# Presupposed demographic changes in the contemporary population and their influence on public state spending

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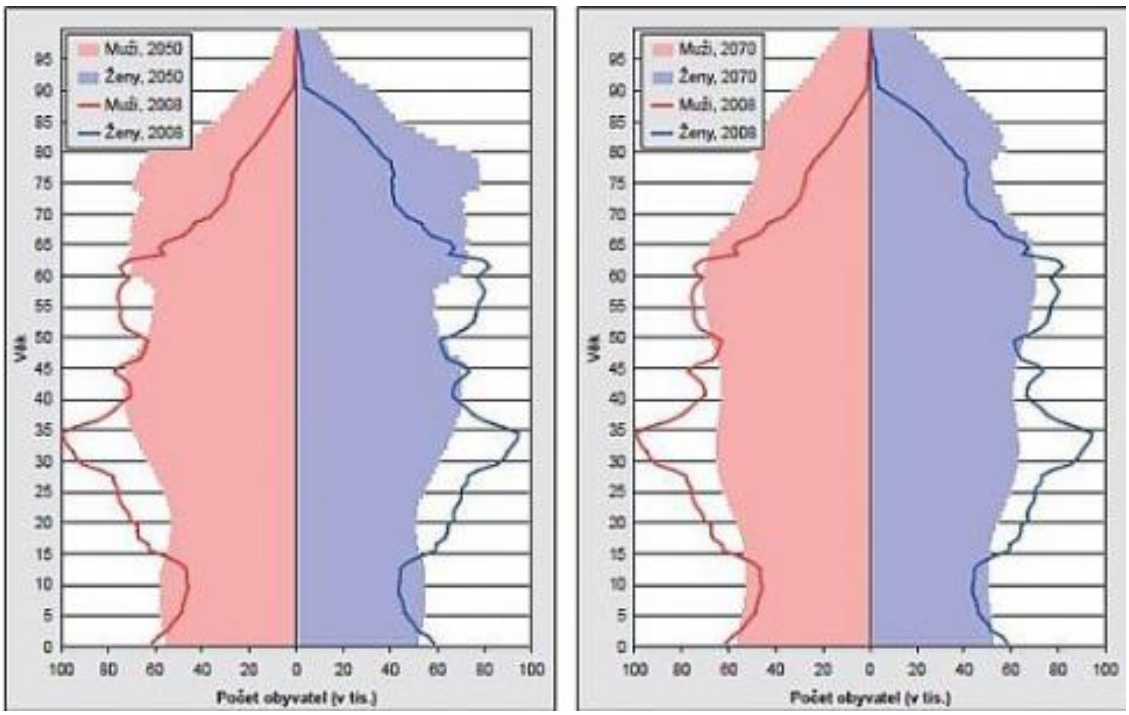
## 1 Introduction

Over the years, people more and more talk about the dangers of the aging population. Almost every developed population is struggling with the fact that people are living longer while fewer children are born. Populations are growing at an unsustainable pace. Figure 1, taken from Demografická situace České republiky - proměny a kontexty 1993-2008 (The Demographic Situation in the Czech Republic - Transformations and Contexts 1998-2003), shows the expected age structure between 2050 and 2070 compared with the starting point in 2008.

**Figure 1: The expected age structure of population between 2050 and 2070 compared to the starting point in 2008**




Source: Demographic Situation in the Czech Republic, Transformations and Contexts 1998-2003

This trend causes problems in pension systems of many countries. The most commonly used methods of funding of current pension systems are currently, for instance, the Pay as you go system (PAYG) or Full funding system (FF). The PAYG system, or a system of ongoing funding, means immediate redistribution of selected funds from the working population towards the population after the productivity period. All resources are in the system within a given period, and they are immediately redistributed within the same period. The continuous funding system is based on complete solidarity and applies fair redistribution. Redistribution

is applied in the direction from the rich to the poor and also between the genders, i.e. towards women. Women, from the perspective of the pension system, participate less, especially due to the absence of earnings during their maternity or parental leaves. Women also live longer, while leaving before retirement (the last statement is valid only in case of the forthcoming merger of the retirement age for both genders), and thus draw money from the system longer. Despite the above facts, sometimes redistribution can be low or even zero. Redistribution can be reduced, for example, through a system of fictitious accounts.

Due to the efficiency and yield rate of this system, the funds are collected from the economically active population given the functions of the economically active population, labour productivity, which is derived from the level of wages, and the tax rate.

$$POJ = (M, P, s) \quad (1)$$

where POJ - Social Insurance
M - number of economically active population
P - productivity
w - wages
s - tax rate

The average retirement pension of an individual is then determined as a ratio of premiums collected and the number of old-age pensioners.

$$SDavg.\ POJ = N / A \quad (2)$$

where SDavg. - Average individual retirement
POJ - Selected insurance
N - number of old-age pensioners

A positive relationship can be identified in M, i.e. a growth in the economically active population, increasing the amount of premiums collected. The same is true of the dependence of labour productivity and tax rates. The function is negatively affected by the number of pensioners. From the macroeconomic perspective, it is the easiest to influence the tax rate. Another option is to change the designated age for retirement. Changing this factor increases M while reduces N.

The advantages of this system include intergenerational solidarity, redistribution of resources from the rich to the poor, relatively low administrative costs, or limited information asymmetry, and the market thus witnesses only minimal effects of fluctuations in the securities market. On the other hand, the disadvantages of the Pay as you go system include changing political decisions, when the funds are used according or contrary to the original plan, ongoing demographic changes (aging population), and de-stimulation to create private pension savings as people rely on the role of the state and the development on securities market.

Not only for these reasons there is also a system of full funding, which is based on the principle that the economically active population is supposed to save funds for their own retirement. The amount of their retirement savings depends on the time for which they saved money, the amount and frequency of payments to the fund, and the net capital gains which the fund achieves. The following rule applies in this system; the faster the economy grows in average real wages, the greater part of the wages system participants must contribute to the fund in order to achieve the same or similar replacement ratio.

