Living Better, Living Longer? Is Ageing in Line with Economic Performance?*

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The goal of this paper is twofold. First, it is to describe and interpret the increase of life expectancy as a positive component of the human development index and the global competitiveness index. For developed countries, age-gain, defined as the difference between life expectancy at age 65 and at birth, is calculated and analyzed.

The second part of the paper is about Hungary which is a developed country according to the human development index and is in catching-up position according to the rankings of the World Economic Forum. Hungarian age-gain is one of the highest, it is above seven years and its old-age dependency ratio is fast increasing accompanied by a relatively low economic performance. To sustain the present Hungarian pay-as-you-go pension system, reliable projection for the ageing tendency is indispensable.

KEYWORDS:
Longevity.
Public Finance.
Pension.

* The research was supported by the Hungarian Scientific Research Grant (OTKA K 77420). An earlier version of this paper was given at the 71st International Atlantic Economic Conference, in Athens, on 17th March 2011.

Economic and mortality modelling have a very long but independent history. Measurement of economic performance was limited to the components of GDP, and GDP per capita was used as a standard statistical indicator of economic progress. Well-being is more than just income. It is a multi-dimensional concept with several aspects. Some of them are measurable, like income or education, and others are latent, for example protecting the environment Longevity in ageing societies is strongly associated with material well-being. Increasing life expectancy is a result of higher economic performance and but it also can moderate further economic growth.

Hundreds of economic and econometric studies tried to understand what determines the wealth of nations. The first attempt originates from *Adam Smith* who focused on specialization and the division of labour.[1] Neoclassic economists emphasize investment in physical capital and infrastructure. More recently, health, education, and training are listed as vital components of a country's competitiveness and productivity. Investments in education and health services are crucial for clear economic considerations. The *Commission of the European Communities* [2009] issued a paper entitled "GDP and Beyond" underlining the strategic importance of this topic.

In this paper, based on available data, the human development index and the global competitiveness index are compared with ageing in highly developed countries.

1. Three complex measures for similar purpose

There are different theories and opinions in the literature concerning the measures of economic development and well-being. According to several researchers, personal income is one of the key factors, and both low and high level of income inequalities may reduce the perception of well-being (*Cserháti–Takács* [2010]).

In the following, we concentrate only on indices including one way or another increasing life expectancy as a positive factor.

Human development index (HDI) has been used since 1990 and it was the first attempt to incorporate different aspects of quality of life. It was modified and redefined in 2010.[2]

[1] His one of the most influential work "An Inquiry into the Nature and Causes of the Wealth of Nations" was published in 1776. (See References.)

[2] Details can be found: http://hdr.undp.org/en/media/HDR_2010_EN_TechNotes_reprint.pdf

This composite index published by UN aggregates three dimensions: *1*. a long and healthy life, measured by life expectancy at birth; *2*. access to knowledge, combining mean and expected years of schooling; *3*. a decent standard of living, measured by GNI per capita (PPP[3] US$).

Higher value means better well being for nations. Norway has got the highest value (0.938) in 2010. Values above 0.788 are classified as very high human development. Next category is called high human development, whose lower limit is 0.67. This paper concentrates only on the analysis of the OECD member states with HDI above 0.67.

The World Economic Forum's annual competitiveness reports are examining 12 pillars to compute the global competitiveness index (GCI). This comprehensive index involves static and dynamic components as a weighted average of many different aspects. GCI combines survey data and hard data to capture microeconomic and macroeconomic foundations of national competitiveness through these pillars. Using all of the data, ranks and scores are published year by year.

The fourth pillar of GCI, as the measure of health and primary education is very important in our analysis. Higher education and training in the fifth pillar are strongly influencing life expectancy as well.[4] Sustainable economic growth cannot be achieved unless the other pillars are stable and efficient. Table 1 summarizes the 12 pillars.

Comparing the HDI as the geometric mean of its three components with the GCI compiling the formerly mentioned pillars, there are no statistically significant differences as it is shown in Figure 1. Higher HDI is followed by higher GCI. In spite of the non-linear relationship, the Pearson correlation coefficient is 0.69 ($p = 0.000$) and the Spearman rank correlation value is 0.658 ($p = 0.000$) for OECD countries ($n = 30$) in 2010. This is due to the overlapping content of the two indices.

