The financial development perspective of funded pension systems

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Abstract. The current distribution pension system is on the verge of financial sustainability, which resulted in a budget deficit of the Pension Fund of the Russian Federation and the redirection of pension funds to the distribution system in 2014. One of the main reasons for this is the demographic risks. One of the tools for solving the demographic problem of the distribution pension system is funded systems. However, they are exposed to demographic risks as well. The paper provides an analysis of the impact of demographic risks on funded pension systems. It offers conditions for the financial sustainability of the funded pension system under the influence of demographic and macroeconomic factors. It investigates the compliance with the conditions of the financial sustainability of funded pension systems of Russia and OECD countries in the period from 1958 to 2012, making the forecast for the financial sustainability of funded pension systems until 2050, and the comparative dynamic analysis is held.

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Introduction

The impact of demographic risks on the pension system is difficult to overestimate. Demographic risks affect the financial sustainability of pension systems through income and expenditure systems. Reasons for such impacts are the effects of age of entry into working life and retirement, the duration of the period of pension savings, an amount of employable citizens, the number of citizens of retirement age and life expectancy [1].

Demographic risks of the pension system are heterogeneous and, in some cases, involve not only demographic factors. In the analysis of demographic risks all pension systems will be divided into two parts: funded and distribution pension systems. The first is affected by such risks as:

• increasing in life expectancy, which will affect the duration of pension payments;

• increasing age of entry into the labor market influencing the amount of pension savings;

• fluctuations in the average retirement age, which will affect both the duration of pension savings and the duration of pension payments.

Demographic risks are not the only risks that affect pension systems [2]. Particularly for defined contribution pensions systems, the main risks are those related to investments. Such risks are managed through active use of portfolio theories [3], [4]. Besides, operational risks should be also highlighted [5].

Pension systems with the distribution character are influenced by demographic risks to a greater extent. So, in addition to those already listed demographic risks for funded pension systems for distribution systems the following ones are significant:

• Increasing the number of citizens - recipients of pensions

• Reducing the number of the working population whose contributions and tax payments fund pensions.

Funded systems act as an alternative mechanism helping to solve problems arising in the distribution of pension systems under the influence of demographic changes. However, funded pension systems are also affected by demographic risks.

In our work, we will focus on the impact of demographic risks for funded pension systems, maintaining their financial sustainability both in the past 50 years and the forecast for the next 40 years.

Impact of demographic risks on the financial y sustainability of funded pension systems. Theoretical basis

The impact of demographic risks on funded pension systems is determined by the following factors: 1) the amount of accumulated pension capital (pension savings) is determined inter alia by the accumulation period, that is, the age of entry into working life and retirement age; 2) the value of

pension benefits depends on the age of survival, i.e. retirement age and age of life.

The impact of demographic risks on the funded pension system can be represented in a mathematical formula through the influence on the basic parameters of pension systems - the value of pension payments (PV) and the replacement rate (PZ).

$$PV = \frac{Pn}{d} \qquad (1)$$

Pn- sum of pension savings

d – age of survival - the period of payments of pension savings

In turn, the amount of pension savings can be expressed in terms of the wage, rate of insurance contributions and the accumulation period:

$$Pn = \sum_{q=1}^{w-v} sn \times Zpl \times ((1+r)\times(1+a))^q = s \times Zpl \times \sum_{i=1}^{w-v}((1+r)\times(1+a)^q \qquad (2)$$

Zpl – average wage

r - average rate of wage indexation

q - period of wage indexation and investment period

sn- rate of insurance contributions directed to the funded system

a- rate of investment income (in shares) received from the investment of pension savings

w- retirement age

v- age of entry into working life

In turn, the term of survival is determined to the age of retirement (retirement age) (w) and age of life expectancy (age of life) (z):

$$d = z - w \qquad (3)$$

Thus, substituting (1) and (2) into (3) we obtain a formula:

$$PV = \frac{s \times Zpl \times \sum_{q=1}^{w-м}((1+r)\times(1+a))^q}{z-w} \qquad (4)$$

characterizing what share of lost earnings is replaced by pension payments and the replacement rate will be calculated accordingly:

$$PZ = \frac{PV}{Zpl\times(1+r)^{w-v}} = \frac{s \times Zpl \times \sum_{q=1}^{w-м}((1+r)\times(1+a))^q}{z-w} \times \frac{1}{Zpl\times(1+r)^{w-v}} = \frac{s \times \sum_{q=1}^{w-v-1}(1+r)^q \times \sum_{q=1}^{w-v}(1+a)^q}{z-w} \qquad (5)$$