The greatest advantages of this system are, unlike in the Pay as you go system, that it contributes to the development of securities markets, allows you to transfer consumption over time by the fact that people save money, and it also solves the problem of aging populations, or rather removes the main cause which causes the pay as you go system fail. The full funding system also creates a stable base of long-term savings and affects the economy by increasing the level of aggregate savings. Its disadvantages, however, consist in particular of uncertainty on the part of participants as they simply do not know whether their funds will be safe and healthy. Also, there is a major information asymmetry, and the fact that the costs of implementation and operation of this system are relatively high and largely limited to intergenerational solidarity.

Most countries still use the Pay as you go system, in particular due to the fact that the costs of switching to another system are high and also because stopping the PAYG system income causes the lack of funds for the current retirees. The pension systems of these countries are not able to respond to ongoing changes in the long run and to resist aging, and thus there is a need to reform these pension systems. The reform trends in most countries tend to introduce multi-pillar pension systems instead of the current one-or two-pillar systems. An important element of change is the introduction of the private funded pillar from the non-public sources. Another very frequently element used is postponing of the age for retirement. This way is very effective, but useless in the long term. Also, it initiates a strong wave of protests by the citizens, who often face the prospect of retiring as late as after the $70^{th}$ year. In general, a solution to this problem is yet to be found.

Options for pension reforms

Basically, it is possible to distinguish two basic aspects. The first aspect includes economic and financial options, and the other can be viewed from the perspective of an ideal option. The economic-financial point of view says, according to Aaron's rule, that "the continuous system is more efficient if the sum of the growth rate of real incomes and the population growth rate is higher than the rate of return from the investment portfolio."

An ideal option could be a balanced combination of all four methods of financing, i.e. the optimum combination of family, individual, national and state capital financing. Also, several international organizations proposed a number of models that could be introduced in order to help the current slowly failing pension systems.

Model of the World Bank

The World Bank proposed a three-pillar system. The first pillar is compulsory and state-operated, funded from general tax funds, and its goal is redistribution of resources and insurance. The second pillar consists of mandatory privately managed contributions and pension funds in the form of personal retirement accounts or employee pension funds, and finally the third pillar is a voluntary fund for people who want to increase their future security.

Model of the International Labour Organisation (ILO)

The International Labour Organization, as well as the World Bank, offers a three-pillar system. The first pillar is minimized and its task is only to protect citizens against poverty in old age. Benefits from this pillar are subject to the test of necessity. The second pillar is a mandatory state Pay as you go system. Benefits from this pillar are indexed according to inflation. The last and third pillar is a fund financed, contribution defined, or even privately managed pension plan. The last pillar is a supplement to the state pillar for maintaining the replacement ratio.

OECD Model

This model includes reforms based on improving the financial stability of the PAYG pension system by reducing the generosity of the system or, conversely, increasing the required contributions to it. Another important element of the OECD model is to promote private pension schemes and to strengthen the role of fully funded pension benefits for future.

Capital-based pension reform

Capital-oriented modernization of the pension system is, according to the publication on the securities markets by prof. ing. Petr Musílek, Ph.D., presented as a multi-pillar system, which is divided into four pillars, from the zero pillar up to the third pillar. The zero pillar is characterized by continuous family financing. The first pillar is the current pillar in a modified version, and the modification mostly concerns a significant reduction in the state pension system. The participants are promised equal pension benefits that are not dependent on previous earnings. The second pillar is a pension investment system with mandatory participation. It can be characterized by financing that is mediated by independent pension companies. The amount of contributions is a fixed percentage of the current income of the participants. The percentage, at first, should be 5% and would be increased up to 8% - 10%. Company pension schemes should give the participant a choice between several alternatives. At least one option should be conservative and would present a combination of progressive possibilities. Finally, the third pillar is a voluntary pillar, fully privately funded.

Due to the demographic changes, there is an increasing pressure on public spending in terms of its use for old-age pensions.

Research objective and methods

**Research objective:** the research is aimed at identifying the level of dependence of factors directly affecting public spending on pensions and identifying interdependencies between the various factors and their development between 2007-2050 and 2007-2060.

**Research methods used:** in order to meet the research objectives, the method of analysis and subsequently the method of synthesis will be used, together with using the regression analysis and correlation matrix.

1. **method of analysis** will be used for segmentation of the researched variables into individual factors in the form of public spending on pension. Each of these factors will be examined using the regression analysis
2. **regression analysis** will be used to measure the level of dependence of individual independent variables on the dependent variable. The dependent variable will be public spending on pensions in relation to the GDP. There will be four independent variables; the dependence ratio, employment rate, the number of pensioners in the population of people over 65 years, and the average pension in relation to the GDP per employee
3. **correlation matrix** is used to provide information related to the linear dependence between the factors that affect public spending on pensions.
4. **synthesis method** will be mostly used in the final summary of results.

## 2 The Research Procedure

The first step before the application of the research methods was extensive collection of relevant data. The 2009 Ageing Report served as the main source. The data used were:

- spending on pensions (% from the spending used for pensions from the total GDP),
- GDP in million EUR,
- Number of persons in the population aged over 65,
- Number of persons in the population in the working age, aged from 15 to 65,
- Number of employed people in the working age (15-64),
- Number of retirees,
- The average pension (as a share of the total spending on pensions to the number of pensioners),
- GDP per employee (as a share of the GDP to the total number of employed persons).

