Impact of demographic dividend for longevity economy – the case of selected European countries

Grażyna Trzpiot[1]

Abstract

The year 2020 will mark the beginning of the decade of the "young old", as the Japanese call people aged between 65 and 75. The height of the baby boom, the period of high fertility in rich countries after the Second World War, was 1955-60. One might therefore expect peak retirement for baby-boomers in the coming years—except that they are not retiring. By continuing to work, and staying socially engaged, the boomers, in their new guise as the young old, will change the world, as they have done several times before at different stages of their lives. The lack of demographic dividend is the main impact on longevity economy. The aim of the paper is to establish some projections on some risks related with longevity economy. In this paper, we consider some economic, financial and demographic variables in the context of their impact on longevity. The Principal Component Regression is used in order to construct investment portfolios for longevity economy that are sensitive to risk factors according to the APT portfolio factor model for selected European countries.

Keywords: longevity, risk, PCA

JEL Classification: C130, C180

1. Introduction

Both rich and developing countries are experiencing dramatic changes in population age structure as a consequence of the demographic transition, post-world war II baby booms and busts, the emergence of very low fertility, and continuing improvements in life expectancy (Mason *et al*., 2016). Longevity is one of the most important trends of next decade. We are living longer than ever, but how we age is changing efficiently. Baby Boomers are actively aware of the later life challenges experienced by their own parents, and of the challenges that they themselves experience as their primary careers. They are making the lifestyle changes needed to ensure that their finances, health and wellbeing are optimized in later life, and that their children's lives are better for it. The "young old" are more numerous, healthier and wealthier than previous generations of seniors. There will be 11% of the population 65- to 74-year-olds in rich countries in 2020, up from 8% in 2000.

[1] Corresponding author: University of Economics in Katowice, Department of Demography and Economic Statistics, ul 1 Maja 50, 40-287 Katowice, grazyna.trzpiot@ue.katowice.pl.

Looking beyond the numbers, Baby Boomers are demanding more from later life, and the products and services on offer for them. This offers both a tremendous opportunity for businesses willing to recognize and seize it, and a threat for those that ignore it. Every sector stands to be disrupted by longevity, by changing customer demographics and opportunities, an ageing workforce, new ways to prevent and treat disease, the intersection with rising in wellness and sustainability trends or change across the pensions market.

In this paper representative countries with different economy growth level and demographic situation are selected by cluster analysis. Next the Principal Component Analysis is used to specify risk factors longevity economy. Finally the multifactor regression models (the Principal Component Regression) were used to build portfolios, which described longevity economy that are sensitive to risk factors.

2. Demographic dividend versus longevity dividend

Demographic dividend, as defined by the United Nations Population Fund means, "the economic growth potential that can result from shifts in a population's age structure, mainly when the share of the working-age population (15 to 64) is larger than the non-working-age share of the population (14 and younger, and 65 and older)"[2]. Demographic dividend occurs when the proportion of working people in the total population is high because this indicates that more people have the potential to be productive and contribute to growth of the economy. Due to the dividend between young and old, many argue that there is a great potential for economic gains, which has been termed the "demographic gift". In order for economic growth to occur the younger population must have access to quality education, adequate nutrition and health including access to sexual and reproductive health. A decline in fertility and mortality rates boosts working population productivity, which leads to a demographic dividend. The first demographic dividend phase refers to a multi-decade long rise in the support ratio that typically occurs during the demographic transition. The average duration of the first dividend phase varies by region (Fig. 1 and 2) but for many countries the duration is heavily dependent on projected values which, in turn, are influenced by the assumed speed of fertility decline. The longest average duration by a wide margin is for Africa – in excess of 90 years. The next longest is in Oceania, at about 65 years, while the average durations in the Americas and Asia are very similar at a little less than 60 years. The shortest average duration, under 40 years, is found in Europe for reasons explained above, that is, Europe's estimates of the dividends are truncated

[2] www.unfpa.org/demographic-dividend.

and therefore, the duration and accumulated size of the dividends are under-estimated (Mason *et al.*, 2017).