Hungary is less developed and less competitive than the OECD's average, and is close to the virtual break point at GCI = 4.4 and HDI = 0.84 in Figure 1. The existence of the break point can be explained by the different content of the two measures. It is easier to gain higher HDI score with higher value in the three components, and more effort is needed to earn higher GCI point. *Zádor* and *Gáspár* [2010] came to a similar conclusion. Hungary is a highly developed country according to the HDI and is in a catching-up position according to the rankings of the World Economic Forum. Descriptive statistical measures of these two indices are presented in Table 2. The coefficient of variation of GCI is greater because of containing more information through the 12 pillars. HDI values have high kurtosis because OECD countries are concentrated around the mean. Both indices are skewed to left underlining the tendency that higher values are more frequent than low values in the OECD.

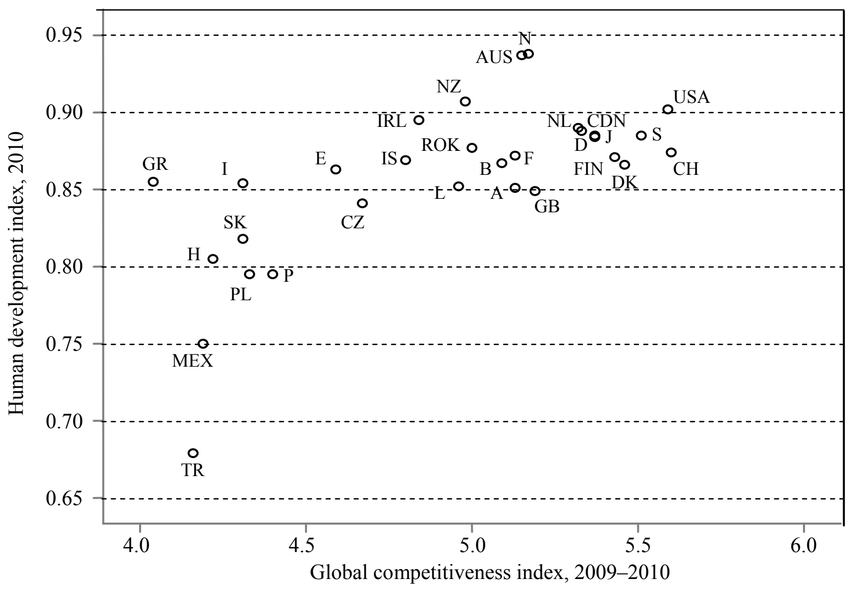
[3] Purchasing power parity.
[4] List of variables combined in the fourth and fifth pillars are given in the Appendix.

Table 1

The 12 pillars of competitiveness

Name	Content
1. Institutions	Institutional environment, legal and administrative framework
2. Infrastructure	Infrastructure networks, transport, location of economic activity, telecommunications network
3. Macroeconomic stability	Fiscal deficit, inflation rate, public accounts managed by the government
4. Health and primary education	Healthy workforce and quantity and quality of basic education
5. Higher education and training	Well-educated workers, secondary and tertiary enrolment rates
6. Goods market efficiency	Supply and demand conditions, market competition, taxes
7. Labour market efficiency	Labour market flexibility, wage fluctuation, worker incentives
8. Financial market sophistication	Well-functioning financial sector, proper assessment of risk, regulation
9. Technological readiness	Access to information and communication technologies
10. Market size	Domestic and foreign market
11. Business sophistication	Quality of overall business networks and individual firms' operations and strategies
12. Innovation	Investment in research and development

Figure 1. HDI and GCI scores of OECD countries in 2010



Source: Author's calculation. In Figures 1–4 the international car codes are used.

Table 2

Statistics of HDI and GCI

Denomination	Human development index 2010	Global competitiveness index 2009–2010
Valid (sample size)	30	30
Mean	0.857	4.921
Median	0.868	5.045
Standard deviation	0.053	0.484
Skewness	–1.553	–0.403
Standard error of skewness	0.427	0.427
Kurtosis	3.754	–1.177
Standard error of kurtosis	0.833	0.833
Range	0.259	1.560
Minimum	0.679	4.040
Maximum	0.938	5.600

Source: Author's calculation.