The data relate to 2007 and the estimates to 2050 and 2060. Also, the data are assessed based on the percentage changes between 2007-2050 and 2007- 2060. In the following steps, the data is used as components of the factors that explain the variable in the form of public spending on pensions (dependent variable). Selection of the following factors was made according to the model mentioned in the publication Public Pension Expenditure in the EPC and the European Commission Projections: an Analysis of the Projection Results. See the following equation:

$$\frac{PensExp}{GDP} = \frac{Pop\ 65+}{Pop\ 15-64} \times \frac{Pop\ 15-64}{EmplNo} \times \frac{PensNo}{Pop\ 65+} \times \frac{PensExp/PensNo}{GDP/EmplNo} \quad (3)$$

where PensExp public spending on pensions,

GDP gross domestic product,

Pop 65 + - number of people aged over 65,

Pop 15-64 number of persons aged from 15 to 64,

EmplNo number of employed persons aged from 15 to 64,

PensNo number of retirees receiving pension.

The equation is integrity. The left side of the equation (3) shows the share of public spending on pensions to the gross domestic product. It represents the dependent variable. The individual fractions on the right side of the equation (3) are the relevant factors (explain the variables).

Furthermore, individual explanatory variables of the equation are developed as follows (3):

1) the dependence ratio defined as the proportion of persons aged over 65 and persons of the economically active population (15-64)

2) the employment rate determines the percentage of employment for the population group aged 15-64. It is defined as the proportion of people aged 15-64 in the number of employed people of the same age.

3) the pensioners rate to the population of persons over 65 shows the proportion between the number of persons receiving a pension and those aged over 65. This ratio was more than 100 % in all studied countries. With this indicator, it is possible to evaluate changes in relation to extending the retirement age, which tool has been lately introduced in many European countries.

4) the average pension to the GDP per employee (economic output per employee).

The above factors of the equation (3) will also be used as explanatory variables. The variable explained is the spending on pensions to the GDP.

## 3 Methodology

In order to examine the dependence of individual explanatory variables on the explained variable, the method of regression analysis was used. The regression analysis is an econometric-statistical method. This method attempts to find a relationship between the explained variable and one or more explanatory variables. The regression function can take the form of a straight line, hyperbola or logarithm. When applying the regression analysis, it is necessary to evaluate the quality of tests using statistical tests such as the coefficient of determination ($R^2$) and the F-test. $R^2$ measures the accuracy of the model as a whole. F-test, according to the chosen level of statistical significance, evaluates the model as a whole and determines the statistical significance of the model.

For the research, the linear regression estimated by the method of least squares was selected. The model passed all tests. In order to reject first-order autocorrelations, all the extreme values, i.e. for 2060 CY and 2050 SK, were removed.

The quality of the test was evaluated using the coefficient of determination $R^2$. The coefficient of determination shows the percentage of the total variance of the monitored parameter which is determined by the explanatory variables. Another indicator is the F-test, which determines whether the model makes sense as a whole. It is also necessary to check the level of autocorrelation. The level of autocorrelation will be tested using the Durbin-Watson statistic (the "DW-test"). The last evaluation criterion is the T-test. The T-test indicates the significance level for the selected explanatory variable. If an explanatory variable does not meet the parameters of the T-test, it is not significant within the model and a better explanatory variable needs to be found.

From the previous research, it was concluded that the linear regression will be used as the only tool. There was an assumption that the values behave linearly, even when the number of pensioners is increasing. It is necessary to note that the value of employment pushes the growth down. The linear regression is thus the highest-quality model.

General notation of the linear regression equation:

$$Y = A0 + A1X1 + A2X2 + A3X3 + A4X4 \quad (2)$$

The estimates of the regression models together with the results of the tests were achieved using the SAS program. In order to determine the level of dependence of the spending on pensions on the individual explanatory variables of the equations, but also on their interdependence, a correlation matrix was used with 28 observations and a 5% critical value, and then comparison of changes in dependencies between 2007-2050 and 2007-2060 was carried out. The elements of this matrix (linear correlation coefficients) were obtained from the covariance matrix elements, obtained using the following formula with the assumptions that the variances $\sigma_j^2, \sigma_i^2$ are not equal to zero.

$$\rho_{ij} \frac{cov\ (x_i, x_j)}{\sqrt{\sigma_j^2 * \sigma_i^2}} \quad (3)$$

where $\rho_{ij}$ – Correlation matrix

cov (xi, xj) – Covariance (xi, xj)

$\sigma_i^2$ – Variance i

$\sigma_j^2$ – Variance j

The correlation matrix is symmetric because $v(x_i, x_j =)\sigma_i^2$ , are elements on the main diagonal and are equal to one $p_{ii} = 1$ . The off-diagonal elements lie in the interval (-1, 1). If the correlation coefficient is zero, the relevant components of the vector x are uncorrelated, which, however, does not mean that the quantities are independent. Therefore, we cannot claim about the components in the vector x, not even if $p_{ii}$ is zero, that the elements are independent (there may be a non-linear dependence). The more the correlation coefficient in the absolute value is close to number one, the more are the vector components reciprocally correlated and linearly dependent.

The relationship between the covariance and correlation matrices can be expressed as $\sum_x > 0$ , than also R > 0 and:

$$\sum_x = M * R * M \tag{4}$$

M = regular diagonal matrix whose elements are standard deviations M = diag($\sigma_1 i$, $[\![ \ldots . \sigma ]\!]_1 n$) . The fact that the correlation matrix R is positively definite can be deduced from the assumption $\sum_x > 0$ and from the equation (4). The covariance matrix is factorable into the product of the matrices $\sum_x = S^T * S$ as $M = M^T$ is $R = (M^T)^{-1} * S^T * S * M^{-1} = D^T * D$ , c, which is, according to the Sylvester's criterion, a positive deficit of a positive definite matrix[1].

To obtain the above data, the Gretl 1.9.2cvs program was used.

[1] *VOBOŘILOVÁ, P.: Porovnání přesnosti náhodných veličin. KATEDRA SPECIÁLNÍ GEODÉZIE FAKULTY STAVEBNÍ ČVUT. Publikace a jiné práce [online]. [cit. 2012-06-01]. Availiable at: http://slon.fsv.cvut.cz/~pavla/por_presn/html/mat_pre_hamp.html*

# 4 Analysis of selected factors

The factors contained in the tables below represent the percentage change between the researched years. Table 1 summarizes the percentage change in the studied factors between 2007-2050.

