LIVING LONGER. WORKING LONGER?
Life Expectancy and Retirement Age Trends in OECD Countries

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ABSTRACT

Mortality trends in aging societies have become one of the most important economic and political considerations. Significant growth in life expectancy of the last 20 years did not result considerable changes in pension systems of most countries, longevity trends are not followed by increasing official retirement ages. Controversial tendencies lay down major challenges to societies: on state level it has high importance to create a *sustainable pension system*, and on individual level the well-grounded *personal/family life-long financial stability* is a key issue for well-being.

The employment period, i.e., the active working time depends on – among other factors – the official retirement age. Despite the rise of longevity, the effective retirement age in most countries does not increase in the same pace. We have analyzed 20 years data of 35 OECD member countries, applied linear factor models on the life expectancy at birth and at age 65 for both male and female population, and compared the age-gain (defined as the difference between the two life expectancies) with effective retirement age. This factor model fits statistically well, however life factor and retirement factor form orthogonal axis, meaning we could not find correlation between longer life expectancy and retirement age. Using hierarchical and k-means clustering, we conclude the longevity and retirement age does not move parallel in these countries, we can find all combination of lower and higher life expectancies and exit-ages.

INTRODUCTION

In our study, we examined whether the increasing trends of male and female life expectancy in OECD countries has been followed by significant retirement age growth in the past twenty years. This question is of particular relevance in aging countries as the vast majority of pension systems are under extreme financial pressure because of the increasing number of retired years lived.

LIFE EXPECTANCY TRENDS

Life expectancy in OECD countries increases constantly during the last decades, but difference between developed and emerging countries have significantly narrowed (Raleigh, 2019). However, some of these countries already face a slowdown in life expectancy increase since 2011, it might not be assessed whether it is a temporary slowdown or a permanent change in trends. Dowd et al. (2010) projected a strong upward sloping trend in life expectancy for the next years, moreover they were not discussing potential changes in trend. Mortality improvements are examined by numerous experts, as well and nowadays there are two mainstream view: (i) the "pessimists" (Olshansky et al. (2001), Olshansky et al. (2005), Ridsdale (2010)) say the life expectancy increase is limited by health factors such as obesity, diseases of older age, or cardiovascular diseases, etc.; (ii) on the other side the "optimists" (Christensen et al. (2009), Vaupel (2002)) indicate there might not be any natural barrier of life expectancy improvements thus most of people born in 21st century would celebrate their 100th birthday. Both views indicate urgent and necessary actions to be taken either in health care or in pension by the social welfare systems of OECD countries.

In OECD countries the life expectancy at age 65 increased with 3 years in average in the last 20 years, meaning the total retired period lived by a man from an OECD country is 18 years, and 21 years lived by a woman. This improvement puts an extra 15-20% burden on pension liabilities. Stevens (2017) investigates full retirement age policies, where the exit-age is dependent on survival probabilities. Bernd et al. (2013) lists numerous policy options to improve the quality of old-age period for retirees, not only health-care related but also work and pension arrangements.

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DATA AND METHODOLOGY

Our study was examining the changes in life expectancy, as well as the correlation between the effective retirement age (exit-age) and increasing life expectancy, involving 35 OECD countries with their 20 years of data. Between 1996 and 2005, data of 34 OECD countries were examined, and Latvia was added to the database from 2006, since we had limited access to the reliable economic data of the country before its join to the OECD. All life expectancy and retirement data were analyzed both on the countries' female and male population.

To explain the changes, life expectancy variables and economic indicators (GDP, GNP, employment, education) were included in our models, however none of the economic variables showed significant correlation with the longevity variables. Considering the low correlations with economic factors, we only included in our final linear factor model the life expectancy and the effective retirement age variables, each separately for male and female. I.e. the eight variables in our final factor model (all for male/female) are: life expectancy at birth and 65, age-gain, and effective retirement age.

