LIFETIME EARNINGS AND LIFE EXPECTANCY

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Abstract

In this paper we test hypothesis that wealthier individuals live longer. Using a large micro data base of current and former retired participants covering years 2005 – 2016 from the Social Insurance Company our paper aims to study and explore trends and differentials in life expectancy based on lifetime earnings in Slovakia. Tobit and probit models confirm a positive relationship between life earning and life expectancy. Furthermore we estimate remaining life expectancy at age 63 especially of Slovak male pensioners. Despite low level of earnings variance, our findings indicate the difference over 4 years in life expectancy between the lowest and the highest income percentile in this group. Results of our analyses are in line with wide foreign research on this topic. The outcomes of the conditional life expectancy may further provide normative implications for the Slovak merit based pension system and the first pillar settings.

Key words: Lifetime earnings, life expectancy, mortality tables.

JEL Code: C40, C67, D31

Introduction

The systematic differences across the population in mortality risk are usually omitted in the social security systems architecture. Then, the unintended redistribution based on differences in life expectancy related to such factors as income, gender, and race can occur. Over 40-years ago Milton Friedman drew attention to this fact. He concluded that people with higher incomes live longer (Friedman, 1972).

Since the essential work of Kitagawa and Hauser (1973), a large amount of research has focused on the extent, causes, and trends of differential mortality determined by socioeconomic status.

A common finding of the cross-disciplinary research is that life expectancy is higher for higher income persons (Brown, 2002). Schalick(2000) reports that the gap in mortality risk has been growing. However, welfare measures based on economic variables such as Gross Domestic Product give an incomplete and potentially biased representation of standards of living (Becker, Philipson and Soares, 2005; Steckel, 2008). Furthermore, if education and income have a causal impact on mortality, then education or redistribution policies can have an impact on health (Lleras-Muney, 2005).

In spite of worldwide rich literature on this topic, empirical evidence of this phenomenon in central Europe is quite rare. There are two main reasons for that: Firstly, data needed to responsible work are not available, resp. only short time series are available. Secondly, in the past there were a relatively high level of income and living standard equality in socialist economics.

Our paper aims to study and explore trends and differentials in life expectancy based on lifetime earnings in Slovakia using a micro data of current and former retired participants covering years 2005 – 2016 from the Social Insurance Company. We use the data structure, which has not been used for this kind of research yet. This data allow us to study our topic using three methods. At first, the variable alive/dead predetermines us to use binary choice models, for instance Probit model. Secondly, the short time series and especially unclosed personal records face us with right censored data. This means a data point is above a certain value but it is unknown by how much. At the last observation we still don’t know how long the person would live. Lastly, cross section data are sufficient enough for mortality tables compilation.

In the second chapter of this paper these data and methodology are described in detail. The third chapter discusses outcomes and results. Last chapter concludes the paper findings.

1 Data and methodology

In this paper, we use a very large dataset of administrative records from the Slovak Social Insurance Company. The main variable for our estimations is retirement pension used as a proxy for a lifetime income. Retirement pension is measured in Slovak crowns and Euros. Observations range from 2005 to 2016. To ensure the homogeneity in our dataset, we use only male retirement pensioners. Using female or other type of pensioners, e.g. disabled or early retired, could cause ambiguity in our estimations due to different calculations of pension income. Retirement pension formula changes slightly over time. [1] That is why we strictly work with separate cohorts. The value of retirement pension is given by salary (or income which is subject to social contribution) and social insurance period.