As it is demonstrated by the obtained formulas for the main indicators of the pension systems, pension payments (4) and the replacement rate (5), the impact of demographic risks in the funded pension system will be largely offset by the investment income, the effect of which is amplified by a function exponent.

The dynamic impact of demographic risks is defined through pension benefits under funded pension system for years i and j and the coefficient of main indicators of the funded pension system.

$$\frac{PV_i}{PV_j} = \frac{s_i \times Zpl_i \times \sum_{q=1}^{w_i-v_i}((1+r_i)\times(1+a_i))^q}{z_i - w_i} \times \frac{z_j - w_j}{s_j \times Zpl_j \times \sum_{q=1}^{w_j-v_j}((1+r_j)\times(1+a_j)^q} \qquad (6)$$

As it can be seen from the formula (6) the impact of demographic risks on pension payments, namely the age of entry into the labor market, the retirement age and the age of life, will be largely limited by the investment income, the effect of which is amplified by a function exponent.

In the absence of growth of wages, the dynamics of pension payments in the funded pension system depends on the rate of insurance contributions (s), rates of investment income (a) and demographic parameters - the retirement age (w), the age of entry into working life (v) and lifetime (z). However, operating the rate of insurance contributions as a factor-effect to increase pension payments to funded pension system would mean a de facto an increase in the tax burden on enterprises. Therefore, when it is impossible or undesirable to increase the tax burden then the investment income and demographic factors will only influence on pension payments:

$$\begin{cases} \dfrac{PV_i}{PV_j} = \dfrac{\sum_{q=1}^{w_i-v_i}(1+a_i))^q}{z_i - w_i} \times \dfrac{z_j - w_j}{\sum_{q=1}^{w_j-v_j}(1+a_j)^q} \\ r \to 0 \\ Zpl_i = Zpl_j \\ S_i = S_j \end{cases} \qquad (7)$$

It should be noted that this issue has been described, for example, by Gontmakher [6]. In the formula (7), the difference in life expectancy (z) and retirement age (w) is the duration of pension payments (tv), and the difference of retirement age (w) and the age of entry into working life (v) is the period of pension savings (tn). Retirement payments

under funded pension system are less susceptible to demographic risks compared with pension payments within the distribution system, as under the funded pension system they can be leveled by the function exponent of investment income. If there is a task of constructing financially sustainable funded pension system that does not require leveling the impact of demographic risks by the investment income (i.e. a = 0), we obtain the condition of the financial sustainability of the funded pension system under the influence of demographic risks:

$$\begin{cases} \dfrac{PV_i}{PV_j} = \dfrac{t_{ni}}{t_{nj}} \times \dfrac{t_{vj}}{t_{vi}} \\ PV_i \geq PV_j \\ \dfrac{t_{ni}}{t_{nj}} \geq 1 \\ \dfrac{t_{vi}}{t_{vj}} \leq 1 \end{cases} \quad \text{or} \quad \begin{cases} \dfrac{PV_i}{PV_j} = \dfrac{t_{ni}}{t_{nj}} \times \dfrac{t_{vj}}{t_{vi}} \\ PV_i \geq PV_j \\ \Delta t_n \geq \Delta t_v \end{cases} \quad (8)$$

The impact of demographic risks for pensions in a funded pension system in the formulas (1 - (8)) can be represented as a diagram (see Figure 1):

As Figure 1 demonstrates the maintenance of pension payments at the current level in terms of demographic risks in the absence of growth of wages and investment income is possible if the increase in the period of pension savings exceeds the period of pension distributions or shortening of the period of pension savings is slower than the reduction of the period of pension distributions.

