HUMAN CAPITAL IN THE EUROZONE: AN ESTIMATION OF THE HEALTH LEVELS

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Abstract

The concept of human capital is directly related to human development. In the United Nations' current approach, the Human Development Index (HDI) is used for the estimation of the differences existing among different countries. Thus, human capital is in the end measured by health, education and the quality of standard of living. However, health is not measured adequately by HDI: it was found in previous studies that life expectancy (LE) measures cannot not accurately represent the health of the population because as LE increases the same may happen with the healthy years lost due to diseases and disabilities. Therefore, a simple procedure is proposed and used here for the evaluation of health levels in order to serve positively for the estimation of the real human development of a population. This procedure will be applied as an example in the Eurozone countries. The scope is to measure the number of healthy years lost because of diseases and disabilities in the populations studied and consequently healthy life expectancy at birth. Results indicate that significant differences in health levels exist among the populations studied and thus in the first component of their human capital.

Keywords: Health, life tables, eurozone

JEL Code: J18, E24, H75

Introduction

The concept of human capital emerges from the work of Adam Smith in his famous book entitled the "*An Inquiry into the Nature and Causes of the Wealth of Nations"* (1977, 1776). In modern neoclassical economic literature, the term dates back to the work of Jacob Mincer (1958). Afterwards, the term was used extensively by numerous scholars which emphasized its importance in economy and thus in societies (see for example Becker (1962; 1993) and more recently Hanushek and Ludger (2008), Rindermann (2008) etc.), however, not without criticism (see Bowles and Gintis (1975).

In the same frame it was recognized by the United Nations that *"people and their capabilities should be the ultimate criteria for assessing the development of a country"*. For that the human development index was created. This index is a combination of life expectancy, education and income indices (see http://hdr.undp.org/en/content/human-development-index-hdi). However, considering that human capital is in the end measured by health, education and the quality of standard of living, health is not measured adequately by HDI: it was found in previous studies that life expectancy (LE) measures cannot not accurately represent the health of the population because as LE increases the same may happen with the healthy years lost due to diseases and disabilities (see for example Skiadas and Zafeiris 2015).

Therefore, a simple procedure is proposed and used here for the evaluation of health levels in order to serve positively for the estimation of the real health levels of a population. This procedure will be applied as an example in the Eurozone countries. It must be stressed that the estimation of the health levels of a population is an effort that dates back to the work of Sanders (1964) and Chiang (1965).

One of the more recent approaches is that of the World Health Organization (http://www.who.int/gho/mortality_burden_disease/life_tables/ha-le/en/) in which data from the Global Burden of Disease Study are combined with life table calculations in order for the health years lost because of diseases and disabilities to be estimated (see also Murray et al., 2016). However, such works, besides their complexity are time consuming and money demanding. Therefore, a parsimonious method is proposed here which gives equivalent results with that of WHO without the need for expending time and money. In this method only life table data will be used.

1 Methods

Data come from the Eurostat database and refers to the population of the Eurozone countries for year 2016. The analysis will be carried out separately for each gender. The life tables of the populations studied were calculated with conventional methods (see Preston et al., 2001).

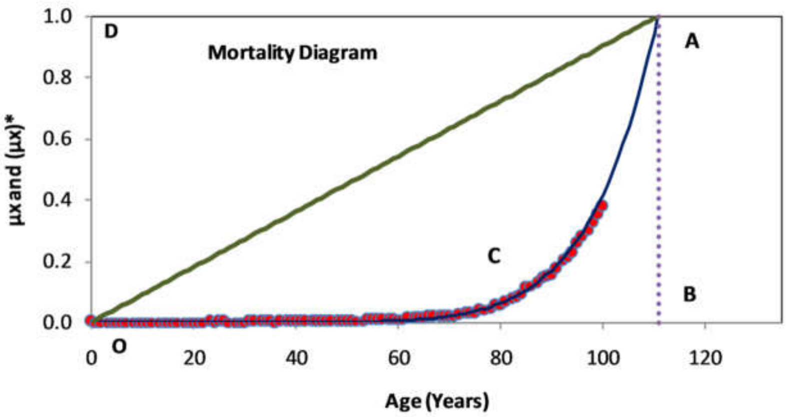
The estimation of healthy years lost because of disabilities and diseases are based on Skiadas and Skiadas (2016). The procedure is briefly described below.