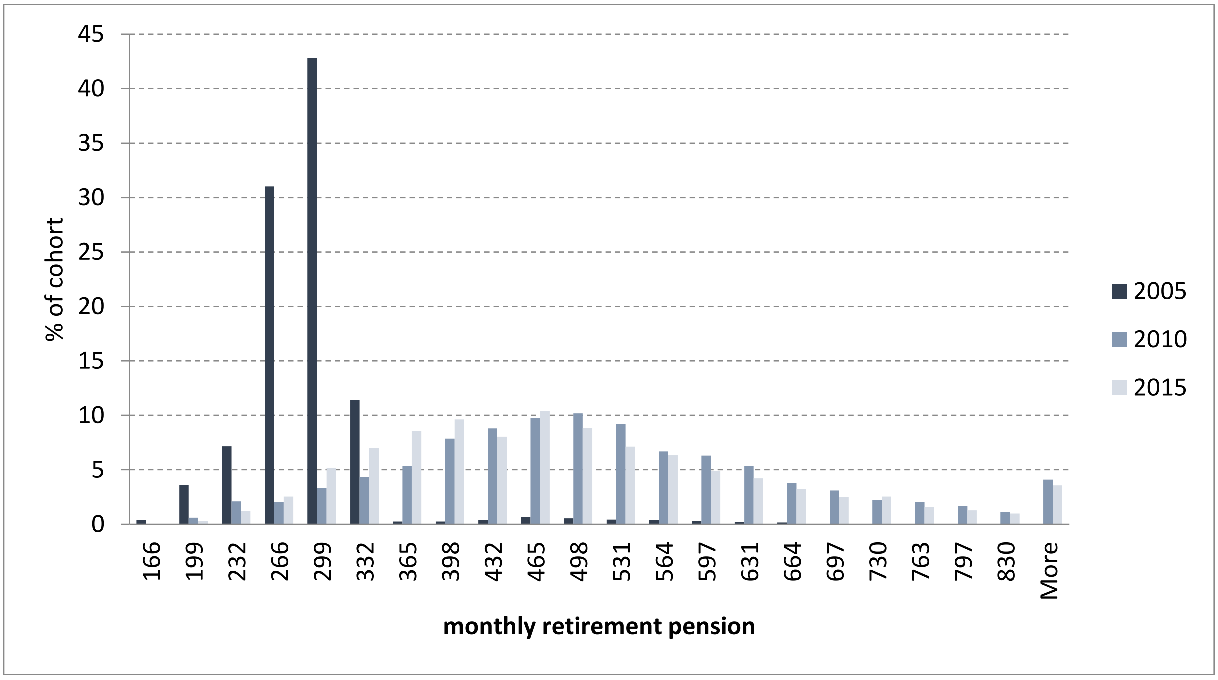
(1)

[1] Current pension value changes every year for newly awarded pensions, but do not match valorization of current pensions. Moreover, there were few parametric changes in retirement pension scheme in last years.

$$y=APWP* \ YSI* \ CPV$$

Salary enters the formula in the form of average personal wage point (APWP). Basically, for each year in which a person is earning the average wage, personal point of 1 is assigned. For lower than average wage, personal point will be lower than 1 and vice versa. Personal wage points are then averaged and multiplied by the number of years of social insurance (YSI) and the current pension value (CPV), which changes every year based on the development of average wages in the economy. The more someone earns and the longer he works, the higher pension should he received.

Fig. 1: Histogram of retirement pensions in 2005, 2010 and 2015 for 63y old males



Source: Social Insurance Company of Slovakia and authors calculations

This simplification does not give us a perfect knowledge about lifetime income because of three main reasons. Firstly, the retirement pension formula disadvantages the higher income groups. Personal wage point says about the income in each single year of social insurance, but in case a personal wage point exceeds the maximum value, it is reduced before imputation to retirement formula. Secondly, our data prevent us to see number of years of social insurance. Our approach also does not consider personal welfare, which could be more robust factor than personal income. Our proxy of lifetime earnings misses out on some things typically included in the income definition such as bequests, capital income or transfers. In addition, income equality was relatively higher in eighties and nineties, which is important for current pensioners.

Bearing the incompleteness in mind, we use retirement pension as a lifetime proxy as no better indicator is available and it is applicable to all retired persons. It enables us to work with relatively large and homogeneous sample.

