 2017; Bassanini and Caroli, 2014), while expenditure remained significant despite the control for more variables. Most recent research focuses on micro-level analysis of social factors, like housing and community outreach (Taylor, Lauren A et al., 2016) and on mental health determinants (Allen et al., 2014), both of which remain beyond the scope of this paper due to a lack of sound fundamental theory and methodology issues, viz. ecological fallacy of using macro data to analyse micro relationships.

Model Specification

Our model is based on the following Cobb-Douglas-like production function used in most of the literature:

$$H_{it} = \alpha_i + \beta x_{it} + \gamma y_{it} + \delta z_{it} + \epsilon_{it}$$

where α_i is the country fixed effect, x_{it} is a vector of lifestyle factors, y_{it} is a vector of socio-economic factors, z_{it} is a vector of healthcare factors and ϵ_{it} is an error term. Like in most studies in the literature, the variables are in log form where appropriate to reflect diminishing marginal effects.

Methodology concerns and their treatment

Lagged effect of inputs

Based on findings by Corrao et al. (1993) and Khuder (2013) stating that alcohol and smoking respectively have a lagged epidemiological effect most appropriately approximated by around 20 years, the model uses a lag of 15 years on lifestyle factors where available, which is more than typical in the literature (5-year lag in OECD, 2017) but not unheard-of (Shaw et al., 2005). This paper argues that it is important to use the most relevant time period possible for each input – rather than use current data as proxy (Joumard 2008) – to avoid introducing significant bias. It would, to a significant degree, defeat the purpose of using Panel Data if the within effects are completely unreliable.

Serial correlation

The Breusch–Godfrey LM tests confirm that yearly data of most of the independent variables relevant to discussion follow an AR process, which must be taken into account. In this paper, the treatment is taking observations from further apart in time and taking averages of 3-5 years around those periods. Taking averages from distinct periods diminishes the cyclicality of the data and allows us to focus on the longer run effects, more typical in health circumstances.

Missing data

For many of the variables there is missing observations in a significant number of years, which if the regression was based on yearly data would likely lead to entirely omitting that country from the analysis. Often, data was missing for poorer European countries which would introduce selection bias based on outcome, a very unfavourable quality when trying to assess contributions to cross-country variations in health status in Europe. In addition, some valuable data are only reported with lower frequencies.

Table 1. Data Selection a)

Measure	Variable	Details	Considerations	Source
Health Status	Life expectancy at birth	Calculated by measuring current mortality rates at all ages and fitting them on a theoretical demographic structure for all countries.	*Health status* includes both length of life and quality of health – physical and mental. Although one could attempt to condense all that into one variable, it would unnecessarily hinder analysis. Henceforth – despite measuring very similar things from two directions – this paper will focus on potential years of lives lost and life expectancy as they incorporate both lifestyle factors affecting health and healthcare factors affecting "recovery".	OECD
Smoking	% of population smoking	Based on population surveys with estimation for missing values using tobacco sales from FAO database.	Notes: A lag of 15 years applied	IHME
Alcohol	Litres consumed per capita	Estimated from alcohol sales.	*Alcohol* consumption is most problematic when consumed in bulk, therefore the best indicator would have been prevalence of heavy episodic drinking, but data collection has only recently begun. In the end, both prevalence of alcohol disorder as a proxy for heavy drinking, and litres consumed per capita per year was used, which may come at the cost of blurring the difference between countries where lot of people consume moderate amounts and countries where fewer people consume higher amounts. Notes: A lag of 15 years applied.	OECD
Obesity	% of population with BMI > 30	Based on 2461 population-based measurement studies.	The estimates are measured, which are more accurate than self-reported data, which underestimates the real value due to people reporting lower weights and higher heights. Notes: A lag of 15 years applied.	WHO
Pollution	PM2.5 µg/m3	Population density-weighted to represent exposure of average citizen.	The *air pollutant* which causes the greatest health risk is the PM2.5 fine particulate matter as it increases the risk of respiratory and cardiovascular diseases (Congbo, 2005). Percentage exposed to more than 10 µg/m3 of PM2.5 was also used to see if using population weighted mean exposure conceals information about the variance of exposure in different parts of the country. Notes: A lag of 10 years applied, the most available. Turkey is excluded because measurements are irreconcilable with the rest of the data.	OECD
Diet	Fruits and vegetables	Kg/person/year consumed	Notes: A lag of 10 years was applied.	Global Dietary Database
Inequality	Gini-coefficient			World Bank Data
Education	% of population with tertiary education		Notes: Missing values for Iceland, New Zealand and Norway.	OECD