**Table 1: Selected factors in % change between 2007- 2050**

| Country | Spending on pensions | | Dependence ratio | Employment ratio | The ratio of pensioners to the population 65 + | Average pension / GDP per employee |
|---|---|---|---|---|---|---|
| | initial level as % of the GDP in 2007 | % change 2007 - 2060 | | | | |
| BE | 0.092 | 0.522 | 0.689 | 0.050 | -0.052 | -0.003 |
| BG | 0.068 | 0.382 | 1.209 | 0.042 | -0.221 | -0.163 |
| CZ | 0.071 | 0.366 | 1.706 | 0.060 | -0.357 | -0.167 |
| DK | 0.070 | 0.043 | 0.802 | 0.014 | -0.357 | -0.087 |
| DE | 0.104 | 0.183 | 0.890 | 0.075 | -0.156 | -0.203 |
| EE | 0.049 | -0.041 | 0.969 | 0.026 | -0.237 | -0.345 |
| IE | 0.026 | 1.538 | 1.488 | 0.049 | -0.239 | 0.407 |
| EL | 0.088 | 1.034 | 1.041 | 0.055 | -0.085 | 0.149 |
| ES | 0.056 | 1.196 | 1.415 | 0.110 | -0.084 | 0.101 |
| FR | 0.130 | 0.092 | 0.775 | 0.037 | -0.147 | -0.252 |
| IT | 0.135 | 0.067 | 0.963 | 0.090 | -0.206 | -0.254 |
| CY | 0.048 | 1.583 | 1.156 | 0.080 | 0.214 | 0.067 |
| LV | 0.048 | 0.146 | 1.045 | 0.000 | -0.173 | -0.322 |
| LT | 0.056 | 0.661 | 1.206 | 0.002 | -0.154 | -0.109 |
| LU | 0.058 | 2.155 | 0.747 | 0.006 | 0.501 | 0.211 |
| HU | 0.090 | 0.344 | 1.199 | 0.065 | -0.351 | 0.003 |
| MT | 0.042 | 1.286 | 1.521 | 0.082 | -0.250 | 0.308 |
| NL | 0.045 | 0.933 | 1.111 | 0.025 | -0.174 | 0.136 |
| AT | 0.095 | 0.168 | 0.925 | 0.038 | -0.212 | -0.201 |
| PL | 0.098 | -0.173 | 1.943 | 0.081 | -0.449 | -0.449 |
| PT | 0.091 | 0.187 | 1.050 | 0.059 | -0.138 | -0.289 |
| RO | 0.053 | 1.528 | 1.515 | -0.031 | -0.321 | 0.435 |
| SI | 0.070 | 1.100 | 1.663 | 0.007 | -0.237 | 0.041 |
| SK | 0.043 | 0.302 | 2.377 | 0.078 | -0.389 | -0.319 |
| FI | 0.075 | 0.560 | 0.852 | 0.057 | -0.217 | 0.137 |
| SE | 0.070 | 0.086 | 0.586 | 0.043 | -0.018 | -0.273 |
| UK | 0.058 | 0.362 | 0.577 | 0.039 | -0.192 | 0.110 |
| NO | 0.057 | 0.789 | 0.867 | -0.026 | -0.095 | 0.031 |
| EU27 | 0.091 | 0.253 | 0.995 | 0.064 | -0.203 | -0.162 |
| EU25 | 0.092 | 0.239 | 0.984 | 0.075 | -0.200 | -0.161 |
| EU15 | 0.093 | 0.247 | 0.878 | 0.070 | -0.159 | -0.155 |
| EU10 | 0.081 | 0.111 | 1.707 | 0.085 | -0.386 | -0.275 |

Source: The 2009 Ageing Report, the data was used for determination of values for individual factors examined

The first column of Table 1 contains the initial level of spending on pensions in 2007 as % of the GDP. The second column is the dependent variable representing the percentage change in spending on pensions as a share of the GDP between 2007-2050. With some exceptions (Estonia and Poland), there was an increase in public spending on pensions in all EU countries. A significant increase is evident at the level of dependence of the population over 65 on the population aged 15-65. Reduction of the employment rate is expected only in Romania and Norway. The proportion of pensioners in the population over 65 years is negative in all countries, which also means that it is expected that the retirement age will be extended for proper retirement. The average pension as a proportion of the GDP per employee is also negative. However, this factor can be interpreted in many ways. It is directly influenced by the assumption of the growth of labour productivity and the associated anticipated growth in average wages. Also, the average pension can be expected to rise. But it is also necessary to note the fact that multi-pillar pension schemes are introduced, which aims to decompose the amount of pensions into the public and private sectors (in the form of individual preparation for retirement).

The result of the regression analysis is an equation (4) showing the number of percentage points by which the percentage change in spending on pensions in proportion to the GDP will change (increase/decrease).

The percentage change in spending on pensions as a share of the GDP = 0.35 **+ 0.66** dependence rate of persons (65 +) on the economically active persons (15-64) **– 1.48** employment rate **+ 1.97** rate of pensioners to persons over 65 years **+ 1.75** rate of average pensions as a proportion of the GDP per employee.

The dependent variable in terms of a percentage change in spending on pensions as a share of the GDP can be explained as follows:

- increasing the percentage change in the rate of dependence of people (65+) on the economically active (15-64) by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 0.66 percentage points,
- increasing the percentage changes in the employment rate by 1 percentage point will reduce the percentage change in spending on pensions as a share of the GDP by 1.48 percentage points,
- increasing the percentage change in the number of pensioners to persons over 65 years by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.97 percentage points,
- increasing the percentage changes in the rate dependence of the average pension as a proportion of the GDP per employee by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.75 percentage points

| | |
|---|---|
| DW = 1.91 | first-order autocorrelation does not occur |
| $R^2$ = 0.989511 | model is very good |
| F-test | model as a whole makes sense |
| T-test | all explanatory variables are significant at the chosen level |

The best explanatory variable is the number of pensioners to persons aged 65 years and the average level of pensions as a proportion of the GDP per employee.