Sustainable development in the ageing societies is investigated by several researchers and from different aspects in the European Union. A new complex measure in this field was proposed by *Stiglitz*, *Sen* and *Fitoussi* [2009]. Their paper, the so-called Stiglitz Report suggests shifting the emphasis from measuring economic performance to measuring people's well-being. The authors of this report propose eight dimensions to be taken into account simultaneously to represent the quality of life in different countries. Five from these eight dimensions (material living standard, health, education, personal activities (work), and economic insecurity (among them inadequate resources during retirement and volatility in pension payments)) are strongly connected to the problems of an ageing society.

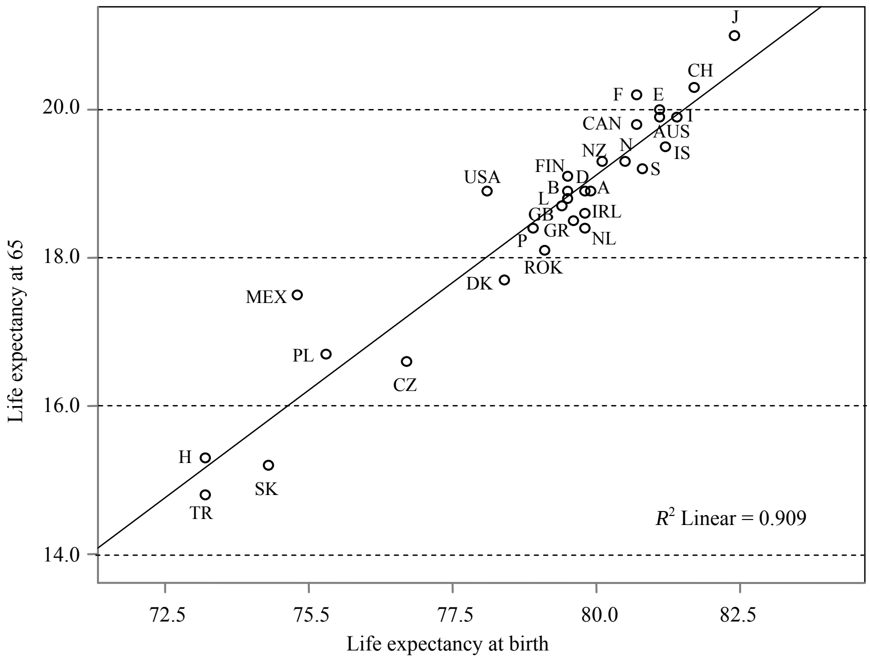
All three complex measures take increasing life expectancy as a positive result of the economic and social progress. However, consequences of ageing for the society have not been quantified in these measures. Longevity will have both positive and negative impact on developed nations. One strong evidence can be mentioned here as an example. Researchers predict very high proportion of health expenditure for individuals and for the society in the next decades. It is in line with the Pareto law: 80 percent of all health costs will be spent in the last 20 percent of our lifetime.

2. Measuring life expectancy at different ages

Life expectancy is a part of all complex measures. Forecasting life expectancy and modelling[5] mortality are key problems not only for economists but also for actuaries and demographers. Most methods of mortality forecasting are extrapolative and give aggregate measures, such as life expectancy at birth. It is only in the last 20–25 years that more sophisticated stochastic methods have been developed and applied. There are different mortality measures, they may refer to overall mortality or be decomposed by sex, socio-economic factors or cause of death. These components are strongly correlated over countries and time.

Life expectancy can be calculated not only at birth but also at different ages. It is higher and higher as age is increasing. Figure 2 shows this tendency in the OECD countries. Life expectancy at 65 has got crucial interest as 65 is the official retirement age in most of the developed countries.

Figure 2. Life expectancy at birth and at 65



Source: Author's calculation from OECD data.

[5] *Gompertz* published his law on mortality in 1825. For further details on mortality modelling see *Lee–Carter* [1992] or *Májer–Kovács* [2011].

Mortality improvement can be measured through increase in life expectancy. The median age at birth in the OECD member states is around 80 years. Under the condition that a person has reached the age 65, he/she can expect to live 19 more years. "Age-gain" is defined as the difference between life expectancy at 65 and life expectancy at birth for the same calendar year and population. This is a cross-sectional measure. The average age-gain is 4.5 year in the OECD countries. Hungary is the second on this list with 7.1 year. Table 3 shows the basic statistical results.