Table 2. Data Selection b)

Resources	CT scans/million people		*Resources* is primarily meant to measure physical and human capital available in hospitals. Human capital is intentionally left out in this study, because there are simultaneity problems with doctors/capita ratio. More patients demand more doctors, therefore few doctors/capita could either mean understaffed unhealthy system or properly served healthy system. Expenditure isn't used for resources because it includes much more than that.. The number of CT scans is used to better circumscribe resource levels. Notes: Missing data for the 2000 period for 9 countries, which are a fairly random cluster.	OECD
Quality of care	Five-year lung cancer survival rate	It reflects how well treatment is conducted. Cancer is the second leading cause of death which warrants the use of cancer survival rate as a measure of healthcare quality.	*Quality of healthcare* is best represented by indicators which report on the treatment effect of health services i.e. *outputs minus inputs*, such as disease detection, survival rate or percentage medicated, rather than merely resources invested without regard for how efficiently they are used. Both 5-year lung cancer survival rate and 30-day mortality post hospital admission with diagnosis of AMI were used, with AMI expected to be a more narrowed proxy. Notes: Missing values for 2000.	OECD
Access to care	Percentage uncovered Health expenditure	Percentage not covered under either a government or private insurance scheme Health expenditure on insurance per capita	*Access to care* is intended reflect the affordability, physical accessibility and adequacy of service available to the low income and geographically displaced fraction of a country's population. Issues arise because healthcare data are either not available at different income level – such as doctor-patient ratio, distance from hospital or number of medications prescribed – or lacking for many countries – like treatments skipped due to costs. Other variables which are available, like the Gini-coefficient or mortality rate, mash together lifestyle and health service factors, hindering separating out an access indicator. The choice of indicator in this study was the percent of population not covered by either government or private insurance schemes and health expenditure per capita which reflects a more broad interpretation of access. Insurance coverage still has limited power since the issue of access is not only the cost but often the mere lack of availability of quality healthcare.	OECD
*Self-rated health was considered as an indicator of quality of health as it would be relevant in directly investigating the cancelling forces of negative lifestyle- and positive treatment factors – i.e. people may be sick often but receive better care and live just as long – however there are concerns of cultural differences, differences in survey methodology and non-health related factors contaminating the data. As Kim and Khang (2019) hypothesise, variations in perceived health may be driven by the number of doctor visits per person engendering increased consciousness about one's own illnesses, which explains why Korea and Japan have low perceived health despite high life expectancy. It could also be argued that self-reported health is more related to mental health, which is somewhat supported by a significant coefficient when running an elementary regression on suicide rates. Although mental health and suicide rates are increasingly researched areas, their primary determinants are beyond the scope of this analysis.				