However, the advantage of funded pension systems as compared with the distribution ones lies in the fact that the impact of demographic risks on them can be offset by investment income, but not only due to the increase of the tax burden through increased insurance payments. Hence, there is a second option of the compliance of the financial sustainability of the funded pension system. At the negative impact of demographic risks, i.e. in the situation of the outstripping growth period of pension payments relative to the period of pension savings, pension payments remain the same, if the impact of investment income through the function exponent will be stronger or if there is an increase in rates of insurance payments.

Thus, the condition for the conservation of the replacement rate, as well as pension payments in funded pension systems is the greater changing of the period of pension savings than the period of pension payments.

The growth of demographic risks is typical not only for the Russian pension system. Demographic risks are one of the main problems for OECD countries' pension systems [7].

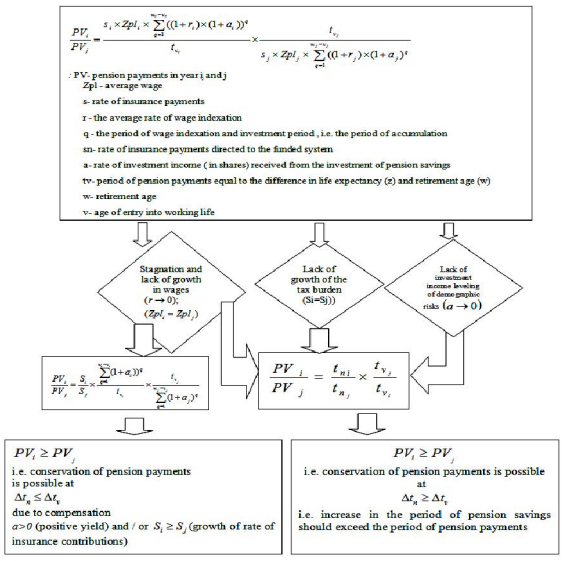

Figure 1. Condition of financial sustainability of pension funded systems under demographic risks

Maintaining financial sustainability of funded pension systems of OECD countries: past, present and future

In OECD countries, there is also a general trend of increasing of life expectancy, which in turn causes an increase in duration of pension payments [8]. As our analysis shows (Fig. 2(a)), the duration of pension payments for men of OECD countries on average in the period from 1958 to 2010 increased from 13.4 years to 18.5 years [9]. The increase amounted to 5.1 years, or 38.5%. Thus, even without an increase in pension payments and the number of pensioners, the increase in costs of pension systems would amount to 38.5%. The growth of the duration of pension payments by OECD countries is observed for women as well. However, the rate of increase is much higher. The duration of pension payments to women from 1958 to 2010 in the OECD countries on average increased from 17 to 23.3 years, i.e. 37.1%.

The retirement age is one of the main instruments by which governments seek to maintain financial sustainability of pension systems and to neutralize the impact of demographic risks to them. It is thanks to increase the retirement age governments reduce the duration of pension payments and increase the financial sustainability of pension systems.

However, to analyze the growth of the duration of pension payments in isolation from changes in the retirement age would be wrong. The graphical analysis of the correlation of the changes of the length in pension payments and increase of the duration of pension payments for women of OECD countries is represented in Figures "Correlation of the change of the retirement age and the period of pension payments for women (2010 to 1958) "and

"Correlation of the change of the retirement age and the period of pension payments for women (2050 to 2010)".