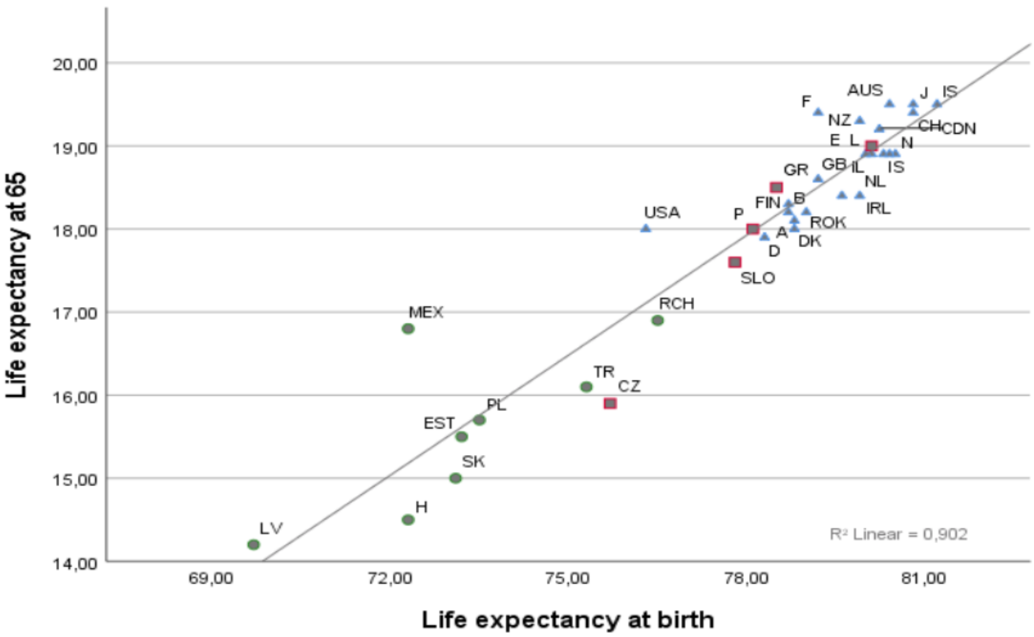
We used factor analysis which is a multidimensional statistical method excellent to explore latent relations derived from the original variables. From the numerous methods of factor analysis, we applied Principal Component Analysis (PCA) for factor extraction, where the uncorrelated linear combination of variables is calculated based on eigenvalue-eigenvector decomposition of correlation matrix (R) of the original variables included in the model.

We also used clustering to identify homogenous groups of countries based on their life expectancy and retirement age variables. The aim of clustering is to form groups where the within group variance in minimal, however the between group variance is maximized. We used agglomerative hierarchical clustering as an explorative method and k-means clustering as confirmatory analysis.