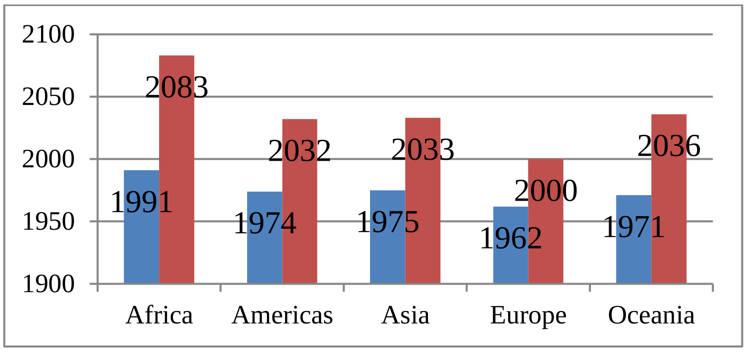

Figure 1. Start (left) and end (right) year of demographic dividend phase

Source: based on: Mason *et al.*, 2017, p. 22.

The elderly are not only growing rapidly in absolute numbers, but have also become substantially healthier. In a phenomenon referred to by demographers and health specialists as the 'compression of morbidity', the length of healthy old-age appears to be increasing. Part of this trend can be attributed to increases in the length of life, and part to shorter and later periods of illness. The net effect is an increase in number of years lived at old age without major health problems (Bloom *et al.*, 2010). Combined with the dynamic evolution of past variations in birth and death rates, recent declines in fertility rates and increases in life expectancy are causing a significant shift in the global age structure. The lag between produces a generational population, the lack of demographic dividend have the main impact on longevity economy.

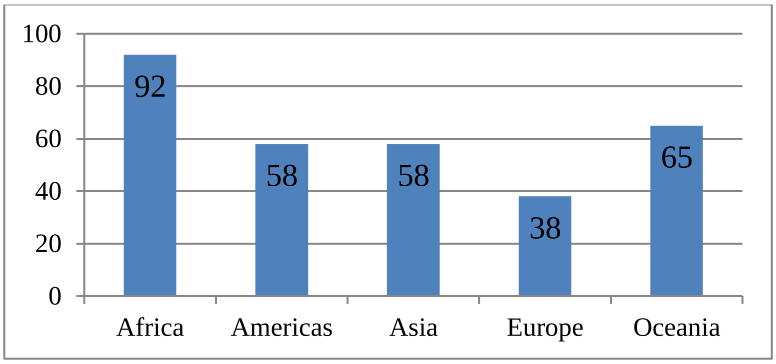

Figure 2. Average duration of the first demographic dividend by region

Source: based on: Mason *et al.*, 2017, p. 22.

Whether increased longevity is a burden or a dividend depends on the extent to which societies prepare for the challenges of ageing populations and plan for making use of the benefits. One of the most tangible benefits of living and working longer is the retention of skills and knowledge. The Longevity Dividend refers to the economic benefits of ending aging and eliminating the associated health care costs. The Longevity Dividend has been defined as "the sum of health, social and economic benefits that result from slower aging"[3]. We contend that the social, economic, and health benefits that would result from such advances may be thought of as "longevity dividends", and that they should be aggressively pursued as the new approach to health promotion and disease prevention in the 21st century (Olshansky *et al.*, 2007). How we can maximize the "Longevity Dividend"? Longevity economy depends on the real scale of demographic dividend and longevity dividend. The balance is important for retail, insurance, retail banking, housing, medicine and healthcare. We attempt to identify risk factors that could have influence on longevity economy. Especially we consider in our approach research on of real estate market, financial market and real effective exchange rates.