VARIABLES	(1) OLS	(2) FE	(3) RE	(4) RE survival	(5) RE AMI30	(6) RE IV	(7) RE reduced	(8) RE YLL
lgdp	0.0656***	0.0267*	0.0408***	0.0558***	0.0240*	-0.00698	0.0249*	-0.384**
	(0.00937)	(0.0131)	(0.00602)	(0.00916)	(0.0132)	(0.0330)	(0.0134)	(0.161)
lCT	0.00507	0.00847	0.00502	0.00618	0.00486	0.000162	0.00507	0.0225
	(0.00384)	(0.00566)	(0.00386)	(0.00479)	(0.00486)	(0.00712)	(0.00498)	(0.0545)
lexpenditure					0.0244***	0.0585*	0.0224***	-0.238**
					(0.00797)	(0.0331)	(0.00782)	(0.0959)
lalcohol	-0.00894	-0.0124*	-0.00518	-0.0113*	-0.00925	-0.00471	-0.0159**	0.227**
	(0.00673)	(0.00696)	(0.00592)	(0.00676)	(0.00816)	(0.0107)	(0.00762)	(0.0928)
smoking	-0.000682*	0.000583	-6.08e-05	1.43e-05	-0.000358	-0.000407	-0.000518*	-0.000912
	(0.000402)	(0.000349)	(0.000284)	(0.000343)	(0.000335)	(0.000408)	(0.000310)	(0.00407)
obese	-0.00116**	-0.00126	-0.000788	-0.00134**	-0.00149***	-0.00104	-0.00164***	0.0213***
	(0.000567)	(0.000801)	(0.000544)	(0.000612)	(0.000576)	(0.000808)	(0.000562)	(0.00651)
lpollution	0.00266	-0.0189	0.00571	0.00875	0.00774	0.0182		-0.0367
	(0.00594)	(0.0337)	(0.00975)	(0.00981)	(0.00891)	(0.0144)		(0.0949)
lgini	0.0283	0.0392	0.00226	0.0165	0.0172	0.0139		0.0491
	(0.0199)	(0.0355)	(0.0228)	(0.0249)	(0.0240)	(0.0290)		(0.276)
lFruitsVegs	0.0236**	-0.0684	0.0320*	0.0173	0.0231	0.0214		-0.277*
	(0.0114)	(0.0502)	(0.0168)	(0.0177)	(0.0150)	(0.0179)		(0.163)
education	-1.59e-06	0.00132***	0.00135***	0.000832**	0.000362	0.000377	0.000258	0.000354
	(0.000339)	(0.000455)	(0.000213)	(0.000375)	(0.000377)	(0.000452)	(0.000384)	(0.00425)
lcoverage	0.359***	0.0491		0.186**	0.128**	0.153**	0.119**	-1.172*
	(0.0794)	(0.0912)		(0.0773)	(0.0517)	(0.0660)	(0.0490)	(0.634)
lAMI30					-0.0120*	-0.0113	-0.0125**	0.170**
					(0.00619)	(0.00756)	(0.00598)	(0.0749)
lquality	-0.00940	0.0369**		-0.00105				
	(0.0100)	(0.0179)		(0.0124)				
Constant	1.873***	4.032***	3.714***	2.762***	3.186***	3.116***	3.469***	20.33***
	(0.377)	(0.557)	(0.133)	(0.390)	(0.276)	(0.338)	(0.230)	(3.342)
Observations	71	71	84	71	55	55	55	55
R-squared	0.816	0.956						
Number of country_id		30	34	30	32	32	32	32

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Issues

Concern	Variable	Consequence, remedies
Functional form misspecification		The functional form used in most of the literature is log-linear. This paper also uses log-linear except that some values like smoking, obesity and education were kept in their original percentage form, which better illustrates that these variables have less of a diminishing effect. The 1st person who stops smoking "gains" just as many additional years as the 1000th.
		Ramsey RESET on Pooled OLS: F(3, 56) = 1.02, Prob > F = 0.396, so the specification cannot be rejected at high significance.
Introduces bias		
Simultaneity	Expenditure, doctors	Simultaneity issue arises when the dependent and independent variables are both determinants of each other in a structural equation relation. The bias it causes could be treated with 2SLS. Ratio of population over the age of 65 was used as an instrumental variable since it increases welfare spending and expenditure costs (relevance) but doesn't have additional effects on life expectancy, since the ratio of death at each age doesn't increase if there are more old people. Doctors were not used as resource indicators due to simultaneity concerns of more patients requiring more staff, however treatment would've been possible with doctor's salary for example. CT needs less instrumentation if any as it is less likely to be influenced by mortality.
Trended variables	GDP, education	There is a concern that spurious correlation will arise due to variables trending as a result of some unobserved variables. On one hand, this is somewhat mitigated by taking logs of these variables and having few time periods, on the other hand trends may not be an issue in the first place if the trend in life expectancy is not a result of unobserved variables but of GDP and education themselves. Studies on the evolution of health status in African countries (Fayissa and Gutema, 2008) show that health status stagnates if there are no advancements in the explanatory variables, which supports our hypothesis.
Selection bias	survival	If there is missing data eliminated based on the dependent variable, then there would be concerns of sample selection bias. 5-year cancer survival was unavailable in Luxembourg, Greece and Hungary, but this was considered a random omission of observations simply reducing the sample size.
Outliers		Outliers were checked and were found relevant in two cases: GDP for Luxembourg and health expenditure for the US, which made no difference in the results or the significance.
Affects standard errors		
Multicollinearity	GDP, gini, pollution, FruitsVegs,	High collinearity is mainly caused by small sample size, and there isn't a formal way of correcting for it.
Heteroscedasticity		**Breusch-Pagan test**: χ^2=0.76, Prob > 0.386. Therefore, constant variance cannot be rejected.
Serial Correlation		Given the methodology of taking 3 time periods 10 and 6 years apart, serial correlation was not formally tested as an AR(6) process is highly unlikely.