Excluded extreme value - SK (autocorrelation)

The same procedure as for the percentage change between 2007 and 2050 was applied for 2007 and 2060. Compared to interpretation of the previous table, the prediction for 2060 of the percentage change in public spending on pensions as a share of the GDP clearly shows

more frequent occurrence of negative values. Specifically, in Estonia and Poland, as in Table 1, and newly in Denmark and Italy. The percentage change in the dependence rate is positive for all countries and when compared with the values from Table 1, it can be identified that in all countries except for Luxembourg there was an increase in this variable. The employment rate takes negative values only in Romania and Norway, which reflects the value prediction for 2050. When comparing changes between Tables 1 and 2, there were only slight changes in the values of per cent. Clearly, a negative change (reduction) occurred in the original EU countries. Also, as for the rate of pensioners to the population of people over 65 years, there was only a slight change between predictions for 2050 and 2060. As in Table 1, a negative percentage change dominates between 2007 and 2060. The factor of the average pension as a percentage of the GDP per employee is predominated by a negative percentage change between 2007 and 2060. However, as stated in the interpretation of Table 1, this indicator is very hard to identify without further examination of individual variables.

**Table 2: Selected factors in % change between 2007 and 2060**

| Country | Spending on pensions | | Dependence ratio | Employment ratio | The ratio of pensioners to the population 65 + | Average pension / GDP per employee |
|---|---|---|---|---|---|---|
| | initial level as % of the GDP in 2007 | % change 2007 - 2060 | | | | |
| BE | 0.092 | 0.522 | 0.764 | 0.050 | -0.061 | -0.036 |
| BG | 0.068 | 0.471 | 1.545 | 0.063 | -0.280 | -0.147 |
| CZ | 0.071 | 0.479 | 2.030 | 0.060 | -0.377 | -0.169 |
| DK | 0.070 | -0.043 | 0.848 | 0.013 | -0.400 | -0.125 |
| DE | 0.104 | 0.231 | 0.981 | 0.076 | -0.162 | -0.202 |
| EE | 0.049 | -0.122 | 1.216 | 0.037 | -0.259 | -0.445 |
| IE | 0.026 | 1.769 | 1.720 | 0.048 | -0.261 | 0.444 |
| EL | 0.088 | 1.011 | 1.056 | 0.052 | -0.058 | 0.093 |
| ES | 0.056 | 1.161 | 1.429 | 0.105 | -0.077 | 0.065 |
| FR | 0.130 | 0.077 | 0.796 | 0.039 | -0.152 | -0.266 |
| IT | 0.135 | -0.015 | 0.969 | 0.087 | -0.203 | -0.317 |
| CY | 0.048 | 1.958 | 1.419 | 0.080 | 0.273 | 0.038 |
| LV | 0.048 | 0.000 | 1.607 | 0.031 | -0.253 | -0.471 |
| LT | 0.056 | 0.839 | 1.816 | 0.011 | -0.224 | -0.149 |
| LU | 0.058 | 2.466 | 0.723 | 0.002 | 0.599 | 0.260 |
| HU | 0.090 | 0.411 | 1.480 | 0.066 | -0.383 | -0.017 |
| MT | 0.042 | 1.643 | 2.059 | 0.082 | -0.283 | 0.304 |
| NL | 0.045 | 1.000 | 1.193 | 0.022 | -0.180 | 0.138 |
| AT | 0.095 | 0.158 | 1.015 | 0.039 | -0.184 | -0.268 |
| PL | 0.098 | -0.194 | 2.643 | 0.093 | -0.487 | -0.529 |
| PT | 0.091 | 0.187 | 1.140 | 0.056 | -0.130 | -0.327 |
| RO | 0.053 | 1.679 | 2.050 | -0.019 | -0.386 | 0.403 |
| SI | 0.070 | 1.143 | 1.788 | 0.012 | -0.256 | 0.045 |
| SK | 0.043 | 0.442 | 3.094 | 0.092 | -0.416 | -0.341 |
| FI | 0.075 | 0.600 | 0.974 | 0.058 | -0.235 | 0.121 |
| SE | 0.070 | 0.171 | 0.769 | 0.044 | -0.041 | -0.279 |
| UK | 0.058 | 0.569 | 0.745 | 0.041 | -0.184 | 0.146 |
| NO | 0.057 | 0.825 | 0.964 | -0.026 | -0.085 | -0.012 |
| EU27 | 0.091 | 0.275 | 1.120 | 0.067 | -0.214 | -0.184 |
| EU25 | 0.092 | 0.261 | 1.090 | 0.075 | -0.205 | -0.184 |
| EU15 | 0.093 | 0.258 | 0.939 | 0.067 | -0.157 | -0.179 |
| EU10 | 0.081 | 0.160 | 2.233 | 0.088 | -0.421 | -0.326 |

Source: The 2009 Ageing Report, the data was used for determination of values for individual factors examined

The result of the regression analysis is an equation showing the number of percentage points by which the percentage change in spending on pensions in proportion to the GDP will change (increase/decrease).

The percentage change in spending on pensions as a share of the GDP = 0.47 + **0.57** dependence rate of persons (65 +) on the economically active persons (15-64) **- 1.39** employment rate **+ 1.99** rate of pensioners to persons over 65 years **+ 1.88** rate of the average pension as a proportion of the GDP per employee.