3. Methodology and data

As an objective in research part we attempt to identify risk factors that could have influence on the longevity economy, by investments return. An evaluation of the impact of each risk factor on portfolio return rates is presented. Investment portfolios based on different financial instrument with different fixed risk profiles, referring to longevity economy have been proposed as the final results of the main research for selected countries. The main contribution is proposed method for building portfolios that are sensitive to risk factors – based on APT portfolio methodology (Ross, 1976)[4]. We propose new approach to constructing the risk factors. Risk factor defined by PCA longevity risk factor has a significant impact on rates of return of investment portfolios. Our research proceeds with the three main steps.

First step: selection of the European countries to the analysis. The cluster analysis is applied to choose representative countries from each cluster of countries due to the macroeconomic variables. Second step: identification factors that could have influence on the long-term investment return. Dimension reduction by PCA is used for transformation of highly correlating variables into set of uncorrelated latent variables, and combination of several variables that characterize demographic changes and economic development into uncorrelated factors. Third step: simulation of the return of the investment portfolios as a particularly possibly investments in longevity economy. Two methods, PCR and PCA, are both good techniques for

[3] https://ieet.org/index.php/tpwiki/Longevity_dividend.

[4] In finance, arbitrage pricing theory (APT) is a general theory of asset pricing that holds that the expected return of a financial asset can be modeled as a linear function of various factors or theoretical market indices, where sensitivity to changes in each factor is represented by a factor-specific beta coefficient. The linear factor model structure of the APT is used as the basis for many of the commercial risk systems employed by asset managers.

dimensionality reduction in modelling data sets (Hotelling, 1933; Jolliffe, 1982, 2002). In the process of identification of risk factors the following variables are taken into consideration (Majewska and Trzpiot, 2019):

1. Demographic old-age dependency ratio – traditionally seen as an indication of the level of support available to older persons (those aged 65 or over, i.e. age when they are generally economically inactive) by the working age population (those aged between 15 and 64) [expressed per 100 persons of working age (15-64)].
2. Life expectancy at birth – the mean number of years that a newborn child can expect to live if subjected throughout his life to the current mortality conditions (age specific probabilities of dying) [expressed in years].
3. Life expectancy at age 65 – the mean number of years still to be lived by a man or a woman who has reached the age 65, if subjected throughout the rest of his or her life to the current mortality conditions (age-specific probabilities of dying) [expressed in years].
4. Consumer Price Index (CPI) – the change over time in the prices of consumer goods and services acquired, used or paid for by households [measured in an index, 2015 base year].
5. Real GDP per capita – the ratio of real GDP to the average population of a specific year; a measure of economic activity, used as a proxy for the development in a country's material living standards (a limited measure of economic welfare) [per capita, in current prices].
6. Unemployment rate – represents unemployed persons as a percentage of the labour force (the total number of people employed and unemployed) [% of active population].
7. Real effective exchange rates (REER) – aims to assess a country's price or cost competitiveness relative to its principal competitors in international markets; changes in cost and price competitiveness depend not only on exchange rate movements but also on cost and price trends [indices].
8. Gross saving – measures the portion of gross national disposable income that is not used for final consumption expenditure; gross national saving is the sum of the gross savings of the various institutional sectors [current prices].
9. Long-term government bond yields – refer to central government bond yields on the secondary market, gross of tax, with residual maturity of around 10 years; the bond or the bonds of the basket have to be replaced regularly to avoid any maturity drift [%].
10. Long-term care (health) expenditures – expenditures on a range of medical and personal care services that are consumed with the primary goal of alleviating pain and suffering and reducing or managing the deterioration in health status in patients with a degree of long-term dependency [share of current expenditures on health].

11. Currency exchange rates: EUR/USD, EUR/PLN.
12. Stock market a main index: DAX in Germany, IBEX35 in Spain, WIG20 in Poland.
13. Real Estate Funds and Equity/Dividend Funds: Unilmmo Deutchland and Allianz Vermögensbildung Deutschland (Germany), Seguffondo Inversion and Bankia Dividendo España FI (Spain), PZU UFK Investor Nieruchomości i Budownictwa and Investor FIO Subfundusz Akcji Spółek Dywidendowych (Poland).