In our paper we would like to prove the positive relationship between retirement pension (as the lifetime income proxy) and lifetime expectancy at age 63 in the Slovak Republic. To confirm this hypothesis we implement 3 methods: a) Tobit model with a censored sample, b) Lifetime expectation based on Probit model forecast of survivorship for income percentiles, c) Life expectancy calculation based on mortality tables for income deciles

add a) Tobit model with censored sample provides estimation of relation between life expectancy and retirement years survived. In our model the sample tracks pensioners from 2005 to 2011[2]. In general, Tobit model is an extension of probit model. Statistically, it can be expressed as (Gujarati, 2004):

$$Y = \begin{cases} \beta_1 + \beta_2 X + u, & if \quad RHS > 0 \\ 0, & otherwise \end{cases} \tag{2}$$

where Y is dependent variable and X is independent variable. Dependent variable Y says how many years person has lived since 2005. This variable ranges from 0 to 7, where 0 means that person died in 2005 and 7 means that person has not died before 2011 and lives 7 or more years since 2005. This means the data for pensioners who died after 2011 are censored. Independent variable X, in our case, is lifetime earning per person represented by retirement pension in January 2005.

add b) The easiest way how to interpret our data is to use a simple binary response model. One type of model from the group of binary models is a Probit. Probit function is the inverse cumulative distribution function and can be generally expressed as

$$P(Y = 1|X) = P(Z \leq \beta_1 + \beta_2 X) = F(\beta_1 + \beta_2 X) \tag{3}$$

where $P(Y=1|X)$ means the probability that an event occurs given the values of explanatory variable X and where Z is the standard normal variable and F is standard normal cumulative distributive function (Gujarati, 2004).

In our model, endogenous variable Y estimates the probability, by which the pensioner will live in the particular year based on his retirement income level. Let's assign 1 for the case, when person lives at certain time and 0 for the case, when person does not live at that particular

[2] Only 2005 to 2011 subset of our database uses stable ID in time, so we are able to track persons over few years.

point of time. Model will then calculate the probability with which person lives at particular moment based on her retirement income.

These probabilities are then used to calculate a proxy for life expectancy (LExi) [3] by (conditional probability) cumulative multiplication for each income percentile i as:

$$LE_x^i = \max_x\{\prod_{a=62}^{x} p_a \geq \frac{1}{2}\} \tag{4}$$

where *pa* denotes survival rate, which means probability a person aged *x* will live to age *x +1*.

add c) Using a cross section data, a period mortality table (life table) based on the mortality experience of a population during a relatively short period of time can be compiled. In this method we work with the individuals grouped into ten income groups - income deciles denoted *d* and cohorts *x*. The standard Mortalitiy tables methodology based on death rates is used (see e.g. WHO, 2013).

We present the 2005 and 2016 mortality tables. Life expectancy at a given age is the average of remaining number of years expected prior to death for a person at that exact age.

$$LE_x^d = \sum_{x=62}^{\infty} (l_x + p_x * l_x)/2l_x \tag{5}$$

where *LEdx* denotes life expectancy at age category *x*, *lx* denotes survivorship, hypothetical number of individuals out of 100000 who will live until next year, and *px* denotes survival rate, which means probability a person aged *x* will live to age *x +1* and is calculated by observed survivals.

2 Results

2.1 Tobit model with censored data

In this regression we use retirement pension in January 2005 as the independent variable and the number of years survived since then as dependent one. This variable is right censored at level 7. We repeat this for each cohort separately due to changes of retirement pension formula over time.

[3] This is our intuitive proxy for life expectancy, however consulted with experts in demographics.

Results of Tobit analyses are displayed in table below. First column represents date of birth of pensioners and ranges from 1926 to 1943. Values of estimated coefficients suggest positive relation between lifetime earnings and retirement years survived in all cohorts. Standard errors indicate that all estimated coefficients are significant on all attainable significance levels. These results confirm our assumption that people, who have higher retirement income live longer.

Tab. 1: Tobit model with censored sample results

born	*coef*	*st error*		*born*	*coef*	*st error*
1926	*0,000428*	*4,62E-05*		*1935*	*0,000821*	*6,46E-05*
1927	*0,000493*	*4,91E-05*		*1936*	*0,000888*	*6,58E-05*
1928	*0,000535*	*4,99E-05*		*1937*	*0,000846*	*6,73E-05*
1929	*0,000508*	*5,15E-05*		*1938*	*0,000866*	*0,000071*
1930	*0,000572*	*5,43E-05*		*1939*	*0,000888*	*7,15E-05*
1931	*0,000691*	*5,83E-05*		*1940*	*0,001084*	*7,58E-05*
1932	*0,000667*	*5,91E-05*		*1941*	*0,001109*	*7,47E-05*
1933	*0,000661*	*6,22E-05*		*1942*	*0,000883*	*7,26E-05*
1934	*0,000793*	*6,35E-05*		***1943***	***0,000687***	***0,000054***

Source: Authors calculations

Rising coefficient of independent variable with the year of birth in line with the rising number of censored data indicates stronger effect. The average effect of an increase in monthly pension by 1000 SKK (33,2 eur) on the prolongation of life expectancy ranges from 1/3 of year to one year.