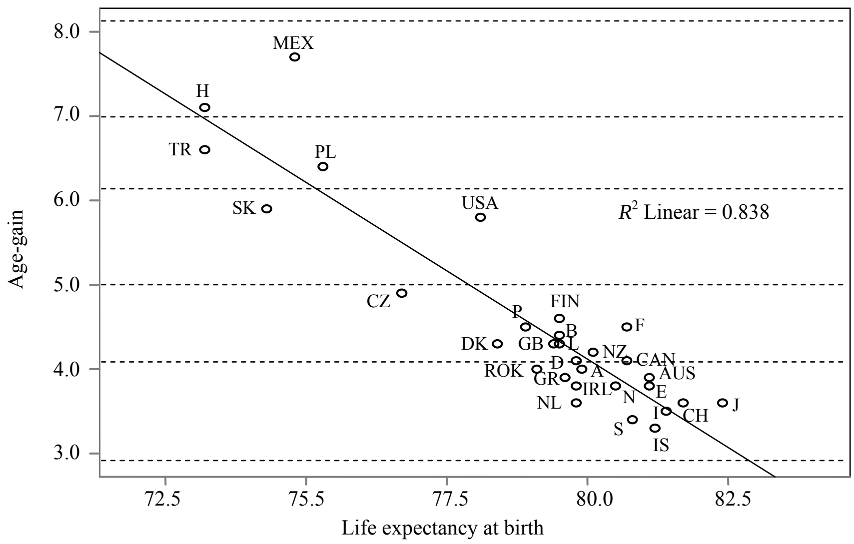
Table 3

Summary statistics of life expectancy

Denomination	Life expectancy at birth	Life expectancy at 65	Age-gain
Valid (sample size)	30	30	30
Mean	79.02	18.55	4.53
Median	79.70	18.90	4.15
Standard deviation	2.50	1.53	1.15
Minimum	73.20	14.8	3.30
Maximum	82.40	21.0	7.70

Source: Author's calculation from OECD data.

Figure 3. Determination of age-gain by life expectancy

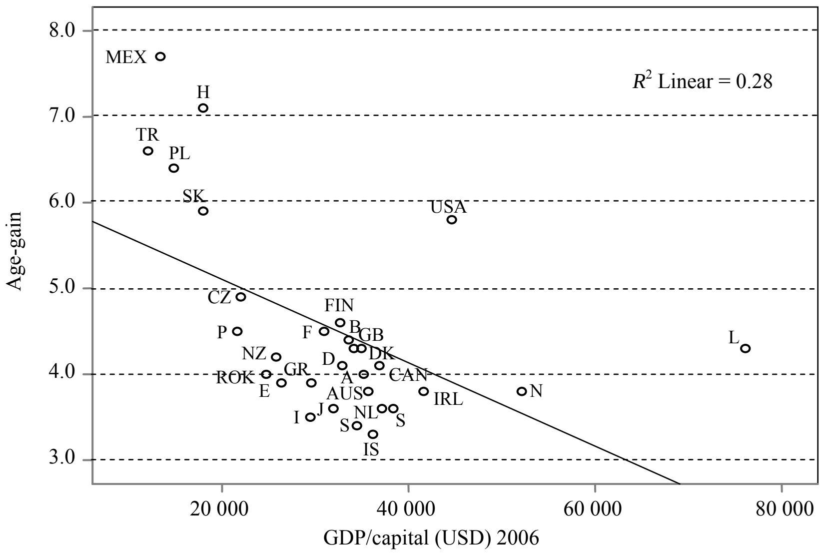


Source: Author's calculation from OECD data.

Higher life expectancy at birth is related to higher life expectancy at 65. But age-gain is decreasing with increasing life expectancy, as it can be seen in Figure 3. The coefficient of determination is 84 percent, so the unexplained variance is 16 percent. It could be interesting to analyze what else can explain the mortality improvement in highly developed countries.

Expected length of a person's life can be estimated in the process of underwriting by knowing individual health conditions and the level of education. These non-monetary measures can significantly increase people's life expectancy. GDP per capita as a proxy of economic performance explains only 28 percent of the age-gain variance. This is statistically significant but they are only weakly correlated. For details, see Figure 4. The level of education measured by the expected number of years of schooling and the sum of public and private health expenditure in absolute number or as a percent of GDP can be used to estimate age-gain more precisely from cross-sectional data. Age-gains in the case of Mexico and Hungary are the highest in the OECD.