Economic and demographic variables are derived from Eurostat database (variables 1-9) and OECD (variable 10), stock quotes – from stock exchange (Frankfurt, Madrid, Warsaw) and financial database (the Yahoo Finance) (variables 12 and 13). Time series were obtained for the time period 2010-2016. The period does not cover years from the financial crisis to avoid unusual observations from financial market.

4. Impact on longevity economy – empirical results

The cluster analysis was conducted according to the following variables: GDP growth rate (%), inflation rate (%), real productivity per hour worked, national savings, proportion of population aged 65 and over, old-age-dependency ratio (Ward linkage, Euclidean distance). As the result of cluster analysis *(*Gordon 1999) we obtain four groups of countries (Trzpiot and Majewska, 2016). One group consisted only of Luxembourg, so as the outlier, it was excluded from the analysis. We choose one representative country from each cluster: Germany, Spain and Poland. Each of these countries represents different level of economic growth and life expectancy. Next PCA was applied for identification risk factors that could have impact on longevity economy[5]. This analysis is new in two points: all variables were expressed as chain indices using a base previous observation and estimation of portfolio will depend on these new filters[6]. As a result of PCA six components for each country separately were selected and treated as F_i risk factors. The correlations between the factors were explained by factor loadings, values greater than or equal to 0.48 were used to indicate significant correlations between the component and the variables.

The results for Germany was as follows: the first principal component explains 27.2% of the variation, while all components – 73.2%, we revived a set of linearly uncorrelated variables:

[5] It is not wide period of time, thus some data were converted to monthly frequency (and then all variables were expressed as chain indices using a base previous observation – this is new approach in main research), with maintaining the strength and direction of correlation between variables.
[6] The previous paper was based on cumulative information – all variables were expressed as indices using a base year of 2010 (Trzpiot and Majewska, 2016, Majewska and Trzpiot, 2019).

The first component is identified as elderly needs risk especially because of the high positive factor loadings life expectancy at birth and life expectancy at 65. The second component has been a set of variables that reflect financial risk. Next to component was identified as labor market and market risk. Advancing age due to increased life expectancy itself is a risk factor. The next is connected with long term investment the last component explains 7.6% of total variance and it would associate with local economy risk.

For Spain the first principal component explains 22.2% of the variation, while all components – 76.4%. The first component reflects economy risk. The second was call long term standard of living (explains 16. 2% of the variation). Next component has been clustered with currency exchange rates and real effective exchange rates so was call market risk, the fourth with gross savings – individual wealth risk. The last two components were explaining 12.1% of total variance: old-dependency ratio – elderly needs risk and with long term government bond yield, it would be associated with long-term investment risk.

Table 1. Defined risk factors for selected European country 2010-2016 (chain indexes)

Risk factors	Germany	Spain	Poland
Factor 1	Elderly needs risk	Economy risk	Market risk
Factor 2t	Financial risk	Long-term standard of living risk	Elderly needs risk
Factor 3t	Labor market risk	Market risk	Long-term standard of living risk
Factor 4	Market risk	Elderly needs risk	Financial risk
Factor 5	Long-term investment risk	Individual wealth risk	Long-term investment risk
Factor 6	Local economy risk	Long-term investment risk	Individual wealth risk

For Poland the first component has been loaded with variables related with market risk and explains 23.3% of variance, all components was explain – 76.6% of the total variance. The second component has been identified as elderly needs risk. Next two components have been clustered with long-term standard of living risk and financial risk. The last two components were explain 14.2% of total variance: long term government bond yield and long-term care expenditures – we call them long-term investment risk – and a gross saving and would be associated with individual wealth risk (Table 1).