Table 5. Estimation discussion

<table>
<tr><th></th><th>Fixed Effects</th><th>Random Effects</th></tr>
<tr><td>Advantages</td><td>• Diminishes the effect of different measurement techniques used in different countries by only using within effects
• Controls for omitted fixed variables specific to a unit/country</td><td>• Uses additional information in cross-country level differences
• Lower standard errors using the error covariance matrix in estimation
• Only causes a loss of 2 degrees of freedom
• Can estimate coefficient on fixed variables</td></tr>
<tr><td>Disadvantages</td><td>• If a variable has little variation within units, its coefficient loses robustness
• There are only 3 observations to determine individual effect
• Reduced the degrees of freedom by N-1, a third of the 105 observations we begin with</td><td>• Needs an important assumption that omitted fixed country-effect variables are uncorrelated with independent variables in the regression</td></tr>
<tr><td>Hausman-test</td><td colspan="2">The STATA Hausman test is not allowed for the log specification of the model but performing it on the level specification yields a p-value of 0.018, so it isn't rejected at 1% significance. However, this is not a confirmation that the log-form is also not rejected.</td></tr>
<tr><td>Discussion of results</td><td>Quite low significance mainly because the log-form reduces the size of within effects and therefore the standard errors.

Coverage is insignificant, because it is practically a fixed variable for several countries so it cannot be estimated with FE.</td><td>Resources aren't significant, which is detailed later on.

The coefficient on 5-year cancer survival is not significant, which is likely due to omitted variables like expenditure. When expenditure is included, 5-year survival regains some significance (0.7), but not substantially.</td></tr>
<tr><td>2SLS</td><td colspan="2">The instrumented regression yielded appropriate but insignificant results for several variables. 65+ population ratio may be a good instrument, but the low number of observations causes the significance of several variables to disappear due to increased standard errors expected in 2SLS.</td></tr>
<tr><td>Reduced RE</td><td colspan="2">The reduced RE regression seems to fit really well, given that GDP, expenditure, alcohol, smoking, obesity, coverage and 30-day mortality all have the right sign with significance. Notably, most of the coefficients agree with the extended RE. Smoking has lower standard errors due to the emission of other variables, which may be a sign of multicollinearity. However, to avoid biased model selection guided by omitting insignificant variables, we resort to using the extended RE for analysis.</td></tr>
<tr><td>Sensitivity Analysis</td><td colspan="2">Multiple explanatory variables were tested with different indicators. When percentage of population exposed to over 10 µg/m3 of PM2.5, the results see no appreciable change, which confirms that using population average exposure isn't hiding information regarding variance within countries.
Prevalence of alcohol disorder was tested to better indicate heavy drinking, the main risk factor with alcohol consumption, but results were once again not affected.
Using different measures of quality had some effect, but that is reasonable given the argument that 5-year cancer survival depends on much more than treatment quality, while 30-day post admission AMI mortality may be less representative of quality in general but will be more concrete.</td></tr>
<tr><td>OLS</td><td colspan="2">The results of the Pooled OLS are quite sensible, however it isn't efficient when there is unobserved heterogeneity with country fixed effect, which is the case here, so the results will not be analysed in detail.</td></tr>
</table>

Critical factors across Europe

We inspect how critical each factor is from two perspectives:

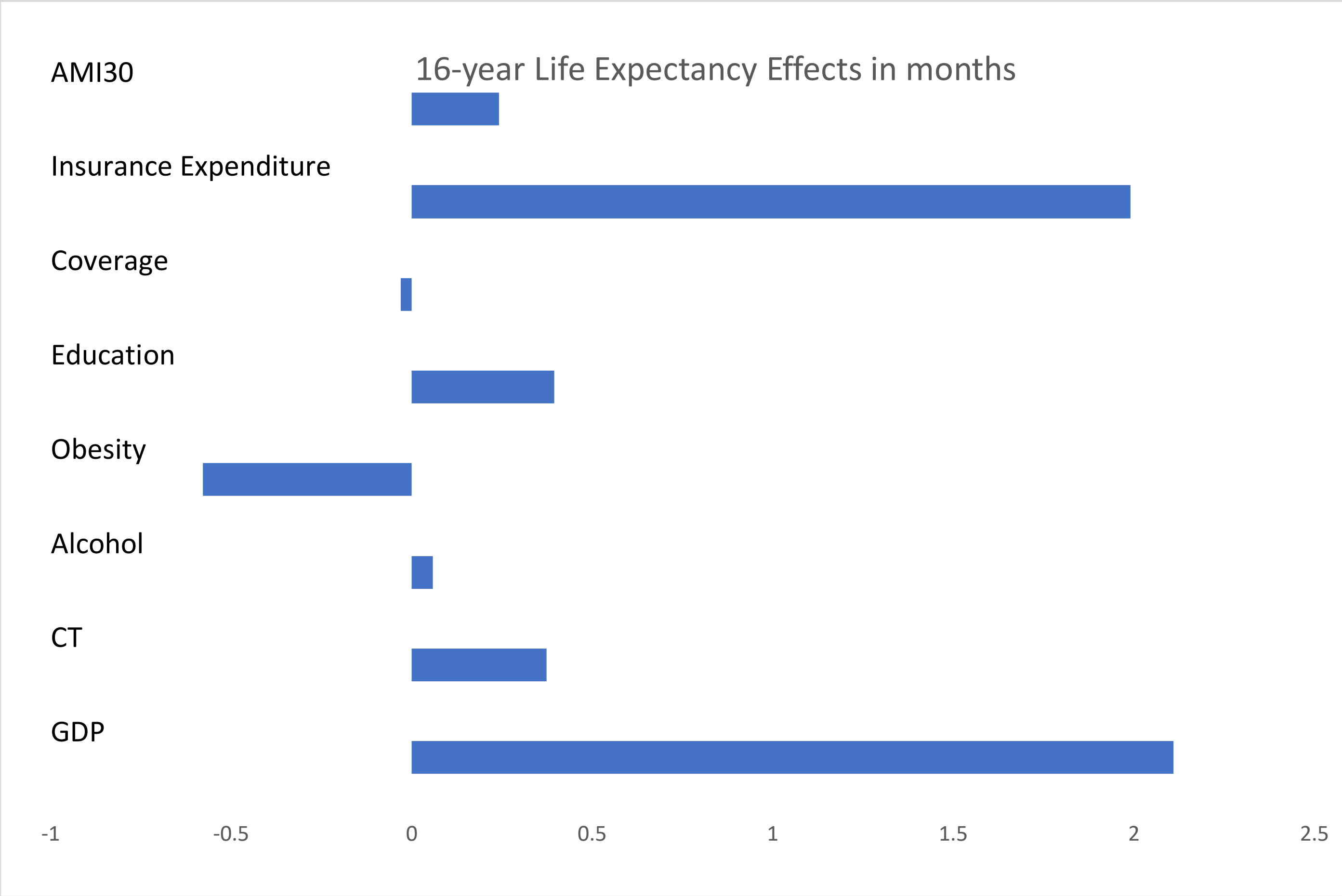
- The estimated impact a predefined change in the variable has on life expectancy
- How much the factors attributed to the change in life expectancy over 16-years