Figure 4. Determination of age-gain by GDP per capita



Source: Author's calculation from OECD data.

Factor analysis, one of the multidimensional statistical methods is best suited for checking interactions and correlations among conventional economic indicators, like GDP and other complex indicators as it can be seen in Table 4.

Using six variables for 30 OECD countries, one factor can be identified with 69 percent of total information. All correlation coefficients are positive and significant in Table 4 (Component A). Instead of life expectancies, age-gain is taken into account in the second part (Component B). Here again one factor is calculated, but the sign of the correlation is negative, since increase of life expectancy becomes smaller at a higher level of education, health, innovation and GDP.

Table 4

*Two-component matrices**

Variables	Component (A)	Component (B)
Life expectancy at birth	0.892	–
Health and primary education	0.883	0.905
Life expectancy at 65	0.854	–
Innovation and sophistication factors	0.841	0.855
Higher education and training	0.829	0.888
GDP/capital (USD) 2006	0.674	0.679
Age-gain	–	–0.805

* Principal component analysis was used as an extraction method.
Source: Author's calculation from OECD data.

From the actuarial point of view, this factor describes the collective risk of ageing for countries. Slow economic development of the country can be associated with fast catch-up in life expectancy as health conditions are improving. Age-gain becomes more expensive at higher life expectancy. The situation cannot be summarized simply as "smaller result at higher cost". Additional effects are associated with this tendency. Long-term care system should be created and financed as old-age dependency ratio[6] is increasing. There is a worldwide problem with no best practice for benchmarking. Higher effective age of retirement or increasing contribution is needed to finance pension benefits in order to sustain pension systems.

3. Increasing life expectancy in Hungary

Hungarian life expectancy is among the lowest in Europe. Hungary will face the risk of the ageing society a bit later, mainly in the next decades. There are two reasons for this time lag. On the one hand, the baby boom started somewhat later, in the early 1950s and there was a second wave in the late 1970s. For details, see Figure 5.

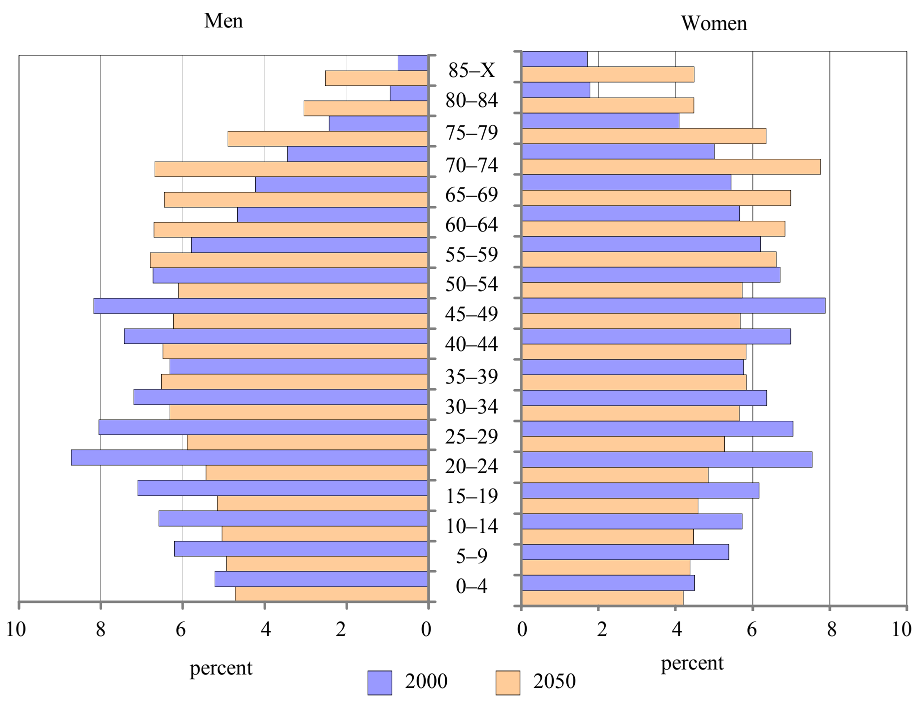
[6] The old-age dependency ratio is the ratio of the number of people aged 65 and over to the working-age population (those aged 15–64). Projected ratios are published in http://www.euphix.org/object_document/o5117n27112.html

On the other hand, the Hungarian male life expectancy is one of the lowest in the OECD. Life expectancy for 65 year-old men is 78.7, while 65 year-old women are expected to live four additional years compared to men.