Final step of procedure was simulation of investment portfolios as a particularly possibly investments in longevity economy. Based on risk factors received by using PCA we started to estimate portfolio according to APT theory, where sensitivity to changes in each factor is represented by a factor-specific beta coefficient. Portfolio return was weighted return of chosen financial instrument and bonds. We used respectively: rate of return of Real Estate Funds, rate of return Dividend Funds as the first component of portfolio and relative change of monthly return rate of long term government bond yields 10-year as a second component of portfolio. We construct different portfolio using PCR with fixed weights (proportion of financial instrument and bond respectively): 40fi/60b (low risk) and 60fi/40b (high risk). *Rp* means portfolio rate of return.

Scenario #1: Portfolio return rate for bond and Real Estate Funds (40b/60fu)

$$R_{pGERMANY} = -0.62F5 + 0.181\,F6 \qquad R^2 = 0.45$$

The interpretation for this result for Germany is as follows: if risk represented by *F5* increase by 1then *Rp* will decrease by -0.62% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.181%.

$$R_{pSPAIN} = 0.326\,F2 + 0.293F3 - 0.24F4 - 0.32\,F5 + 0.455\,F6 \qquad R^2 = 0.56$$

The interpretation for this result for Spain is as follows: if risk represented by *F2* increase by 1, then *Rp* will increase by 0.326%, if risk represented by *F3* increase by 1, then *Rp* will increase by 0.293%, if risk represented by *F4* increase by 1, then *Rp* will decrease by 0.24%, if risk represented by *F5* increase by 1then *Rp* will decrease by 0.32% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.455%.

$$R_{pPOLAND} = 0.255F5 \qquad R^2 = 0.14$$

The interpretation of this equation for Poland is as follows: if risk represented by *F5* increase by 1, then *Rp* will decrease by will increase by 0.255%.

Scenario #2: Portfolio return rate for bond and Real Estate Funds (60b/40fu)

$$R_{pGERMANY} = -0.63F5 + 0.188\,F6 \qquad R^2 = 0.46$$

The interpretation for this result for Germany is as follows: if risk represented by *F5* increase by 1then *Rp* will decrease by -0.63% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.188%.

$$R_{pSPAIN} = 0.360\,F2 + 0.330F3 - 0.21F4 - 0.21\,F5 \qquad R^2 = 0.32$$

The interpretation for this result for Spain is as follows: if risk represented by *F2* increase by 1, then *Rp* will increase by 0.360%, if risk represented by *F3* increase by 1, then *Rp* will increase by 0.330%, if risk represented by *F4* increase by 1, then *Rp* will decrease by 0.21%, if risk represented by *F5* increase by 1then *Rp* will decrease by 0.21%.

$$R_{pPOLAND} = 0.415\,F5 \qquad R^2 = 0.24$$

The interpretation of this equation for Poland is as follows: if risk represented by *F5* increase by 1, then *Rp* will decrease by will increase by 0.415%.

Scenario #3: Portfolio return rate for bond and Dividend Funds (40b/60fu)

$$R_{pGERMANY} = -\, 0.20F2 - 0.63F5 + 0.206\, F6 \qquad R^2 = 0.49$$

The interpretation for this result for Germany is as follows: if risk represented by *F2* increase by 1, then *Rp* will decrease by 0.2%,if risk represented by *F5* increase by 1then *Rp* will decrease by 0.63% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.206%.

$$R_{pSPAIN} = 0.289\, F2 + 0.376F3 + 0.139F4 + 0.124F5 + 0.802\, F6 \qquad R^2 = 0.9$$

The interpretation for this result for Spain is as follows: if risk represented by *F2* increase by 1, then *Rp* will increase by 0.289%, if risk represented by *F3* increase by 1, then *Rp* will increase by 0.376%, if risk represented by *F4* increase by 1, then *Rp* will increase by 0.139%, if risk represented by *F5* increase by 1then *Rp* will decrease by 0.124% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.802%.

$$R_{pPOLAND} = -\, 0.49F1 + 0.391F5 \qquad R^2 = 0.4$$

The interpretation of this equation for Poland is as follows: if risk represented by *F1* increase by 1, then *Rp* will decrease by 0.49%, if risk represented by *F5* increase by 1, then R_p will increase by 0.391%.