2.2 Probit model forecast of survivorship for income percentiles.

Our independent variable is again retirement pension in January 2005. Dependent variable now reaches 0 or 1 along with the observed timeline.

Table 2: Probit model results for male in 2005

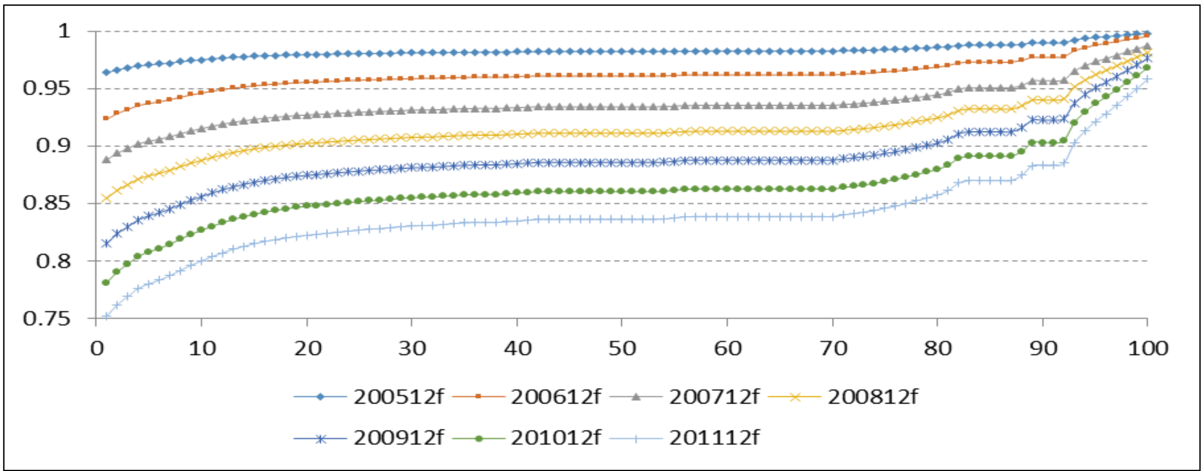
born	**coef**	**st error**		**born**	**coef**	**st error**
1926	8,05E-05	2,00E-05		1935	0,000115	2,23E-05
1927	8,95E-05	2,03E-05		1936	0,000123	2,29E-05
1928	6,60E-05	2,00E-05		1937	0,000141	2,30E-05
1929	8,80E-05	2,04E-05		1938	0,000103	2,32E-05
1930	0,000109	2,13E-05		1939	0,000098	2,32E-05
1931	0,000101	2,24E-05		1940	0,000137	2,35E-05
1932	0,000129	2,32E-05		1941	0,000202	2,35E-05
1933	0,000117	2,31E-05		1942	0,000126	2,27E-05
1934	0,000117	2,26E-05		**1943**	**0,000109**	**1,90E-05**

Source: Authors calculations

Table of results is similar to the previous one, representing the Tobit outcomes. All the tests are statistically significant and they came up with positive coefficients.

One of the probit outputs is survivorship forecast probability. The results displayed in the graph below are forecasted survivorships for income percentiles of male born in 1943. This forecast is slightly predetermined by probit function characteristics.

Fig.2: Probability of survivorship for 63y old male income percentiles in 2005



Source: Authors calculations

Results of survivorship forecasts for income percentiles were used to calculate lifetime expectancy at age 63 in line with formula (4). The results show that there is a big difference in life expectancy between the lowest and the highest income percentile.

2.3 Life expectancy calculation based on mortality tables for income deciles

Mortality tables, which are based on 2005 and 2016 cross section data for male pensioners cohorts, indicate life expectancy at age 63 in range from 11,7 to 15,8 years, respectively 13,5 to 18.