Two tendencies meet in Hungary in this decade: *1*. fertility rate is below 1.3.; *2*. demographers expect a fast catch-up in life expectancy. Therefore the old-age dependency ratio is increasing at a high speed. Our pay-as-you-go pension system needs reliable projections for the ageing tendency.

Hungarian population by age and gender in 2000 and in 2050 (in percentage of the total population in each group) can be seen in Figure 5. The healthy triangle shape is not yet visible at present. But the picture of the future is more challenging. Dramatic change in old-age dependency is foreseen: it is expected to double in this 50-year-long period.[7]

Figure 5. Hungarian population in 2000 and 2050



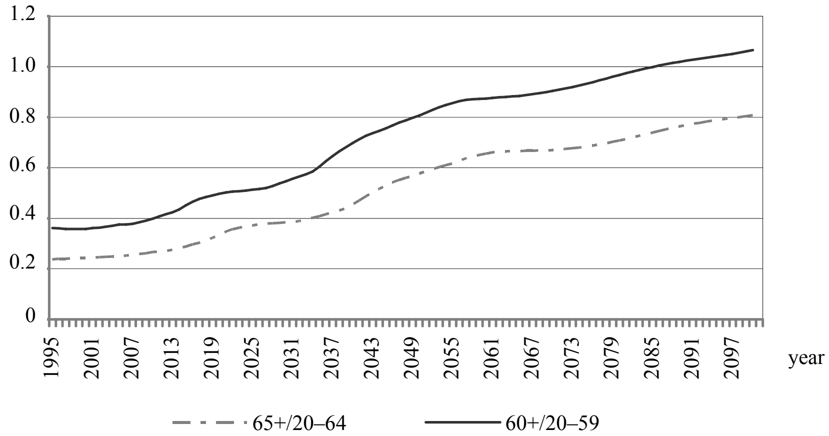
Note. The total population was 10.2 million in 2000 and is expected to be 8.7 million in 2050. The old-age dependency ratio was 0.24 in 2000 and will be around 0.5 in 2050.

Source: OECD Population Pyramids. (www.oecd.org/dataoecd/52/31/38123085.xls)

[7] The old-age dependency ratio is expected to be at least twice higher for most of the OECD member states in the investigated period. The increase comparing 2050/2000 for Japan will be 2.6, and the greatest growth rate is predicted for Mexico: 3.9.

Here is again a special Hungarian problem, which becomes clear when comparing Figure 6 and 7. The official age of retirement is 62 for both genders, but the effective age of retirement is less than 60 years. According to Figure 6, without any dramatic change in the economic activity, two active persons will finance one pension in 2020, that is, the solid line which shows the ratio of people above 60 to persons who are between 20 and 59 years, will reach 0.5 at that point. The lower dotted line shows the ratio of people above 65 to persons who are between 20 and 64 years.

Figure 6. Hungarian old-age dependency ratio



Source: Author's calculation from demographic prognosis elaborated by *László Hablicsek* [2010].

It has been decided to increase the official pension age to 65 within the next 6 years. Supposing real changes in this field, this problem can be postponed by 20 years.