If μ_x is the force of mortality in age x, then it comes that:

$$\mu_x = \left(\frac{x}{T}\right)^b$$

where T is the age at which μ_x=1 and b is a parameter expressing the curvature of μ_x.

Fig. 1: The mortality diagram used in the μ_x based method.



The main task is to calculate the healthy life years as a fraction of surfaces in a mortality diagram (see Figure 1). This idea, which originates from the First Exit Time Theory and the Health State Function approach (See Skiadas, 2012), is to estimate the area E_x under the curve OCABO:

$$E_x = \int_0^T \left(\frac{x}{T}\right)^b d_x = \frac{T}{(b+1)}\left(\frac{x}{T}\right)^b$$

where $d_x$represents the life table's death distribution. The resulting value for E_x in the interval [0, T] is given by:

$$E_{mortality} = \frac{T}{(b+1)}$$

It is also clear that the total area E_{total} for the healthy and mortality part of the life is the area included in the rectangle of length T *a*nd height 1, thus $E_{Total}=T$. Then, the healthy area is given by:

$$E_{healthy} = T - E_{mortality} = T - \frac{T}{(b+1)} = \frac{bT}{(b+1)}$$

Obviously:

$$\frac{E_{health}}{E_{mortality}} = b$$

and

$$\frac{E_{total}}{E_{mortality}} = b + 1$$

These two indicators can describe the health status of the population, the second one being compatible with the severe and moderate causes indicator of the health state approach and thus it can be used as an estimator of the loss of healthy life years (LHLY) in the form of:

$$LHLY = \lambda\,(b+1)$$

where λa correction multiplier, which for multiple comparisons can be set to be one year. In that way similar results with the World Health Organization approach are found.

Four ways for the estimation of b have been developed. In the direct estimation, without applying any model, the calculations can be done either on the mortality (m_x) curve or the probability of death curve (q_x). Then we have concerning the m_x curve:

$$b+1 = \frac{E_{total}}{E_{mortality}} = \frac{xm_x}{\sum_0^x m_x}$$

and

$$b = \frac{E_{health}}{E_{mortality}} = \frac{xm_x - \sum_0^x m_x}{\sum_0^x m_x} = \frac{xm_x}{\sum_0^x m_x} - 1$$

Concerning the q_x curve we have:

$$b+1 = \frac{E_{total}}{E_{mortality}} = \frac{xq_x}{\sum_0^x q_x}$$

$$b = \frac{E_{health}}{E_{mortality}} = \frac{xq_x}{\sum_0^x q_x} - 1$$

Afterwards, a Gompertz model was applied on the probability density functionin the form:

$$f_x = e^{-k+bx-e^{-l+bx}}$$

where x is the age and the other letters on the right of the equation above (except e) are parameters. The parameter expressing the loss of healthy life years is *l*. This is also demonstrated by observing the cumulative distribution function of the form:

$$F_x = e^{-e^{-l+bx}}$$

the relevant survival function is:

$$S_x = 1 - e^{-e^{-l+bx}}$$

the probability density function is:

$$f_x = be^{-l+bx} - e^{-e^{-l+bx}}$$

and the hazard function is:

$$h(x) = \frac{f_x}{F_x} = e^{-k+bx}$$

Finally, the Weibull model was used. This model has a probability density function (b and T are parameters) in the form:

$$f_x = \frac{b}{T}\left(\frac{x}{T}\right)^{b-1} e^{\left(\frac{x}{T}\right)^b}$$

the hazard function is:

$$h_x = \frac{b}{T}\left(\frac{x}{T}\right)^{b-1}$$

and the cumulative hazard is given by:

$$H_x = \left(\frac{x}{T}\right)^b$$

which is precisely the form for the single mode presented earlier. The parameter b expresses the healthy life years lost.

Obviously, the four ways developed for the calculation of healthy years lost gave different results. Thus, it was chosen to present the results as the average of the four methods.