The dependent variable in terms of a percentage change in spending on pensions as a share of the GDP can be explained as follows:

- increasing the percentage change in the level of dependence of people (65 +) on the economically active persons (15-64) by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 0.57 percentage point
- increasing the percentage change in the employment rate by 1 percentage point will reduce the percentage change in spending on pensions as a share of the GDP by 1.39 percentage points,
- increasing the percentage change in the number of pensioners to persons over 65 years by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.99 percentage points,
- increasing the percentage change in the dependence rate of the average pension as a proportion of the GDP per employee by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.88 percentage points

| | |
|---|---|
| DW = 2.3 | first-order autocorrelation does not occur |
| $R^2$ = 0.970503 | model is very good |
| F-test | model as a whole makes sense |
| T-test | all explanatory variables are significant at the chosen level |

The best explanatory variable is the number of pensioners to persons aged 65 years and the average pension as a proportion of the GDP per employee.

Excluded extreme value - CY (autocorrelation)

In order to determine the dependence of spending on pensions on individual numerators and denominators of the basic equation, a correlation matrix was used using 28 observations with a 5% critical value (both sides), which was 0.3739.

The analysis of the results of 2007 confirms that there is a strong positive linear dependence of spending on pensions mainly on the GDP, number of persons over 65, number of people in the working age, the number of employees, and the number of pensioners where the ratio exceeds 0.9. There is a positive linear relationship, but weaker than in the above case, between spending on pensions and the average pension in thousands of EUR, and a very weak positive linear relationship between spending on pensions in relation to the GDP per employee.

The similar results are also shown in a linear dependence of the GDP on the number of people aged over 65, the number of people in the working age, number of employees and retirees, where a linear dependence also exceeds 0.9, and the same trend is seen even in weak linear dependencies of the GDP on average pensions in thousands EUR and the GDP on GDP/employee, where the values of correlation coefficients are 0.5669 and 0.2168.

We can also observe a strong positive linear relationship between the majority of members of the monitored part of the equation. Worth noting, however, is also a weaker and very weak

linear relationship between the average pension in thousand EUR and the GDP/employee and other members, where in some cases there is a very weak positive linear dependence. The only exceptions are GDP/employee and the average pension in thousands EUR, due to their relative values (fraction of GDP/employee) and exogenous variables such as the number of people over 65 and those working.

**Table 3: 2007, using observations from 1 to 28**
**5% critical value (both sides) = 0.3739 for n = 28**

| Pens. Spend. | GDP (mil. EUR) | Number of persons aged over 65 | Number of persons aged 15 to 64 | Number of employed persons aged 15 to 64 | Number of retirees receiving pension | Average pension (thousands EUR) | GDP/ employee | |
|---|---|---|---|---|---|---|---|---|
| 1.0000 | 0.9407 | 0.9377 | 0.9053 | 0.9017 | 0.9254 | 0.6005 | 0.1909 | **Pens. Spend.** |
| | 1.0000 | 0.9582 | 0.9472 | 0.9647 | 0.9244 | 0.5669 | 0.2168 | **GDP (mil.eur)** |
| | | 1.0000 | 0.9874 | 0.9850 | 0.9874 | 0.4485 | 0.0872 | **Number of persons aged over 65** |
| | | | 1.0000 | 0.9951 | 0.9880 | 0.4120 | 0.0588 | **Number of persons aged 15 to 64** |
| | | | | 1.0000 | 0.9752 | 0.4257 | 0.0810 | **Number of employed persons aged 15 to 64** |
| | | | | | 1.0000 | 0.4132 | 0.0418 | **Number of retirees receiving pension** |
| | | | | | | 1.0000 | 0.8074 | **Average pension (thousands EUR)** |
| | | | | | | | 1.0000 | **GDP/ employee** |

Source: own processing using gretl 1.9.2cvs.

A similar behaviour is shown in the analysis of correlation coefficients for 2050, which implies mostly positive linear relationships with similar results -- see above. Worth noting, however, is a change in the positive linear dependence in the GDP per employee on the number of pensioners into a very weak negative linear relationship, which was caused by a greater number of pensioners in 2050 compared to 2007 and reduction on GDP/employee, i.e. by a change in demographics of the population.

**Table 4: Correlation Matrix for 2050, using observations from 1 to 28**
**5% critical value (both sides) = 0.3739 for n = 28**

| Pens. Spend. | GDP (mil. eur) | Number of persons aged over 65 | Number of persons aged 15 to 64 | Number of employed persons aged 15 to 64 | Number of retirees receiving pension | Average pension (thousands EUR) | GDP/ employee | |
|---|---|---|---|---|---|---|---|---|
| 1.0000 | 0.9598 | 0.9421 | 0.9561 | 0.9515 | 0.9516 | 0.3824 | 0.1269 | **Pens. Spend.** |
| | 1.0000 | 0.9208 | 0.9732 | 0.9827 | 0.9179 | 0.3689 | 0.1326 | **GDP (mil.eur)** |
| | | 1.0000 | 0.9771 | 0.9685 | 0.9961 | 0.2200 | 0.0002 | **Number of persons aged over 65** |
| | | | 1.0000 | 0.9963 | 0.9763 | 0.2619 | 0.0322 | **Number of persons aged 15 to 64** |
| | | | | 1.0000 | 0.9635 | 0.2757 | 0.0473 | **Number of employed persons aged 15 to 64** |
| | | | | | 1.0000 | 0.2238 | -0.0001 | **Number of retirees receiving pension** |
| | | | | | | 1.0000 | 0.8926 | **Average pension (thousands EUR)** |
| | | | | | | | 1.0000 | **GDP/employee** |

Source: own processing using gretl 1.9.2cvs.

The following Table 5 shows relative changes in linear dependencies of individual members of the equation for 2050 compared to 2007. We can see that in eighteen cases the positive linear relationship between the members declines, which is due to demographic predictions, i.e. the number of pensioners per employee grows. Also noteworthy is the dependence of GDP/employee on the number of pensioners whose positive linear dependence fell by more than 100%, which means a switch from a positive to negative linear relationship, which is again explained by a change in demographics of the population.

