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The longevity dividend - multivariate risk analysis

Abstract

Increased longevity means paying more for pensions, health care, and long-term care for the elderly. Many countries will be able to raise taxes enough to cover more than a fraction of the age wave's total cost. That is more important longevity risk. Most countries will have to cut old-age benefits, but the required reductions are large and are likely to meet with resistance from aging people. On the other hand we can look for longevity dividend. An older working population facing an extended retirement period has a powerful incentive to accumulate assets to support themselves. The benefits gotten from a demographic transition is neither automatic nor guaranteed. The longevity dividend occurs as the result of the productivity of older adults which depends on tax incentives, health programs, and pension and retirement policies.

Keywords: Longevity risk, multivariate analysis, longevity dividend
JEL J11, C50, C53

1. Introduction

A study used demographic data to explore current and projected population changes around the world. Europe and Asia are shrinking, while Africa is still growing. For the first time in history, people aged 65+ outnumber children younger than five. Underpopulation will cause serious challenges for sustainability. These changes won't spread evenly across the globe. By 2050, the regions set to see the biggest increases in elderly populations include Europe, Asia, and North America, while most nations in Africa will continue to have a relatively young population.

The declining number of younger people, who tend to buy rather than save, will further reduce the demand for all kinds of investments. Longevity risk is the risk that actual life span of individuals or whole populations will exceed expectations (Trzpiot 2016):

-Longevity risk as individuals outliving their financial resources (also called individual or idiosyncratic longevity risk),

-Longevity risk as mortality improving more than expected (, or uncertainty about future mortality improvements (also called systematic, aggregate, or pooled longevity risk),

-Longevity risk as the additional cost to a society or, more narrowly, a pension system, when mortality improvements are underestimated,

-Longevity risk as the adverse consequences of living a long time.

Looking for economic and business conditions that are weakening or even reversing individuals would need to save more for retirement, retire later, or reduce consumption during retirement. Longevity dividend refers to the economic benefits of delaying the aging process and eliminating associated health care costs. The longevity demographic dividend arises to the extent that consumers and policymakers are forward looking and respond effectively to the demographic changes with a rise in the share of the elderly population. Consumption in the future can be maintained only through the accumulation of wealth in some form. One possibility is that individuals and/or firms and governments acting on behalf of consumers accumulate capital.

2. Methodology

As an objective in research part we attempt to identify risk factors that could have influence on the longevity dividend. An evaluation of the impact of each risk factor is presented, regardless of longevity risk profile in established country. We apply multivariate analysis to find out the most important risk factor. The main contribution is proposed method – definition and the estimation for two Index of Risk of Loss Longevity Dividend that are sensitive to risk factors. In empirical part we exam the impact on longevity dividend in the following steps (Trzpiot, 2022):

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. Hierarchical method allows for determining the best number of clusters as well as to see the hierarchical relations between obtained groups of countries. Second step: identification factors that could have influence on the longevity dividend.

So in the first step, after cluster analysis we choose: Germany, Spain and Poland, then we fix time period: 2011-2020 and d Data sources: OECD, Eurostat, World Development Indicators. Seventeen variables relating to the areas of longevity economics discussed in the context of the longevity dividend were selected for analysis (Trzpiot 2022). The choice of variables was justified by substantive aspects and the availability of appropriate time series in the period that was

selected for the study (European Commission (DG ECFIN) and Economic Policy Committee (Ageing Working Group, 2018)).

Variables

1. Age dependency ratio, 1st variant (population 0 to 14 years and 65 years or over to population 15 to 64 years)
2. Age dependency ratio, 3rd variant (population 0 to 19 years and 65 years or over to population 20 to 64 years)
3. Old-age dependency ratio 1st variant (population 65 years or over to population 15 to 64 years)
4. Proportion of population aged 60-79 years
5. Proportion of population aged 60 years and more
6. Old-age dependency ratio 2nd variant (population 60 years or over to population 20 to 59 years)
7. Percentage of individuals who have basic or above basic overall digital skills, Males, 25 to 64 years old
8. Percentage of individuals who have basic or above basic overall digital skills, Females, 25 to 64 years old
9. Adult participation in learning by sex , Males, 25 to 64 years old
10. Adult participation in learning by sex, Females, 25 to 64 years old
11. Health expectancy in absolute values at 65, Males
12. Health expectancy in absolute values at 65, Females
13. Health expectancy in absolute values at 50, Males
14. Health expectancy in absolute values at 50, Females
15. Persons in the labour force (former name: active persons), From 15 to 64 years
16. Persons outside the labour force (former name: inactive persons), From 15 to 64 years
17. Employed persons, From 15 to 64 years

Then for this paper, we add some additional variables describing Senior's Human Capital

18. Transition from fixed term contracts to permanent contracts, Males, 40 to 64 years old
19. Transition from fixed term contracts to permanent contracts, Females, 40 to 64 years old
20. Transition from unemployment to employment by degree of urbanization, Cities, 55 to 74 years old
21. Transition from unemployment to employment by degree of urbanization, Total, 55 to 74 years old
22. Transition from unemployment to employment by previous work experience, Males, 55 to 74 years old
23. Transition from unemployment to employment by previous work experience, Females, 55 to 74 years old

Dimension reduction by Principal Component Analysis (PCA) – which was used for transformation of highly correlating variables (23 variables relating to the 5 areas: demography, human capital, health, labour force and Senior's Human Capital) into set of uncorrelated factors, and combination of several variables that characterize demographic changes and economic development into uncorrelated factors.