Scenario #4: Portfolio return rate for bond and Dividend Funds (60b/40fu)

$$R_{pGERMANY} = -\, 0.17F2 - 0.63F5 + 0.199\, F6 \qquad R^2 = 0.48$$

The interpretation for this result for Germany is as follows: if risk represented by *F2* increase by 1, then *Rp* will decrease by 0.17%, if risk represented by *F5* increase by 1then *Rp* will decrease by 0.63% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.199%.

$$R_{pSPAIN} = 0.348\, F2 + 0.386F3 + 0.723\, F6 \qquad R^2 = 0.9$$

The interpretation for this result for Spain is as follows: if risk represented by *F2* increase by 1, then *Rp* will increase by 0.348%, if risk represented by *F3* increase by 1, then *Rp* will increase by 0.386% and if risk represented by *F6* increase by 1, then *Rp* will increase by 0.723%.

$$R_{pPOLAND} = 0.498F5 \qquad R^2 = 0.29$$

The interpretation of this equation for Poland is as follows: if risk represented by *F5* increase by 1, then R_p will increase by 0.498%.

5. Conclusions

Results of our analysis based on reduction on number of variables are not in conflict with mentioned early empirical studies (e.g. Bloom *et al.*, 2010, Acemoglu and Restrepo, 2017). We confirmed some projected consequences of longevity economy especially in valuation portfolio with Real Estate Funds and Dividend Funds as an asset. There is statistically significant effect extracted by PCA risk factors. In Germany we can point out three factors, all are connected with financial risk, long term investment risk and local economy risk, that impact statistically significant effect on longevity economy. In Spain we have, depend on scenario, almost all significant factors. At the end, for Poland we receive two factors: long term investment risk and market risk. Calibrated models are statistically significant, so we can use these models for prediction return of portfolio.

References

Acemoglu, D., Restrepo, P. (2017). Secular Stagnation? The Effect of Aging on Economic Growth in the Age of Automation. *American Economic Review, 107(5)*; 174-179.

Bloom, D.E., Canning, D., Fink, G. (2010). Implications of population ageing for economic growth. *Oxford Review of Economic Policy, 26(4).* 583-612.

Majewska, J., Trzpiot, G. (2019). Longevity risk factors: the perspectives of selected European countries. In Papież M. and Śmiech S. (Ed), The 13th Professor Aleksander Zeliaś International Conference on Modelling and Forecasting of Socio-Economic Phenomena. Conference Proceedings. C.H. Beck, Warszawa: p 132-140.

Mason, A., Lee, R., Xue Jiang, J. (2016). Demographic dividends, human capital, and saving, *The Journal of the Economics of Ageing*, 7, 106-122.

Mason, A., Lee, R., Abrigo, M., Lee, S. (2017). Support Ratios and Demographic Dividends: Estimates for the World, United Nations Department of Economic and Social Affairs Population Division Technical Paper No1.

McKinsey Global Institute (2016) Diminishing Returns: Why Investors May Need to Lower Their Expectations.

Olshansky, S.J., Perry, D., Miller, R.A., Butler, R.N. (2007). Pursuing the Longevity Dividend Scientific Goals for an Aging World, *Ann. N.Y. Acad. Sci. 1114: 11–13*. New York Academy of Sciences.

Trzpiot G., Majewska J. (2016). The Impact of Longevity on Long-term Investments Returns: Scenarios for Europe. Available at: www.cass.city.ac.uk/__data/assets/pdf_file/0020/334082/L12-32-TRZPIOT-and-MAJEWSKA.pdf.