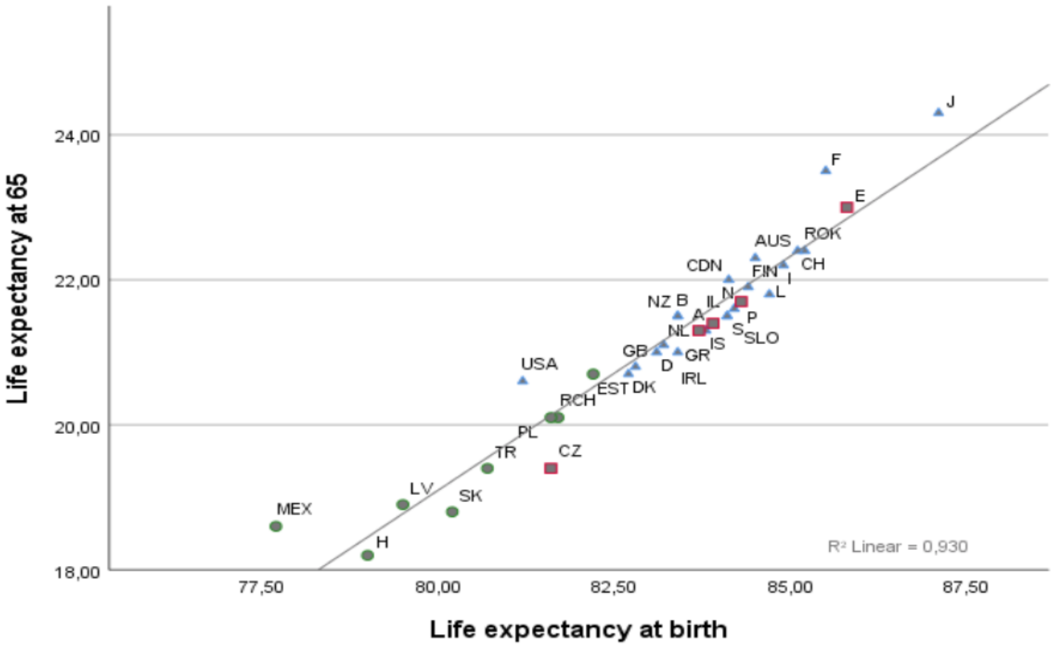
LIFE EXPECTANCY AT DIFFERENT AGES

Life expectancy at birth and at age 65 are the most often analyzed longevity variables. The age 65 is highly important (Kovács, 2012/b), since the official retirement age in most OECD countries is around 65, female effective retirement age (exit-age) is slightly lower. Figures 1 and 2 illustrate the relationship between life expectancy at birth and age 65.

Considering male population of Hungary, the life expectancy at birth was 72.3 years in 2015, furthermore men alive at the age of 65 is expected to live another 14.5 years. Considering the Hungarian female population, life expectancy at birth (79 years) is about 7 years higher than men's rate, however surplus of female life expectancy at 65 is less than 4 years. With these figures, Hungary is one of the lowest life expectancy OECD countries. Italy and the South-European countries have significantly higher life expectancy for all sexes.



Figures 1: Life expectancy at birth and 65 (male, 2015)



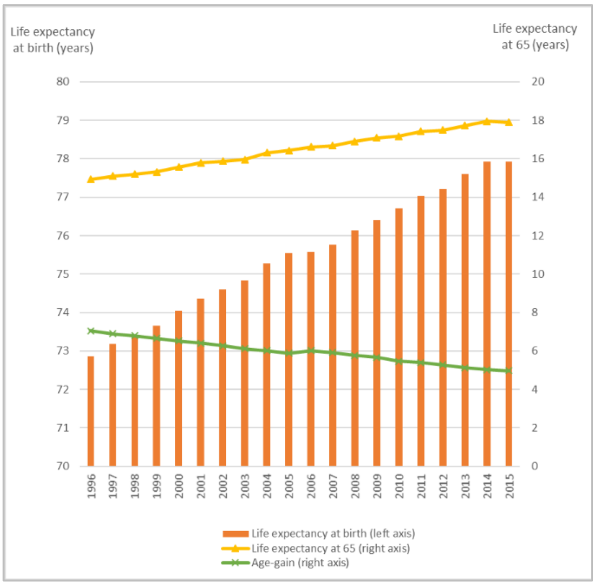
Figures 2: Life expectancy at birth and 65 (female, 2015)

Figure 2 also shows that in 2015, Hungary and Mexico had the lowest female life expectancy at birth, while Hungarian women at the age of 65 live the lowest expected years among all the 35 countries surveyed. At the other end of the line are Japanese women, whose both life expectancy indicators are far beyond other OECD countries. However, Japanese male do not exceed significantly other developed countries, on Figure 1 we see that male life expectancy is more concentrated in the upper end of the line. It is also important to point out that among the southern European countries, Spanish women significantly live longer than those in countries of similar development and culture.

However, life expectancy is constantly increasing in all OECD countries thus mortality is improving significantly, the age-gain (Kovács, 2012/a) shrinks. We define age-gain as the difference between male and female life expectancy at the age of 65 and at birth:

$$Age\ gain = 65 + life\ exp\ at\ 65 - \ life\ exp\ at\ birth$$

Figure 3 shows the male life expectancy trends and age-gain for two decades in the average of OECD countries.



Figures 3: Life expectancy and age-gain trends (male, OECD average)

Life expectancy at birth (male) increased by more than 5 years in the 20 years studied, while life expectancy at 65 increased by only 3 years, as a result of which the age-gain fell from 7 to 5 years. In Hungary, life expectancy figures are far behind, and nowadays, the gap with OECD average is slowly closed up. Due to this slow catch-up, the Hungarian age-gain was still 2.23 years higher in 2015 than the OECD average.

AGE-GAIN AND EXIT-AGE

Table 1 shows descriptive statistics for male life expectancy variables in OECD countries. We see that the average male life expectancy at birth has risen by more than 5 years (up to 77.92) in the last 20 years, furthermore average life expectancy at 65 has increased on average by app. 3 years (to 17.89 years). The female life expectancy indicators, however show different levels of growth, life expectancy at birth was extended by about 4 years up to 83.16 years, and life expectancy at 65 rose by 2.5 years up to 21.14 years.