**Table 5: Relative changes in dependence of the correlation matrices 2050/2007 in%**

| Pens. Spend. | GDP (mil. EUR) | Number of persons aged over 65 | Number of persons aged 15 to 64 | Number of employed persons aged 15 to 64 | Number of retirees receiving pension | Average pension (thousands EUR) | GDP/ employee | |
|---|---|---|---|---|---|---|---|---|
| 0 % | 2.030% | 0.469% | 5.611% | 5.523% | 2.831% | -36.320% | -33.525% | **Pens. Spend.** |
| | 0.000% | -3.903% | 2.745% | 1.866% | -0.703% | -34.927% | -38.838% | **GDP (mil.eur)** |
| | | 0.000% | -1.043% | -1.675% | 0.881% | -50.948% | -99.771% | **Number of persons aged over 65** |
| | | | 0.000% | 0.121% | -1.184% | -36.432% | -45.238% | **Number of persons aged 15 to 64** |
| | | | | 0.000% | -1.200% | -35.236% | -41.605% | **Number of employed persons aged 15 to 64** |
| | | | | | 0.000% | -45.837% | -100.239% | **Number of retirees receiving pension** |
| | | | | | | 0.000% | 10.552% | **Average pension (thousands EUR)** |
| | | | | | | | 0.000% | **GDP/ employee** |

Source: own processing using gretl 1.9.2cvs.

Very similar results as in 2050 shows the analysis of correlation coefficients for 2060, as shown in Table 6

**Table 6: Correlation matrix for 2060, using observations from 1 to 28**
**5% critical value (both sides) = 0.3739 for n = 28**

| Pens. Spend. | GDP (mil. EUR) | Number of persons aged over 65 | Number of persons aged 15 to 64 | Number of employed persons aged 15 to 64 | Number of retirees receiving pension | Average pension (thousands EUR) | GDP/ employee | |
|---|---|---|---|---|---|---|---|---|
| 1.0000 | 0.9761 | 0.9337 | 0.9692 | 0.9673 | 0.9476 | 0.3846 | 0.1374 | **Pens. Spend.** |
| | 1.0000 | 0.9222 | 0.9763 | 0.9845 | 0.9266 | 0.3748 | 0.1401 | **GDP (mil.EUR)** |
| | | 1.0000 | 0.9791 | 0.9710 | 0.9960 | 0.2104 | -0.0005 | **Number of persons aged over 65** |
| | | | 1.0000 | 0.9965 | 0.9816 | 0.2750 | 0.0468 | **Number of persons aged 15 to 64** |
| | | | | 1.0000 | 0.9703 | 0.2880 | 0.0597 | **Number of employed persons aged 15 to 64** |
| | | | | | 1.0000 | 0.2246 | 0.0087 | **Number of retirees receiving pension** |
| | | | | | | 1.0000 | 0.9070 | **Average pension (thousands EUR)** |
| | | | | | | | 1.0000 | **GDP/ worker** |

Source: own processing using gretl 1.9.2cvs.

Table 7 provides an overview of the relative change in linear dependencies of individual members of the equation for 2060 to 2007. The linear dependence is positive and decreases again in eighteen cases. A significant decline occurred in the dependence of GDP/workers on the number of people over 65, where a very weak positive relationship turned into a very

weak negative dependence with a correlation coefficient of -0.0005, which is again due to the increased number of future pensioners.

**Table 7: Relative change in dependence of the correlation matrices 2060/2007 in%**

| Pens. Spend. | GDP (mil. EUR) | Number of persons aged over 65 | Number of persons aged 15 to 64 | Number of employed persons aged 15 to 64 | Number of retirees receiving pension | Average pension (thousands EUR) | GDP/ employee | |
|---|---|---|---|---|---|---|---|---|
| 0.000% | 3.763% | -0.427% | 7.058% | 7.275% | 2.399% | -35.953% | -28.025% | **Pens. Spend.** |
| | 0.000% | -3.757% | 3.072% | 2.052% | 0.238% | -33.886% | -35.378% | **GDP (mil.EUR)** |
| | | 0.000% | -0.841% | -1.421% | 0.871% | -53.088% | -100.573% | **Number of persons aged over 65** |
| | | | 0.000% | 0.141% | -0.648% | -33.252% | -20.408% | **Number of persons aged 15 to 64** |
| | | | | 0.000% | -0.502% | -32.347% | -26.296% | **Number of employed persons aged 15 to 64** |
| | | | | | 0.000% | -45.644% | -79.187% | **Number of retirees receiving pension** |
| | | | | | | 0.000% | 12.336% | **Average pension (thousands EUR)** |
| | | | | | | | 0.000% | **GDP/employee** |

Source: own processing using gretl 1.9.2cvs.

## 5 Conclusion

The paper pointed to demographic changes in the age structure of the population and their impacts on the countries' pension systems. The most common methods of financing pensions systems are the Pay as you go system and the Full finance system (FF). However, both of them have their pros and cons. The greatest disadvantage of the Pay as you go system is the fact that it cannot respond to the dangerous future situation and it ceases to be able to meet the future needs of today's actively working population. The FF system has a great advantage, mostly due to its positive effect on accumulating savings in the economy, which supports economic growth. However, it transfers all the risk on citizens by information asymmetry, as people cannot know whether they savings will return.

The paper also outlined possible future developments as proposed by international organizations. The World Bank model suggests a three-pillar system, while the International Labour Organisation (ILO) also proposes a three-pillar system, however, with another composition. The Organization for Economic Cooperation and Development suggests a system, which should increase contributions or decrease benefits. Finally, a suggestion by prof. Pan Petr Musílek, Ph.D was mentioned, who in his book proposes a four-pillar pension system which includes the family, state, a mandatory investment pillar and a capital pillar (the last one voluntary).