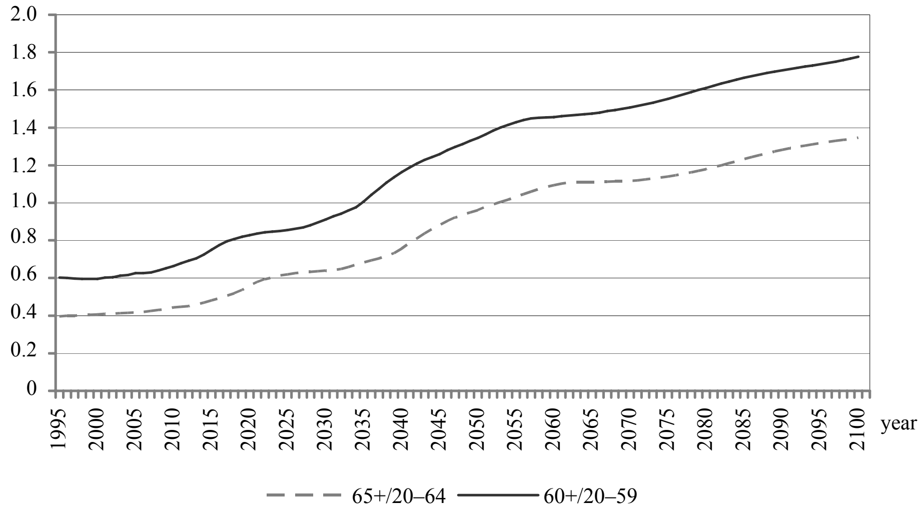
Old-age dependency ratio as a statistical measure should be adjusted for Hungary. Its numerator is higher because of early retirement. The denominator should be lower because of the grey economy: only 56 percent of the active population pays pension contributions regularly. Figure 7 presents a more realistic picture for the next period. One "contributor" will finance one pension in 2035 if the effective retirement age and the activity rate will not become significantly higher.

Report of the Pension and Old-Age Round Table (*Holtzer* [2010]) on its activities highlighted several problems and suggested different paradigms to support decision-making.[8] Appendix 6 of this report presented a demographic forecast with three scenarios. The basic version – based on low fertility rate and average migration – pro-

[8] Nineteen experts – among them the author of this paper – worked together between 2007 and 2009. The report covers projections for the present pension system and compares five possible pension schemes. The demographic prognosis was elaborated by László Hablicsek with the *component method,* taking into account childbirths (fertility), life expectancy (mortality), and international migration.

jected one-year increase in life expectancy in 5-6 years. Can we accept this for a constant growth rate?

Figure 7. Adjusted old-age dependency ratio



Source: Author's calculation from the demographic prognosis elaborated by László Hablicsek.

Reliable prediction of increasing life expectancy is very important for Hungary for several reasons: *1*. Health care, disability, and old-age pension reforms are all hot issues. *2*. Increase in life expectancy can be faster than the economic catch-up process. However, this tendency cannot be modelled by time series methods. *3*. New technology in medicine and genetics, innovations in pharmaceutics appear and cause revolutionary changes in life expectancy in the global world.

4. Longevity risk in the Hungarian pension system

The significance of life expectancy was usually underestimated in the past decades, while previously mortality probabilities were treated as deterministic input variables for life tables. Annuity providers, pension schemes must give annuities or pension benefits for a longer period than it was calculated earlier. As baby boomers retire, decumulation of wealth and longevity risk will become key issues. Instead of constant mortality, decreasing rates are preferred to be considered for the future.

The defined benefit (DB) pension system[9] introduced after the Second World War and extended in the 1960s is planned to change and will be transformed to a defined contribution (DC) scheme[10]. The DC system gives a chance for the government to balance the pension budget year by year. This idea is very similar to the German point system and the Swedish non-financial defined contribution (NDC) system. Both are pay-as-you go pension systems by their financial basis and are combined with individual accounts. To calculate monthly benefits, projected future life expectancy should be considered.

Based on experience, using a deterministic model, 15.4 years can be forecasted for a 65 year-old Hungarian in 2007. Unisex mortality data are used for pension calculations because of the EU principle of equal treatment between men and women.[11]

Estimation of increase in life expectancy requires age-specific mortality statistics, which are modelled by three factors: age, period, and cohort. Mortality reduction is of stochastic nature. More precisely, the improvements in mortality are viewed as stochastic processes, and cannot be projected by simple linear regression models.

The difficulty of projecting longevity risk lies in its complexity. It is composed of three underlying risks:

– modelling risk (due to limited availability of data, census is taken once in a decade);
– trend risk (changes in socio-economic environment or health care can significantly increase longevity); and
– idiosyncratic risk (random error).