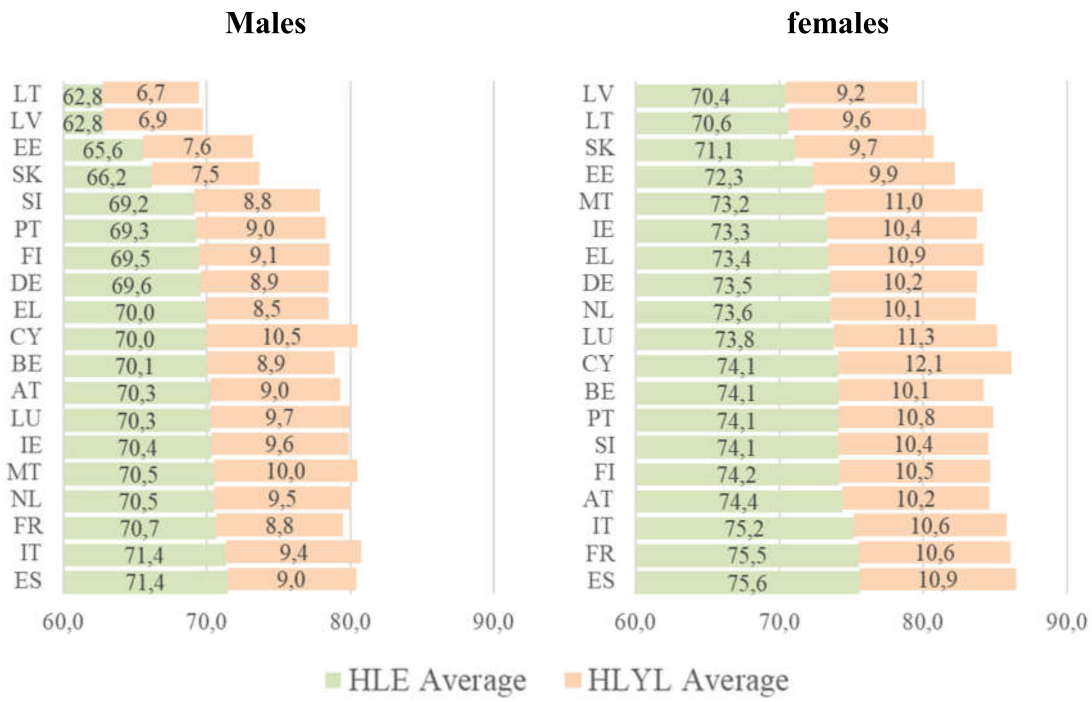
2 Results

The results of the analysis are seen in Figure 2, in which healthy life expectancy (HLE) and the years lost because of diseases and disabilities (HLYL average) are seen. Life expectancy at birth is calculated as the sum of these two components, but it is not cited in this figure. Countries are sorted according to healthy life expectancy for comparative reasons.

A first conclusion drawn from figure 2 is that males, besides living a shorter life than females, also lose fewer healthy years. In other words, the general trend recorded among the two genders is that the number of healthy years lost depends on the longevity. If people live longer, then they tend, on average, to spend more time with burdened health. Thus, females live longer lives than males but at the same time they spend more years in poor health for more years.

A similar conclusion is drawn by comparing the results among the countries separately for each gender. People from the higher longevity countries tend to spend more time with burdened health. This finding is not taken into consideration when studying the development of a population with the Human Development or other indices or concerning the pension, medical care and social protection systems. Thus, social cohesion will be enhanced if this is taken into consideration in the developed strategies and interventions in a population.

Fig. 2: Healthy life expectancy (HLE) and Healthy Years Lost because of diseases and disabilities (HLYL average) in the Eurozone countries. 2016.



Index of the countries: Lithuania, LT; Latvia, LV; Estonia, EE; Slovakia, SK; Slovenia, Sl; Portugal, PT; Finland, FI; Germany, De; Greece, EL; Cyprus, CY; Belgium, BE; Austria, AT; Luxembourg, LU; Ireland, IE; Malta, MT; Netherlands, NL; France, FR; Italy, IT; Spain, ES.

A second conclusion which can be drawn from picture 2 is that the Eurozone is of course a monetary union, but many things must be done in order to promote and enhance its social integration. The differences in life expectancy at birth and healthy life expectancy among the Eurozone countries in both genders are significant and, at their core, represent social inequalities and developmental disparities.

Thus, the democracies of the former Soviet Union along with Slovakia (Lithuania, LT; Latvia, LV; Estonia, EE; Slovakia, SK) are the less benefited countries if the criterion of socio-economic development will be taken into consideration. In males, these countries are followed by Slovenia (Sl), Portugal (PT) Finland (FI) and Germany (DE) in which healthy life expectancy is about 69 years. At the other edge is Italy (IT) and Spain (ES) in which healthy life expectancy is more than 71 years.