The paper analysed the changes in public spending on pensions. The default variable was public pension spending as a percentage of the GDP. This variable was analysed using the decomposition of the individual factors. These factors included the level of dependence determined as a percentage of the population over 65 years on the economically active population group aged 15 to 64, the effect of employment as a percentage of employed persons in the group of economically active persons aged 15 to 64, the rate of pensioners to the population of people aged over 65, and finally the average pension per employee performance (GDP per employee). The analysis of the research was based on the research

titled Public Pension Expenditure in the EPC and the European Commission Projections: an Analysis of the Projection Results from 2006, which dealt with decomposition of public spending on pensions using four main factors. These factors used in the above research were taken and used for evaluation of the level of dependence using a regression analysis. The research covered all EU countries and Norway.

The research objective was to identify the level of dependence of factors directly affecting public spending on pensions. The levels of dependence were identified, including identification of mutual correlations of the individual explanatory variables. In order to achieve the objectives of the research, the methods of analysis and subsequent synthesis were used, using the regression analysis and correlation matrices. The research objective was achieved. Below is listed a summary of the levels of dependence of factors directly affecting public spending on pensions, first between 2007 and 2050 and then between 2007 and 2060. Some of the variables operate in the same direction (direct dependence) while some in the opposite direction (indirect dependence). The power of dependence can be measured by the coefficient of the variable.

Between 2007 and 2050, it is possible to explain the dependent variable in terms of a percentage change in spending on pensions as a share of the GDP as follows:

- increasing the percentage change in the level of dependence of persons (65 +) on the economically active persons (15-64) by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 0.66 percentage points,
- increasing the percentage change in the employment rate by 1 percentage point will reduce the percentage change in spending on pensions as a share of the GDP by 1.48 percentage points,
- increasing the percentage change in the number of pensioners to persons over 65 years by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.97 percentage points,
- increasing the percentage changes in the dependence rate of the average pension as a share of the GDP per employee by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.75 percentage points.

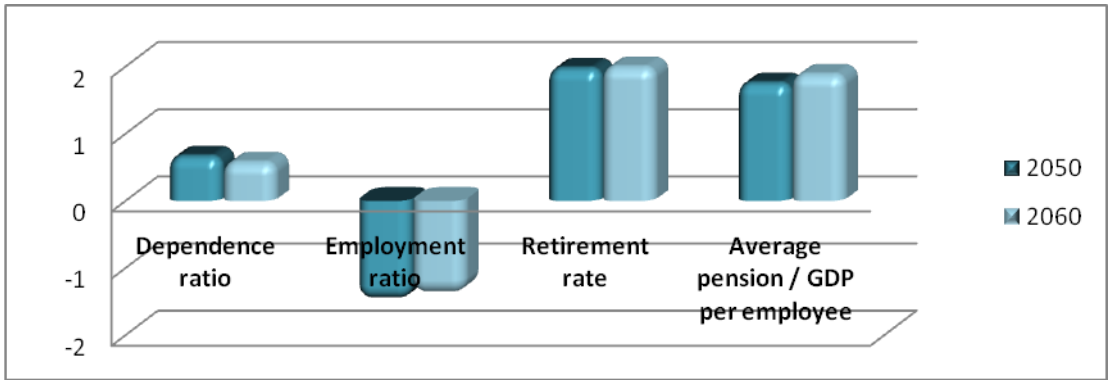
Between 2007 and 2060, it is possible to explain the dependent variable in terms of a percentage change in spending on pensions as a share of the GDP as follows:

- increasing the percentage change in the level of dependence of persons (65 +) on the economically active persons (15-64) by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 0.57 percentage points,
- increasing the percentage change in the employment rate by 1 percentage point will reduce the percentage change in spending on pensions as a share of the GDP by 1.39 percentage points,
- increasing the percentage change in the number of pensioners to persons over 65 years by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.99 percentage points,
- increasing the percentage change in the dependence rate of the average pension as a share of the GDP per employee by 1 percentage point will increase the percentage change in spending on pensions as a share of the GDP by 1.88 percentage points.

From the above conclusions, it can be stated that in the estimates for 2050 and 2060 there is a decrease in the dependent rate of persons over 65 years on the economically active persons,

and that the employment rate is expected to decrease. On the other hand, as for the number of pensioners and the average pension to the GDP per employee, there is an increase.

**Graph 1: Results of the Regressive Analysis**




After quantification of the level of dependence between the variables for 2007, it is possible to see a strong positive linear dependence for most of the explanatory variables. Similar results were achieved both for 2050 and for 2060, when in 2050 there was a change in a positive linear dependence of GDP/employee on the number of pensioners into a very weak and negative linear dependence, and in 2060 this trend can be seen in a positive linear dependence of GDP/employee on the number of people aged over 65, which in both cases is due to demographic changes in population distribution.

The quantified monitored relative changes in the linear dependence of the individual members of the given integrity for 2050 to 2007 revealed that positive linear dependence between the variables decreases in eighteen cases and the same occurs for 2060 and 2007, which both resulted from the demographic distribution of population in the future, but also there is a possibility of another variable.

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## Summary

The paper analyses the changes in public spending on pensions. The default variable is public spending on pensions as a percentage of the GDP. This variable is analysed by decomposition of the individual factors. These factors include the rate of dependence determined as a percentage of the population over 65 years on the economically active group of population aged 15 to 64, the employment effect as a percentage of employed persons in the group of the economically active persons aged 15 to 64 years, the rate of pensioners to the population of people aged over 65 years, and finally the average pension per employee performance (GDP per employee). The analysis is based on the research titled Public Pension Expenditure in the EPC and the European Commission Projections: an Analysis of the Projection Results from 2006.

**Key words:** spending on pensions, ageing population, pension system reforms.

**JEL classification:** H55