A 10% increase in alcohol consumption and 1 pp increase in obesity prevalence is predicted to lower life expectancy by about 1 month each, yielding very similar results to those in the literature (OECD, 2017). If GDP increases by 10%, life expectancy is predicted to increase by about 2.3 months, explained by the fact that people can purchase more nutritious food, have better living conditions and afford more out-of-pocket expenditure on healthcare. A percentage point increase in the percentage of population with tertiary education is associated with 1.1 months increase in life expectancy. Higher education level leads to better awareness about the health effects of different risk factors, as well as a more efficient use of medical care. Furthermore, combined insurance coverage by government and private schemes was found to be significant at 5%, with an increase of 10% leading to 3 months gain in life expectancy. Using CT scanners as proxy for physical resources suggests that more equipment leads to higher life expectancy, however the results were insignificant with a p-value of 1.1. Meanwhile, we find that expenditure on insurance is very significant with a predicted increase of 2.3 months upon a 10% increase, as well as that the CT scanners-to-expenditure ratio is decreasing while the fraction spent on insurance is increasing with total expenditure. Therefore, it could be argued that the high coefficient on expenditure in the literature is primarily driven not by more resources available but by an increasing extent of the welfare state as countries grow more affluent. Meanwhile, a 10% increase in the proxies for quality of care gives an expected life expectancy increase of 3.2 months and a decrease of 1.1 month for cancer survival- and AMI mortality rates respectively. Pollution is insignificant in our findings, which is likely to be because there is small variation in Europe: the average levels are at 11 μg/m3 while they are at around 100-200 μg/m3 in Asia with studies saying that every 10 unit increase in PM2.5 leads to a 6% increase in "risk of disease" (Song, 2017).

Our results on inequality are insignificant, which contradicts some studies, which posit that income inequality leads to health inequalities. A potential explanation is the close to 100% insurance coverage in the European region, and the welfare state effectively reaching the vulnerable parts of the population.

Further, we find that over the 16-year period between 2000 and 2016, GDP growth and higher insurance spending contributed most to improvements in longevity followed by higher levels of education, healthcare quality improvements and increased hospital equipment. The primary cause of life expectancy reductions was the increase in obesity prevalence, while alcohol consumption didn't change substantially over time.

Graph 1. LE over time



Cross-national variations

In order to establish each factor's contribution to cross-national variations, we examine for each country how their deviation from the European average affects their predicted life expectancy. Then we aggregate the results into one indicator by taking the sum of the squares.

The main sources of variation in the EU is from GDP. *The access* factor of expenditure on health insurance and rate of insurance coverage explain 36,7% of variation, but only 4 percent of that is coverage, while the Gini-coefficient has an insignificant coefficient, which overall leads to the conclusion that welfare states are extensive in EU countries and succeed in reaching the vulnerable parts of the population. Hence, the cross-country differences are stemming from different levels of support beyond basic provision. *Quality of care* is essentially understood to be the Total Factor Productivity of healthcare, which accounts for the improvements in life expectancy holding the amount of resources fixed. The indicator for quality of care, AMI30, explains around 6% of the variation, which is not a lot compared to GDP or expenditure but still is 20 percent of the remaining variation, a significant amount. *Risk factors of* alcohol consumption and obesity explain around 2% and 3% of variation.