Table 3: Life expectancy by income decile 2005

age category x / income decile	LEd1	LEd2	LEd3	LEd4	LEd5	LEd6	LEd7	LEd8	LEd9	LEd10
63	**11,7**	**13,7**	**14,4**	**15,1**	**15**	**15,5**	**15,9**	**15,9**	**15,9**	**15,8**
64	11,2	13,1	13,7	14,4	14,2	14,7	15,1	15	15,2	15,1
65	10,8	12,5	13	13,7	13,4	13,9	14,4	14,3	14,4	14,2
66	10,3	11,8	12,4	12,9	12,8	13,1	13,6	13,5	13,7	13,5
67	9,8	11,2	11,8	12,2	12,1	12,4	12,8	12,7	12,9	12,9
68	9,3	10,6	11,2	11,5	11,4	11,7	12	12	12,2	12,3
69	8,8	10,1	10,6	10,7	10,7	10,9	11,3	11,3	11,5	11,6
70	8,4	9,5	9,9	10,1	10	10,1	10,6	10,5	10,8	10,9

Source: Authors calculations

Despite using age groups from 63 to 80, we consider this method very important and suitable in line with proving higher life expectancy across income deciles. Here just pure demographic and no statistical methods are used.

Results are in line with wide range of literature studying GDP per capita and life expectancy in various countries. The results indicate that life expectancy rises with rising welfare but only to a certain limit. In our 2005 sample, life expectancy does not increase after reaching seventh decile income level. The seventh decile includes pensioners with the average retirement pensions. Life expectancy for males at age 63 for the lowest decile in 2005 is estimated at level 11,7 years. It rises to seventh decile, where it reaches 15,9 years and hold this level for the highest income deciles. A similar pattern is observed also for other cohorts.

Table 4: Life expectancy by income decile 2016

age category x / income decile	LEd1	LEd2	LEd3	LEd4	LEd5	LEd6	LEd7	LEd8	LEd9	LEd10
63	13.55	13.63	14.55	15.00	15.19	15.86	16.08	16.42	16.39	17.88
64	12.98	13.01	13.89	14.35	14.49	15.15	15.35	15.69	15.64	17.15
65	12.43	12.41	13.26	13.73	13.82	14.47	14.66	14.99	14.89	16.34
66	11.90	11.79	12.64	13.11	13.13	13.82	13.97	14.33	14.16	15.55
67	11.35	11.18	12.02	12.49	12.43	13.15	13.32	13.67	13.43	14.81
68	10.78	10.62	11.42	11.89	11.79	12.48	12.63	13.00	12.72	14.07
69	10.21	10.08	10.85	11.33	11.19	11.83	11.94	12.33	12.04	13.32
70	9.67	9.56	10.27	10.80	10.63	11.18	11.27	11.69	11.35	12.55

Source: Authors calculations

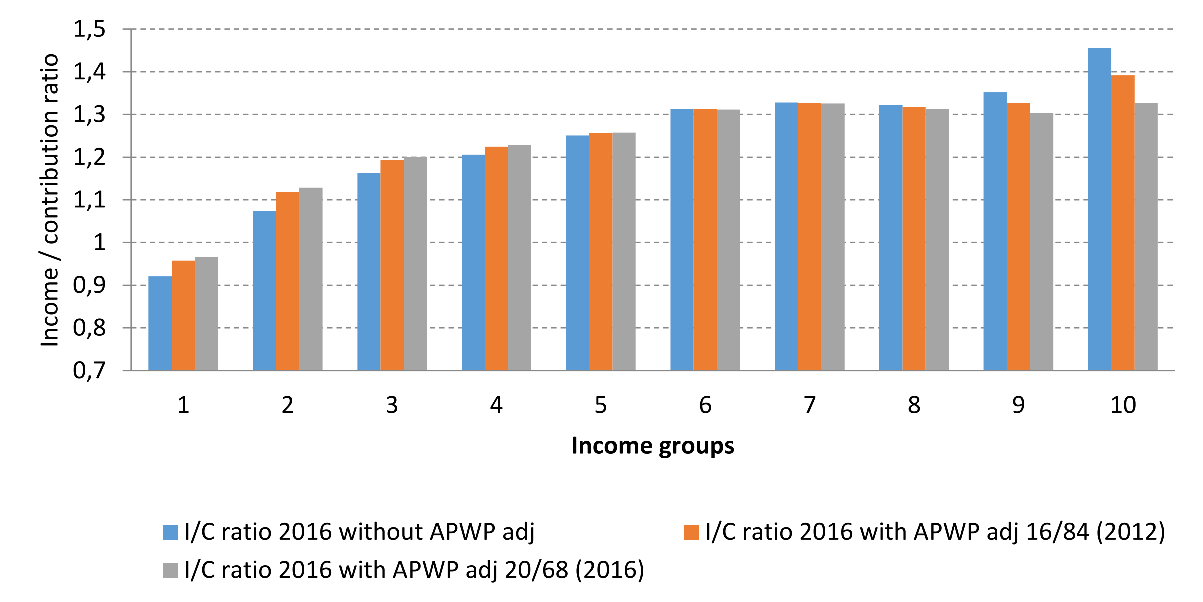
Vice versa, life expectancy for the 2016 sample increase in the top decile, while the increase is moderate for fourth to eight deciles. Here we can see the likeness in life expectancy calculated using probit forecast probabilities.