Idiosyncratic and modelling risks can be managed in large populations. To quantify the trend risk, various mortality forecasting models have been proposed. One of the most popular extrapolative models is the Lee–Carter model introduced by *Lee* and *Carter* in 1992. It has several variations and extensions. In the original model: $\ln m_{x,t}^{(g)} = \alpha_x^{(g)} + \beta_x^{(g)}\kappa_t^{(g)} + \varepsilon_{x,t}^{(g)}$, where $m_{x,t}^{(g)}$ is the mortality rate of an *x* year old person at time *t*, $\alpha_x^{(g)}$, $\beta_x^{(g)}$, and $\kappa_t^{(g)}$ are estimated parameters, and $\varepsilon_{x,t}^{(g)}$ is the error term. Logarithm of the mortality rates can be efficiently projected by ARIMA models (*Baran et al*. [2007]).

[9] A pension scheme where the benefits accrued are linked to earnings and the employment career (the future pension benefit is pre-defined and promised to the member).

[10] A pension scheme where the level of contributions, and not the final benefit, is pre-defined: no final pension promise is made.

[11] For details on equal gender treatment visit the EU website or see Council Directive 2004/113/EC of 13 December, implementing the principle of equal treatment between men and women in the access to and supply of goods and services (http://curia.europa.eu/jcms/upload/docs/application/pdf/2011-03/cp110012en.pdf)

Based on the Lee-Carter model age-specific mortality statistics for a 65 year-old Hungarian was estimated by ARIMA(0,1,0) in the study of *Májer* and *Kovács* [2011]. This model gives 16.43 years as expected value and has a very high determination coefficient R^2= 92%. The lower bound is 15.35 years while the upper bound is 17.6 years at a 95 percent confidence level in 2007. The confidence interval keeps getting wider in the future as uncertainty grows.

This stochastic projection shows *one year extra life expectancy* for pensioners without taking into account any possible changes in the socio-economic environment or health care.

Annual budget of the state pension fund is around 12 percent of our GDP. This amount exceeds the total pension budget in most of the developed countries. The Hungarian pension system has no reserves to help finance a longer pension period. It got additional financial support from the budget in the last decade and this was one of the components in the high deficit. Stopping this process was among others a reason why the government weakened the second – mandatory private – pillar in 2010.[12]

5. Conclusion

Uncertainties in life expectancy estimations are significantly influencing the financial stability of pension systems. Pay-as-you-go pension systems strongly need reliable projections for the ageing tendency. Hungary will face the risk of an ageing society in the next decades. This period is characterized by lower GDP growth rate and moderate increase of productivity. Hungarian macro models and forecasts calculate with higher pension payments while politics keeps promising to maintain the present pension level. These projections underestimate future benefits without adding longevity to the model. It would be wise to link pension age to life expectancy as it is done in the Danish pension system.

Consequences of longer age are hidden using defined benefit pension rules. At retirement, calculation by the defined contribution principle reacts on increasing life expectancy year-by-year. The result should be lower pension or longer contribution period if we do not want to put this financial burden on the shoulders of the next generations.

We can observe two tendencies. Ageing is faster in highly developed countries, because more money is spent on education and health. At the same time, age-gain

[12] Only 100 000 people from the 3 million members of the second pillar insisted to remain in the private scheme knowing the new regulation introduced in 2010. The accumulated wealth from the second pillar is sold and used to reduce high deficit.

decreases as life expectancy grows. Poor economic performance and high unemployment rate after the recent financial crisis does not provide enough resources to support the pension system if it remains unchanged. This is also the lesson for Hungary. Our economic development has slowed down due to the crisis but life expectancy and the old-age dependency ratio keep increasing continuously. Longevity is going to be a dominating issue in the future development of the Hungarian society and poses several questions calling for further research.

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Appendix

Components of pillars 4 and 5 of the global competitiveness index

4. Health and primary education
    A. Health
        4.01 Medium-term business impact of malaria
        4.02 Medium-term business impact of tuberculosis
        4.03 Medium-term business impact of HIV/AIDS
        4.04 Infant mortality (hard data)
        4.05 Life expectancy (hard data)
        4.06 Tuberculosis prevalence (hard data)
        4.07 Malaria prevalence (hard data)
        4.08 HIV prevalence (hard data)
    B. Primary education
        4.09 Primary enrolment (hard data)
5. Higher education and training
    A. Quantity of education
        5.01 Secondary enrolment ratio (hard data)
        5.02 Tertiary enrolment ratio (hard data)
    B. Quality of education
        5.03 Quality of the educational system
        5.04 Quality of math and science education

5.05 Quality of management schools

C. On-the-job training

5.06 Local availability of specialized research and training services

5.07 Extent of staff training