Table 6. Cross-country variation

	GDP	InsuranceExp	CT	Alcohol	Obesity	Education	Coverage	AMI30
Coefficient	0,024	0,0244	0,00486	-0,098	-0,00149	0,00036	0,128	-0,012
Average (2016)	48723	3446,3	23,74	9,77	22,70	36,16	98,74	7,037
Austria	0,0038	0,0109	0,0010	-0,0023	0,0035	-0,0008	0,0006	-0,0007
Belgium	0,0014	0,0079	-0,0001	-0,0008	0,0008	0,0020	0,0001	-0,0007
Czech Republic	-0,0048	-0,0061	-0,0016	-0,0022	-0,0044	-0,0039	0,0006	0,0007
Denmark	0,0040	0,0086	0,0033	0,0006	0,0040	0,0016	0,0006	0,0055
Estonia	-0,0069	-0,0111	-0,0011	-0,0011	0,0020	0,0018	-0,0024	-0,0050
Finland	-0,0001	0,0035	0,0002	0,0016	0,0007	0,0035	0,0006	-0,0036
France	-0,0018	0,0090	-0,0013	-0,0027	0,0015	0,0002	0,0006	0,0019
Germany	0,0025	0,0133	0,0023	-0,0028	0,0005	-0,0022	0,0006	-0,0018
Greece	-0,0101	-0,0094	0,0021	0,0040	-0,0030	-0,0013	0,0006	
Hungary	-0,0095	-0,0109	-0,0030	-0,0013	-0,0050	-0,0038	-0,0019	
Ireland	0,0183	0,0063	-0,0009	-0,0012	-0,0035	0,0039	0,0006	0,0018
Italy	-0,0036	-0,0021	0,0022	0,0034	0,0037	-0,0125	0,0006	0,0027
Latvia	-0,0099	-0,0143	0,0032	-0,0013	-0,0012	-0,0058	0,0006	-0,0120
Lithuania	-0,0072	-0,0108	-0,0001	-0,0054	-0,0048	-0,0003	-0,0031	-0,0072
Luxembourg	0,0351	0,0098	-0,0014	-0,0027	0,0001	0,0020		-0,0015
Netherlands	0,0042	0,0107	-0,0021	0,0019	0,0031	0,0009	0,0006	0,0046
Norway	0,0094	0,0163		0,0048	-0,0006	0,0031	0,0006	0,0056
Poland	-0,0095	-0,0116	-0,0014	-0,0009	-0,0006	-0,0017	-0,0036	0,0044
Portugal	-0,0080	-0,0063	0,0000	-0,0009	0,0025	-0,0038	0,0006	-0,0026
Slovak Republic	-0,0089	-0,0096	-0,0013	-0,0005	0,0029	-0,0042	-0,0021	0,0010
Slovenia	-0,0057	-0,0061	-0,0018	-0,0022	0,0033	-0,0001	0,0006	0,0027
Spain	-0,0048	-0,0032	-0,0011	0,0019	-0,0015	0,0006	0,0006	-0,0012
Sweden	0,0022	0,0109	-0,0011	0,0033	0,0028	0,0026	0,0006	0,0047
United Kingdom	-0,0014	0,0020		0,0003	-0,0069	0,0040	0,0006	
Sum of squares	0,00244	0,00007	0,00015	0,00023	0,00018	0,00089	0,00029	0,00223
Ratio of total sum of squares	0,3545	0,3248	0,0099	0,0213	0,0339	0,0268	0,0420	0,0573

Policy Recommendations

We examine appropriate policy alternatives from the perspective of the European Council. It is worth stipulating that the Council has limited jurisdiction in the EU states, it can make recommendations, act as a facilitator in cooperation between countries and push its agenda using its budget. Furthermore, policy should aim to be feasible and efficient on a cost-benefit basis. On a European level, the priority should be on education and investing in further improvements in health technology. While education is a long-term investment, it has been shown to increase life expectancy by half as much as health expenditure, while it's still just an added benefit to a more educated and efficient workforce. The Council can subsidise building educational infrastructure, with a special focus on less developed regions to reduce cross-country inequalities. Subsidising the research of new health technology and facilitating collaboration further improves quality of care, which is a main driver of health improvements. Lifestyle factors of obesity and alcohol are more difficult to influence given the limited jurisdiction and political issues with interfering with everyday life. Public policy efforts seem to have been ineffective as there was little change in alcohol consumption, which leaves the EU with the possibility of raising tariffs on imported spirits to raise domestic prices, shifting demand to other alcohols. Obesity is arguably going to be the main health concern in the future given that obesity prevalence has been steadily increasing since the 1960s, however interventions in the foods people can consume are likely to be ideologically opposed, while investments on the physical activity front – building sports infrastructure – are costly and take more time to take effect. Nevertheless, more significant intervention is imminent to curb the obesity epidemic. To reduce cross-country differences, the most timely and cost-efficient approaches should involve equalization in quality of care by facilitating the share of best practices, and promoting movement of doctors, as well as subsidizing the broad implementation of technology – with the consideration that doctors need to have the skills and the time to make use of the provided resources.