2.4. Distributional consequences of Life expectancy differentials

The income-related differences in life expectancy are substantial when evaluating the distributional consequences and solidarity of retirement pension's system scheme. The Graph (3) presents the simple version of retirement pension income/contribution ratio for newly retired males, based on APWP adjustments valid in 2005.[4] If the average personal wage point (APWP) in 2005 was over 1.25, then 60 percent of the difference of 1.25 and the average personal wage point was added. And vice versa if the average personal wage point was lower than 1.0, and then 40 percent of the difference between the value 1 and that lower average personal wage point was added. At the income side we use life expectancies at age 63 calculated above and an average retirement pensions for each income decile. On the other side, the average personal wage point and contribution period in years are used.

[4] The principle of solidarity in the retirement pension calculation was settled by § 63 Act no. 461/2003 Z. z. on Social Insurance and prolonged by latest novel. The average personal wage point reduction coefficients are settled for period 2004 to 2018.

Fig. 3: Retirement pension income/contribution ratio 2016



Source: Authors calculations

The ratio is relatively not so favorable for the lowest income decile. The explanation could be found in short retirement period. Moreover, the lowest decile would be disadvantaged by the system setting with no PAWP adjustments. From forth to highest decile, the rude retirement pension formula does not generate distributional consequences. The PAWP adjustments taken in effect in 2005 are essential to strengthen solidarity. It favors three bottom deciles and penalizes especially highest income decile.

Conclusion

In this paper we present the results of a comparative analysis of mortality incidences based on the three different measures in this paper. All three methods confirm our hypotheses about differences in life expectancy based on the lifetime income. Male pensioners with higher retirement pension in Slovakia live longer.

The official life expectancy at age 63 for total male population in 2016 published by Slovak Statistical Office is 16.43 years. Our proxy for life expectancy gives 16.64 years. We explain the higher value by the fact, we do not work with the complete male population, but only regular retirement pensioners. This mean we do not count disabled or other special pensioners. Our sample pensioners are supposed to be healthier than the total population. This gives us conformity about our results. Life expectancy varies from 13.6 for lowest decile to 18.9 for the highest income decile for 63 years old males in 2016.

Using the probability methods we draw the difference in life expectancy proxy at over 8 years. While its value for lowest income percentiles is 12-13 years, the highest income percentiles reach over 20 years of life expectancy. This outcome can be slightly affected by Probit function characteristics for higher income percentiles.

Our results are in line not only with official mortality tables, but also with foreign research findings. Gaudecker and Scholz (2007) compute life expectancies at age 65 and find six years on the difference in life expectancy between the lowest and the highest socio-economic group in Germany. Dugan (2007) estimates difference in age of death between low and high lifetime income of two to three years for males and females in United States.

The income-related differences in life expectancy are substantial when evaluating the distributional consequences and solidarity of retirement pension's system scheme. According to our simple retirement pension income/contribution ratio, the personal average wage point adjustment taken in effect since 2005 are essential to ensure solidarity in 1.st pillar pension scheme.

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