Table 1: Descriptive statistics
of life expectancy variables

data in years			Mean	Median	Std.	Min	Max
Life exp at birth	*Male*	1996	72.87	73.65	3.14	64.20	77.00
		2006	75.59	76.90	3.57	65.00	79.50
		2015	77.92	78.80	2.98	69.70	81.20
	Female	1996	79.42	80.05	2.46	71.80	83.60
		2006	81.56	82.20	2.42	75.60	85.80
		2015	83.16	83.70	2.02	77.70	87.10
Life exp at 65	*Male*	1996	14.92	14.95	1.32	12.20	16.90
		2006	16.60	17.00	1.67	12.50	18.50
		2015	17.89	18.30	1.51	14.20	19.50
	Female	1996	18.61	18.85	1.49	14.80	21.50
		2006	20.07	20.40	1.61	15.70	23.40
		2015	21.14	21.30	1.35	18.20	24.30
Age gain	*Male*	1996	7.06	6.35	2.11	4.50	13.00
		2006	6.02	5.20	2.06	3.90	12.50
		2015	4.97	4.40	1.61	3.30	9.50
	Female	1996	4.18	3.75	1.19	2.90	8.00
		2006	3.51	3.20	0.98	2.50	6.70
		2015	2.98	2.80	0.80	2.10	5.90

Age-gain shrinks in both male and female population of OECD countries because of different pace of life expectancy increase in various ages, as discussed in previous section.

Data in Table 2 show, in spite of the significant increase in life expectancy, the change in the effective retirement age (exit-age) in all OECD countries is significantly lower than the life expectancy growth trends.

Table 2: Descriptive statistics of Exit-age

data in years			Mean	Median	Std.	Min	Max
Exit age	*Male*	1996	63.26	62.44	3.60	57.94	72.05
		2006	63.61	63.40	3.80	58.48	74.59
		2015	64.70	63.70	3.37	59.48	72.22
	Female	1996	61.50	60.67	3.85	55.47	73.69
		2006	62.29	62.19	3.63	55.14	74.27
		2015	63.32	62.96	3.18	59.21	71.89

The average OECD male life expectancy at 65 increased by 3 years between 1996 and 2015, while the effective retirement age (exit-age) rose only by 1.5 years. However, the correlation between female longevity indicators and exit-age is more significant, i.e. the 2.5 years increase of life expectancy at 65 is followed by a rise of 1.82 years in exit-age.

To prove the a priori low correlation between life expectancy indicators and exit-age variables, a linear factor model was created with Principal Component Analysis. With the development of independent components, we sought to find out the relationship between the different life expectancy variables and the exit-age. In our factor model, two orthogonal, uncorrelated components were extracted from the 8 original variables, with an extraction of 89% to 90.75% of original eigenvalues in each year. The

Factor 1 is the life-factor, comprising of 6 life expectancy variables, while Factor 2 is the retirement factor, built up from 2 exit-age variables.

The first component compresses the life expectancy variables, while the second component contains only the retirement age variables. We found that the two factors are uncorrelated, which confirms our prior assumption that the exit-age of the population in most OECD countries would not be adjusted to the longer life expectancy. Figures 4 shows the countries in the space of the two independent components:

Figures 4: OECD countries in factor space (2015)

In developed countries, the average Life factor is usually associated with an average Retirement factor. South Korea (ROK) seems to be an outlier country, with the highest Retirement factor.

Emerging countries, without exception, have a lower Life factor with diverse values of Retirement factor. Mexico is far from the rest of the OECD countries in the factor space, with its low Life factor but with almost the highest Retirement factor.

CLUSTER ANALYSIS

Based on the 8 variables included in our factor model, we ran agglomerative hierarchical and also k-means clustering on the 35 countries (with the most recent data of year 2015). As distance measure of hierarchical cluster analysis we used squared Euclidean distance:

$$d_{ik}^2 = \sum_j \left(x_{ij} - x_{kj}\right)^2$$

The applied clustering method was Ward's method where clusters are created in a way to minimize the within group variance. However, F-test for k-means clustering should be used only for descriptive purposes since we form the clusters to maximize the between groups variance, the ANOVA shows all the variables included are significant on all possible significance levels.