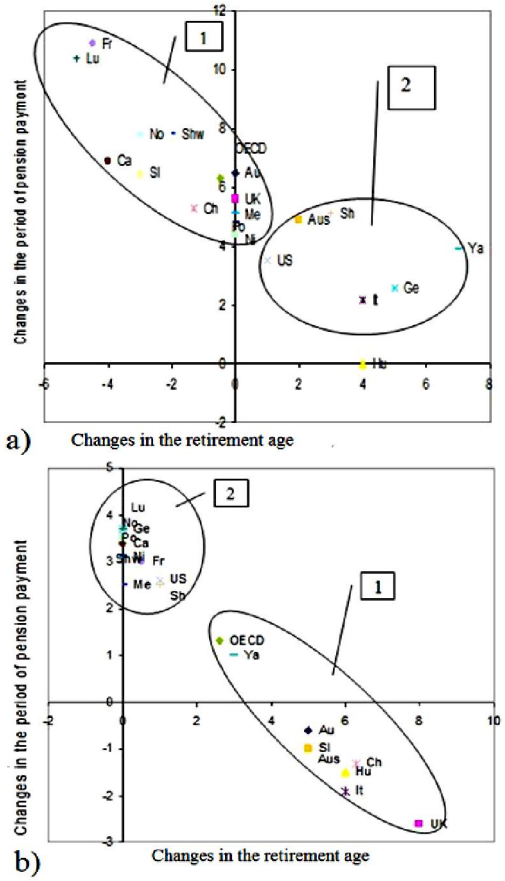

Fig. 2. a) The correlation of changes in the retirement age and the period of pension payments for women (2010 to 1958).*
b) The correlation of changes in the retirement age and the period of pension payments for women (2050 to 2010)*

Note for figure 2 (a,b):

* Calculated by the authors on the base of statistic data of OECD [10], [11]

** The graph shows the following symbols of countries:

Australia - Aus, Austria - Au, United Kingdom -UK, Hungary - Hu, Germany -Ge, Italy - It, Canada -Ca, Luxembourg - Lu, Mexico -Me, Netherlands -Ni, Norway -No, Poland -Po, Slovakia - Sl, USA -US, Czech Republic -Ch, France -Fr, Switzerland -Sh, Sweden -Shw, Japan -Ya, the average for the OECD countries – OECD.

*** For the 1st group of countries - the condition to maintain the financial sustainability of the pension system under the influence of demographic risks (inequality (p. 69) , for the 2nd group - is not satisfied.

In Figures all the countries are divided into 2 groups: the 1st group of countries is characterized by the performance of the condition to maintain the financial sustainability of the pension system under the influence of demographic risks in accordance with the inequality in Fig. 1, for the 2nd group the terms of financial sustainability of the pension system is not satisfied. In Table 1, countries are structured by dedicated groups represented in "The execution of the condition of financial sustainability of pension systems under the influence of demographic risks for women" and the distribution of countries according to the inequality is shown (8).

As it is demonstrated by Figures 1 and 2 (a) and Table 1, not in all countries in the period from 1958 to 2010 the development of the pension system for women occurred in compliance with the condition of the conservation of conditions of financial sustainability, according to which the growth of the duration of pension payments in order to preserve the financial equilibrium of pension system is compensated by the increase of retirement age. For example, against the background of the duration of pension payments in countries such as Canada, France, Slovakia, Luxembourg, Norway, Switzerland, the Czech Republic and Poland retirement age for women decreased. In other countries, such as Austria, the UK , the Netherlands, Mexico, the USA, Australia, Sweden, Germany, Italy, Japan, Hungary, the growth of the duration of pension payments is accompanied by an increase or fixation of retirement age.

In the period from 2010 to 2050, the situation changes: the conditions of financial sustainability has been performed in 8 countries - Japan, Hungary, Italy, Australia, Austria, Great Britain, the Czech Republic, Slovakia, and on the average for the countries of OECD (Figure 1 and 2 (a) - Group 1). In other countries - Canada, Luxembourg, Mexico, Netherlands, Norway, Poland, USA, France, Switzerland, Sweden and Germany (Figure 1 and 2 (a) - Group 2) the inequality (8) is violated.

The conditions of conservation of financial stability of the pension system under demographic risks for men (see Figure 3(a) and 3(b)) in accordance with the inequality in Fig. 1 were carried out not in all countries. Between 1958 and 2010, under the influence of demographic risks the financial sustainability decreased in pension systems for men in the following countries: Hungary, USA, Mexico, Netherlands, the United Kingdom, Australia, Austria, Sweden, Switzerland , Italy , Canada, Norway , Luxembourg , France. In these countries the growth of the period of pension payments outstripped the

increase of the retirement age. On the average in OECD countries the situation was the same.

The condition of conservation of the financial sustainability in accordance with the inequality (Fig. 1) is observed in Germany, Japan, the Czech Republic, Slovakia and Poland. In these countries the retirement age was increasing faster than the duration of pension payments. In the period from 2010 to 2050, the situation changes (Fig. 3 (b)). On the average the financial sustainability of pension systems is maintained in the United States, Australia, Czech Republic, Great Britain, Hungary, Italy and in the OECD countries. It is planned that the duration of pension payments will increase faster than the retirement age in Slovakia, Sweden, Switzerland, Norway, Luxembourg, Austria, Germany, Canada, France, Netherlands, Poland, Mexico.