Limitations

There are many limitations to the methodology used in this study, most importantly the low number of sample periods due to limited data availability on lagged variables as well as the missing observations in the dataset, despite averaging over longer periods. In addition, there were several instances of having to choose suboptimal explanatory or control variables due to informative, granular data – such as unmet healthcare needs or working conditions – only being collected in recent years. Endogeneity issues and omitted variables were also liable to introduce bias, weakening the findings. Lastly, many of the healthcare issues can only be truly understood and addressed on a micro-level as national aggregations cannot make use of some important information.

Conclusions

The results of this paper’s analysis are quite promising and largely in line with the literature. The main drivers of life expectancy gains are also the sources of cross-country inequalities: GDP and expenditure on insurance. It was concluded that insurance systems across the EU are extensive and effective in combating inequalities in access, by providing basic healthcare and more. On the other hand, obesity is a significant and growing concern as the main cause of reductions in life expectancy independent of national income. The conclusion is that sticking to the current path in ratio of health spending and GDP will continue to increase life expectancy, while the path of growing numbers of obesity needs to be broken.

Bibiliography

Backhouse et al. (1987) *International cross-section analysis of the determination of mortality*, Social Science & Medicine, Volume 25, Issue 5, 1987, Pages 427-441

Bichaka Fayissa & Paulos Gutema, 2008. *A Health Production Function for Sub-Saharan Africa (SSA)*, Working Papers 200808, Middle Tennessee State University, Department of Economics and Finance.

Cochrane AL, St Leger AS, Moore F. *Health service 'input' and mortality 'output' in developed countries*. J Epidemiol Community Health (1978). 1978;32(3):200-205.

Corrao G, Aricò S, Lepore R, et al. *Amount and duration of alcohol intake as risk factors of symptomatic liver cirrhosis: a case-control study*. J Clin Epidemiol. 1993;46(7):601-607.

Congbo Song, Jianjun He, Lin Wu, Taosheng Jin, Xi Chen, Ruipeng Li, Peipei Ren, Li Zhang, Hongjun Mao, 2017, *Health burden attributable to ambient PM2.5 in China*, Environmental Pollution, Volume 223

Grossman M., (1972), *On the Concept of Health Capital and the Demand for Health*, Journal of Political Economy, 80, (2), 223-55

Jessica Allen, Reuben Balfour, Ruth Bell & Michael Marmot (2014) *Social determinants of mental health*, International Review of Psychiatry, 26:4, 392-407,

Joumard, I., et al. (2008*), Health Status Determinants: Lifestyle, Environment, Health Care Resources and Efficiency*, OECD Economics Department Working Papers, No. 627, OECD Publishing, Paris,

Khuder SA. *Effect of cigarette smoking on major histological types of lung cancer: a meta-analysis. Lung Cancer*. 2001

Lim, Stephen S et al. *A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010.* Lancet (London, England) vol. 380,9859 (2012): 2224-60.

Mackenbach JP, Stirbu I, Roskam AJ, et al. *Socioeconomic inequalities in health in 22 European countries* [published correction appears in N Engl J Med. 2008 Sep 18;359(12):e14]. N Engl J Med. 2008

OECD (2017), *What has driven life expectancy gains in recent decades? A cross-country analysis of OECD member states*, in Health at a Glance 2017: OECD Indicators, OECD Publishing, Paris,

Shaw, J., Horrace, W., & Vogel, R. (2005). *The Determinants of Life Expectancy: An Analysis of the OECD Health Data*. Southern Economic Journal, 71(4), 768-783.

Song L, Lin N. *Social capital and health inequality: evidence from Taiwan*. J Health Soc Behav. 2009;50(2):149-163.

Taylor, Lauren A et al. *Leveraging the Social Determinants of Health: What Works?*. PloS one vol. 11,8 e0160217. 17 Aug. 2016

Thornton, J. (2002) *Estimating a health production function for the US: some new evidence*, Applied Economics, 34:1, 59-62,

Wilkinson, Richard G, Marmot, Michael, World Health Organization. *Social determinants of health : the solid facts,* Regional Office for Europe, WHO Centre for Urban Health (Europe) & International Centre for Health and Society. (1998).