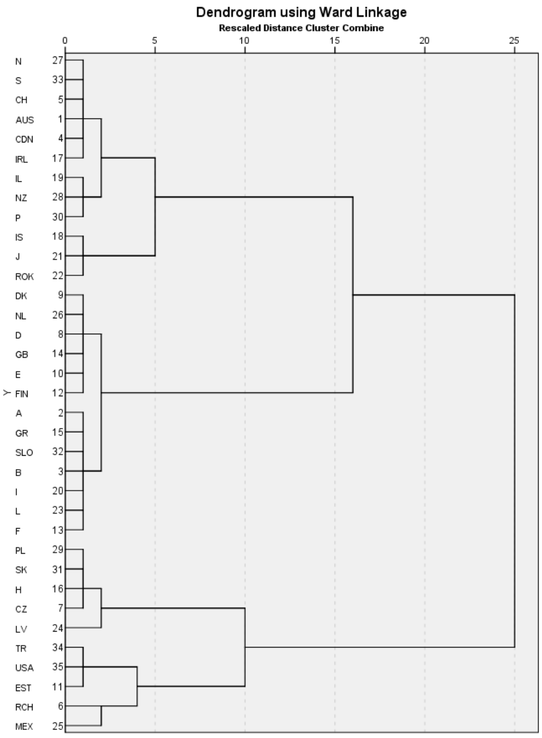
Our findings resulted in 4 well-distinct clusters shown in Table 3.

Table 3: Final cluster centers (2015)

Mean (data in years)		Cluster 1	Cluster 2	Cluster 3	Cluster 4
Members of cluster		12	13	5	5
Male	Life exp at birth	80.09	79.1	72.86	74.72
	Life exp at 65	18.97	18.45	15.06	16.66
	Exit age	67.37	62.07	62.26	67.59
Female	Life exp at birth	84.44	83.98	80.38	80.70
	Life exp at 65	21.96	21.65	19.08	19.80
	Exit age	65.79	61.13	60.13	66.26

1. The first cluster includes 12 countries where male and female life expectancies are all high and the exit-age is in line with the high longevity (eg Israel, Japan, Sweden). We named this cluster as: "*hobby workers*".
2. There are 13 countries in the second cluster, where life expectancy is very high, although the exit-age for men is 5 years, and for women 4.5 years below the average of the first cluster (eg Austria, Spain, France). This cluster might be named as "*lazy guys*".
3. The third cluster brings together the countries with the lowest life expectancy, where the exit-age is also low (eg. Hungary, Latvia, Slovakia). Obviously this is the "*Eastern block*".
4. The fourth cluster comprises of 5 countries, with a low life expectancy, but with a high exit-age (eg USA, Mexico, Estonia, Turkey). These countries are the "*workaholics*".

We also include dendrogram of the hierarchical clustering (Figure 5) which shows the combination of each countries. Between distance 5 and 10 four clusters are formed.



Figures 5: Dendrogram of hierarchical cluster analysis (2015)

Based on our clustering results, we state that due to the economic development and social characteristics of each country, we have found examples of all combination of lower and higher values of life expectancy and retirement age variables.

CONCLUSIONS

In our study, we examined the life expectancy and the effective retirement age (exit-age) of the 35 OECD countries. With a linear factor model, we discovered that in the last 20 years (from 1996 to 2015) *there was no significant correlation between the examined life expectancy and the retirement age*. With the clustering of countries, we found only a few countries where the retirement age adjusts to higher life expectancy.

The seemingly unstoppable growth in human life expectancy, coupled with the current state of health and social services, has led to a remarkable rise in longevity in all OECD countries, as well as other developed countries on Earth. While this may be heralded as great news for mankind, it nevertheless lays down a major challenge to societies. The retired population lives significantly longer than in the past. This trend has two main implications:

1. on state level it has high importance to create a *sustainable pension system*, and
2. on individual level the well-grounded *personal/family life-long financial stability* is a key issue for well-being.

As further research question, it might be examined whether the pensions paid or the disability free life expectancy affect our models and what other well-being variables can be successfully integrated into the models. It might improve the accuracy of our models, therefore we intend to include in our calculations the employment rates (Gál-Radó, 2018) and the effect of aging due to low fertility rates (Németh, 2016).

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