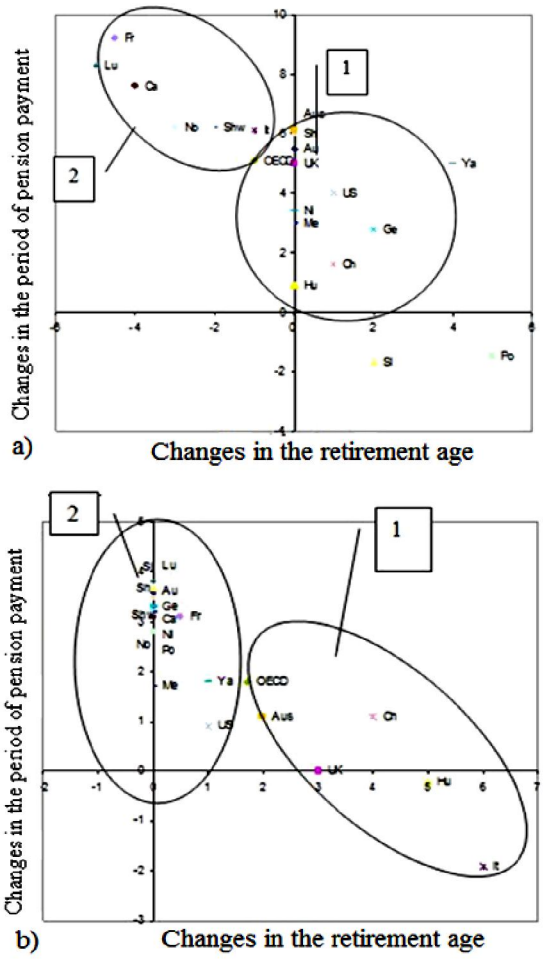

Fig. 3. a) Correlation of changes of the retirement age and the period of pension payments for men (2010 to 1958). *

b) Correlation of changes of the retirement age and the period of pension payments for men (2050 to 2010). *

Note for figure 3 (a, b):

* The graph shows the following symbols of countries:

Australia - Aus, Austria - Au, United Kingdom -UK, Hungary - Hu, Germany -Ge, Italy - It, Canada -Ca, Luxembourg - Lu, Mexico -Me, Netherlands -Ni, Norway -No, Poland -Po, Slovakia - Sl, USA -US, Czech Republic -Ch, France -Fr, Switzerland -Sh, Sweden -Shw, Japan -Ya, on the average for the OECD-OECD countries

** Calculated by the authors on the base of statistic data of OECD [10], [11]

*** For the 1st group of countries - the condition to maintain the financial sustainability of the pension system under the influence of demographic risks (inequality in Fig. 1), for the 2nd group - is not satisfied.

In Figures 3 (a) and 3(b) all the countries are divided into 2 groups: the 1st group of countries is characterized by the implementation of the condition of conservation of financial sustainability and for the 2nd group the condition of financial sustainability of the pension system (the inequality (8)) is not satisfied.

The division of countries on the principle of the conservation of financial sustainability is shown in Table 1

Table 1. The performance of the condition of financial sustainability of pension systems under the demographic risks for men and women

Periods	Financial sustainability is observed (inequality (8) is satisfied)		Financial sustainability is not observed (inequality (8) is not satisfied)	
	Pension system for women	Pension system for men	Pension system for women	Pension system for men
Period from 2010 to 2050	Japan, Hungary Italy, Australia, Austria, Britain, the Czech Republic, Slovakia, on average for the OECD countries	USA, Australia, Czech Republic, Great Britain, Hungary, Italy, on average for the OECD countries	Canada, Luxembourg, Mexico, Netherlands, Norway, Poland, USA, France, Switzerland, Sweden, Germany	Japan, Germany, Slovakia, Poland, Austria, Canada, Luxembourg, Mexico, Netherlands, Norway, Switzerland, Sweden
Period from 1958 to 2010	Japan, Germany, Hungary, Italy	Japan, Germany, Slovakia, Czech Republic, Poland	Australia, Austria, Britain, Canada, Luxembourg, Mexico, Netherlands, Norway, Poland, Slovakia, USA, the Czech Republic, France, Switzerland, Sweden, on average for the OECD countries	Australia, Austria, Britain, Canada, Luxembourg, Mexico, Netherlands, Norway, the United States, Hungary, Italy, France, Switzerland, Sweden, on average for the OECD countries