However, the observed variability is high and the range between the minimum and the maximum value of healthy life expectancy is 8.7 years. The variability is also significant in females; however, it is limited to 5.1 years. The ranking of the countries bears some similarities with that of males, though many differences exist (see for example the position of Malta, MT; and Austria, AT).

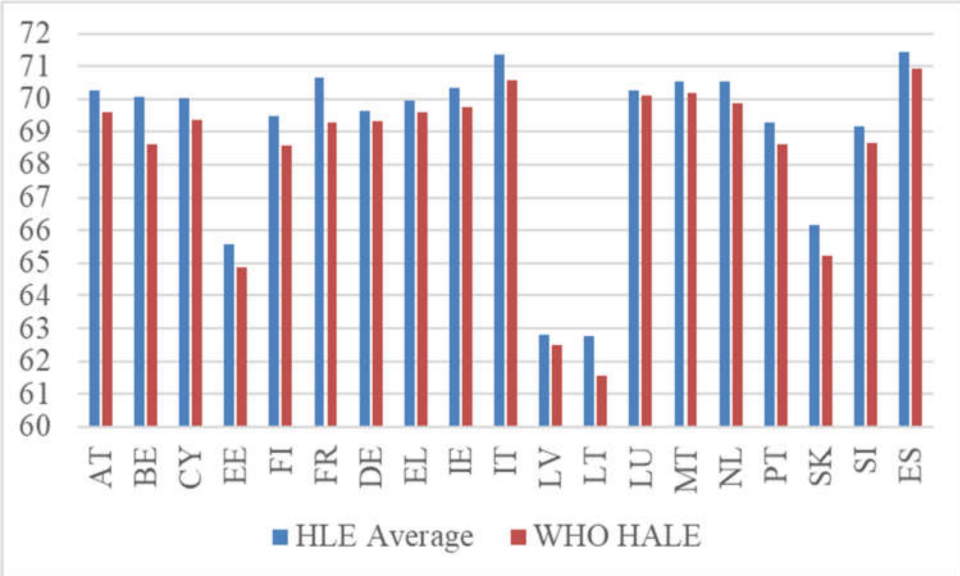
Overall, it is very difficult to find any spatial pattern for these differences. Local agents, like political, economic and social development seem to have played an important role. Also, because these measurements are based on one-year data, there is a possibility that year by year fluctuations may have occurred which scrutinize the observed situation.

The final thing that needs clarification deals with the efficiency of the method used here for the estimation of healthy life expectancy. Thus, the results were compared against those published by Murray et al. (2016), which are actually based on the methodology of the World Health Organization. Unfortunately, these published results refer to the year 2015 but even in that case no significant changes are expected to be found concerning health levels in the Eurozone countries.

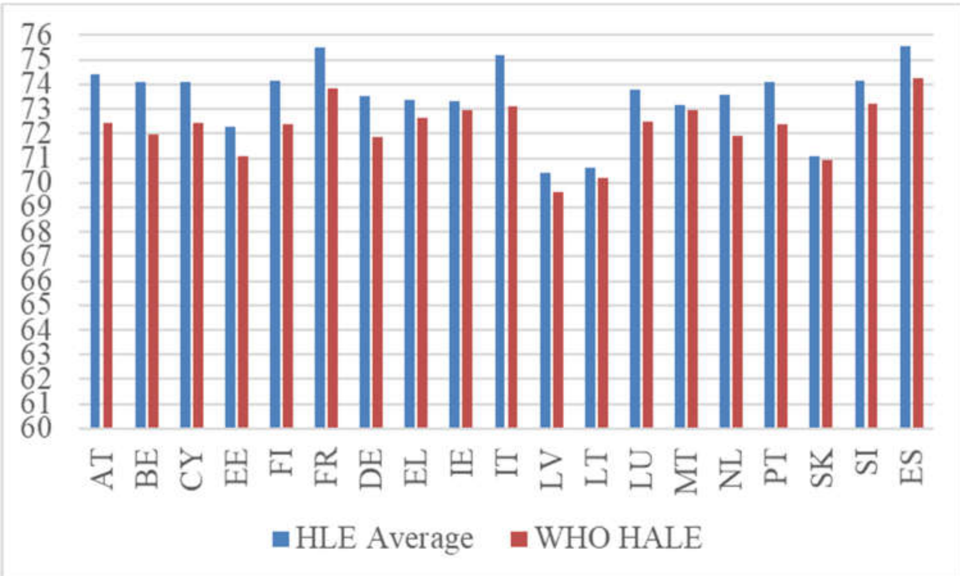
In Figure 3 it is seen that the two methods give quite similar results especially in males where in the majority of cases the differences are less than 1 year and only in a few cases greater. These differences are very small considering the different procedures that were applied to both methods for the estimations and the fact that Murray's estimations refer to the year 2015. Besides that, these differences are not only related with the estimation of Healthy Life Expectancy, but also deal with the method applied for the calculation of life tables. In females, the differences between the two methods are greater though at an acceptable level. Also, the general trend existing among the countries studied are clearly described adequately by the two methods. However, a question emerges, which needs further examination, concerning the reasons for the somewhat greater differences in comparison to males from the application of the two methods.