Longevity dividend risk factors for selected European countries (2011-2020)

	Germany	Spain	Poland
Factor 1	**Risk of burden on younger seniors labour market**	**Risk of burdening all seniors**	**Risk of social conditions**
Factor 2	**Risk of burden on seniors labour market**	**Risk of loss of life in health**	**Risk of loss of life in health**
Factor 3	**Risk of loss of life in health**	**Risk of lack of digital education**	**Risk of burden on seniors labour market**
Factor 4	**Risk of lack of up-to-date education**	**Labour market risk**	**Risk of lack of up-to-date education**
Factor 5		**Risk of lack of necessary education**	**Risk of lack of digital education**

Source: Trzpiot G. (2022): Longevity Risk Versus Longevity Dividend, „Modern Classification and Data Analysis. Methodology and Applications to Micro- and Macroeconomic Problems", Studies in Classification, Data Analysis, and Knowledge Organization - 1431-8814, ed. K. Jajuga, G. Dehnel, M. Walesiak, Springer, pp. 225-239, DOI: doi.org/10.1007/978-3-031-10190-8_16

Third step: we define two Index of Risk of Loss Longevity Dividend[1] by used: Exports of goods and services (% of GDP), High-technology exports (% of manufactured exports), Income share held by lowest 20%, Merchandise trade (% of GDP).

[1] Trzpiot G. (2022)

INDEX of Risk of Loss Longevity Dividend

INDEX_ RLLD_1 = 0,25 EXP+ 0,25 TECH + 0,25 DST+ 0,25 VAL

INDEX_ RLLD_2 = 0,3 EXP+ 0,3 TECH + 0,2 DST + 0,2 VAL

based on variability of:

EXP - Exports of goods and services (% of GDP)

TECH - High-technology exports (% of manufactured exports)

DST - Income share held by lowest 20%

VAL - Merchandise trade (% of GDP)

Final step of the research procedure was estimation of the defined Index of Risk of Loss Longevity Dividend. We present results for Sain and Poland (impact of lack of some data for Germany). We applied principal component regression model. The explanatory variable in the PCA model is a defined Index of Risk of Loss Longevity Dividend, as the explanatory variables were longevity risk factors obtained for each country individually.

MODEL PCA results for Spain:
estimation of INDEX of Risk of Loss Longevity Dividend

INDEX_ RLLD_1 = 0,482 F1 + 0,347 F3 - 0,67 F4 + 0,0029

R^2* = 0*.91

The interpretation for this **r**esult for Spain is as follows: if risk represented by *F1* increase by 1, then INDEX_ RLLD_1 will increase by 0.482%, if risk represented by *F3* increase by 1, then INDEX_ RLLD_1 will increase by 0.347%, if risk represented by *F4* increase by 1, then INDEX_ RLLD_1 will increase by 0.67%.

INDEX_ RLLD_2 = 0,501 F1 - 0,64 F4 + 0,0024
***R^2* = 0.74**

The interpretation for this **r**esult for Spain is as follows: if risk represented by *F1* increase by 1, then INDEX_ RLLD_2 will increase by 0.501%, if risk represented by *F4* increase by 1, then INDEX_ RLLD_2 will decrease by 0.64%,

MODEL PCA results for Poland:
estimation of INDEX of Risk of Loss Longevity Dividend

INDEX_ RLLD_1= 0,844 F1 - 0,44 F2 +0,21 F3 + 0,029
R^2 = 0.97

The interpretation for this result for Poland is as follows: if risk represented by *F1* increase by 1, 1 will increase by 0.844%, if risk represented by *F2* increase by 1, then INDEX_ RLLD_1 will decrease by 0,44%, if risk represented by *F3* increase by 1, then INDEX_ RLLD_1 will increase by 0.21%

INDEX_ RLLD_2 = 0,878 F1 – 0,42 F2 + 0,162 F3 +0,032
R^2 = 0.98

The interpretation for this **r**esult for Poland is as follows: if risk represented by *F1* increase by 1, then INDEX_ RLLD_2 will increase by 0.878%, if risk represented by *F2* increase by 1, then INDEX_ RLLD_2 will decrease by 0.42%, if risk represented by *F3* increase by 1, then INDEX_ RLLD_1 will increase by 0.162%

There is statistically significant effect extracted by PCA risk factors which impact the level of defined indexes. Econometric models estimated by applied PCR are statistically significant. In Germany we can point one main factor connected with burden on seniors on labour market. In Spain we have factors connecting with labour market: risk of burdening all seniors, risk of loss of life in health and lack of digital or ever necessary education. At the end, for Poland we receive significant factor: risk of social conditions, risk of loss of life in health and risk of burden on seniors' labour market. These results 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, Trzpiot 2022). We confirmed some projected consequences.

Conclusions

The results of PCA analysis, was used to describe some risk factor, which impact on longevity dividend. We applied PCA regression to observe defined Indexes of Risk of Loss Longevity Dividend for some given scenarios. The Index of Risk of Loss of Longevity Dividend was defined, the variability of which was estimated using principal components regression (PCR), so the estimation depends on the designated factors. Two different fixed longevity risk profiles have been proposed as the final results of the main research as particularly likely Indexes and can be considered as scenarios for the future level of longevity risk for selected countries. PCA's longevity risk factors have a significant impact on the long-term return on investment portfolios.

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