As Table 1 and figures 2 (a) – 2(b) show, the financial instability of pension systems is observed in the majority of countries surveyed between 1958 and 2010, and will continue until 2050. It can have three negative effects: the reduction of social efficiency, i.e. the main indicators - the replacement rate and pension payments in financially unsustainable pension systems or the growth of state budget expenditures in the form of various subsidies, or increase the tax burden on economic entities. In this connection there must be some measures to counter these negative effects. One possibility is to increase

the retirement age actually or latently through the stimulation of continued employment that we have already discussed in another paper [10].

Employment and pension policy in the second group of countries is of interest in terms of measures against demographic risks. In these countries, it is a continuation of work incentives and thus the period of accumulation of pension assets while reducing the period of pension payments. The combination of these two measures would minimize demographic risks and increase financial sustainability of pension distribution systems. Exceeding of the actual retirement age over the legally established, observing in the first group of countries, is exacerbating the impact of demographic risks to the financial security of pension systems.

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Conclusion

1. Funded pension systems are under the influence of demographic risks in a less degree than the alternative distribution systems;

2. The condition of conserving financial sustainability of funded pension systems is proposed: the dynamics of pension payments and the replacement rate should not exceed the dynamics of insurance payment rates, the rates of the investment income, periods of savings and payments;

3. Countries with financially sustainable and unsustainable pension systems are identified. The prognosis of the fulfillment of the condition of financial sustainability until 2050 has been made.

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References

1. Potapenko, V.V. and A.A. Shirov, 2012. Development of the Pension System as an Element of Long-Term Economic Policy. Problems of Forecasting, 4: 86-99.
2. Nepp, A., 2013. The role of demographic risks for unfunded pension systems. World Applied Sciences Journal, V. 27, 13 A: 234-240.
3. Nepp, A.N., S.V. Kruglikov, M.V. Pusanova and T.V. Kuprina, 2012. Using Portfolio Models As a Mark of Efficiency of Bank Investment Risk-taking Strategy. IFAC Proceedings Volumes (IFAC-PapersOnline), pp: 251-255.
4. Nikonov, O. and M. Medvedeva, 2012. On the Microeconomic Problems Studied by Portfolio Theory. In the Proceedings of the International Conference of Numerical Analysis and Applied Mathematics, ICNAAM 2012, pp: 2253-2256.
5. Nikonov, O.I., V.E. Vlasov and M.A. Medvedeva, 2013. Operational risk economic capital allocation. In the Proceedings of the 11th International Conference of Numerical Analysis and Applied Mathematics 2013, ICNAAM 2013, pp: 1550-1553.
6. Gontmakher, E., 2012. Problem of Population Aging in Russia. World Economy and International Relations, 1: 22-29.
7. Maclnnes, J., 2003. Sociology and Demography: A Promising Relationship? Women's Employment, Parental Identity and Fertility in Europe. An Analysis of the Family and Gender Roles. Edinburgh Working Papers in Sociology, 23.
8. Mesle, F. and J. Vallin, 2006. The Health Transition: Trends and Prospects. Demography: Analysis and Synthesis. A Treatise in Demography. N.Y.: Elsevier. P. 247 – 602.
9. Official Website for Goskomstat RF. Date Views 05.04.2013 www.gks.ru.
10. Pensions at a Glance 2011: Retirement –Income Systems in OECD and G20 Countries. OECD. 2011. P. 124.
11. World Bank. The Pension System in Crisis. Regional Report for Europe and Central Asia. Date Views 05.04.2013 www.siteresources.worldbank.org/ECAEXT/Resources/258598 - 1256842123621/6525333 - 1260213816371/PensionCrisisPolicyNotefinalru.pdf.

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