Fig. 3: Healthy life expectancy (HLE) estimated by the current method and Healthy adjusted life expectancy according to Murray et. Al. (2016).

males



females



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Conclusion

The use of life expectancy at birth as a component of the human development index (HDI)in order to measure health and development levels and thus the human capital which exists in a population in a sense is problematic. This is because (HDI) doesn't take into consideration that in the populations with higher longevity people spend more time with burdened health than in the others with lower longevity. In fact, healthy life expectancy is always lower than life expectancy at birth. All these must be taken into consideration for the effective planning of social policies and interventions and the development of more effective indices.

In order to serve this effort, we proposed and applied a parsimonious method here, which is based only on life table data in order to calculate the healthy life expectancy of a population. Because of the need of data that can easily be found and used, this method is less time demanding and cost free than the other methods used so far. It also can be used for historical analyses or in population projections very easily.

As for the paradigm used here for the demonstration of this method it is seen that even though the Eurozone exists as a monetary union, the differences found among its countries are indicative of the need for effective social and economic integration policies. This is in fact the only way to blunt the differences among the people living in the European continent.

References

Becker, G. S. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education* (3rd ed.). University of Chicago Press, 1993

Becker, G. S. Investment in Human Capital – a theoretical analysis. *The Journal of Political Economy.* 70 (5): 9–49, 1962. *doi:10.1086/258724.*

Bowles S., Gintis, H. The problem with Human Capital Theory – A Marxian critique. *American Economic Review*, 65(2), pp. 74–82, 1975

Chiang,C. L. An Index of Health: Mathematical Models, U.S. Department of HEW, Public Health Service, Publication No. lCXK). Series 2, No. 5, 1965.

Hanushek, E., Woessmann, L. The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature,* 46 (3): 607–668, 2008 doi:10.1257/jel.46.3.607

Mincer, J. *Studies in Human Capital. Investment in Human Capital and Personal Income Distribution".* Edward Elgar Publishing, 1993.

Murray, C. Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*, 388: 1603-1658, 2016

Preston,H., Heuveline P., Guillot, M. Demography. Measuring and Modeling Population Processes. Blackwell Publishers, Oxford, 2001.

Rindermann, H. Relevance of education and intelligence at the national level for the economic

welfare of people. *Intelligence,* 36 (2): 127–142, 2008. doi:10.1016/j.intell.2007.02.002.
Sanders,B. S. Measuring Community Health Levels. *American Journal of Public Health,* 54: 1063-1070, 1964.
Skiadas, C. H. and Zafeiris, K. N. Population aging and healthy life: lessons from the related studies. Proceedings of the conference: REPRODUCTION OF HUMAN CAPITAL(mutual links and connections) Praha: Vysokáškolaekonomická v Praze, NakladatelstvíOeconomica, 2015
Skiadas, C. H., Skiadas, C. *Estimating the Healthy Life Expectancy from the Health State Function of a Population in Connection to the Life Expectancy at Birth*. In The Health State function of a population. (Skiadas, C. H. and Skiadas, C., eds). 1st ed. Athens, 97-109, 2012.
Skiadas, C. H., Skiadas, C. *The Health-Mortality Approach in Estimating the Healthy Life Years Lost Compared to the Global Burden of Disease Studies and Applications in World, USA and Japan.* In: Exploring the Health State of a Population by Dynamic Modeling Methods. Springer, (Skiadas, C. H. and Skiadas, C., eds). p.p. 67-124, 2016
Smith, A. *An Inquiry into the Nature and Causes of the Wealth of Nations*. University of Chicago Press, 1977, 1776.

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