UDC 330.4

USING ACTUARIAL CALCULATIONS IN PENSION SCHEMES

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Журавльова Н.М., Сенкевич Б.А. Використання актуарних розрахунків у пенсійних схемах.

У цій статі розглянуто актуарні розрахунки для пенсійних схем на трьох рівнях пенсійного забезпечення України: солідарного, накопичувального та недержавного. Проаналізовано українське пенсійне законодавство для кожної системи. Представлено методику проведення актуарних розрахунків. Виділено основні вхідні та вихідні показники, що використовуються для розрахунку актуарних моделей. Надано порівняльну характеристику кожної із пенсійних систем. Представлено формули для розрахунку пенсій у солідарній системі, види пенсій у накопичувальній системі пенсійного забезпечення, ризики у недержавних пенсійних фондів, які актуарії фіксують у параметрах при розробці актуарних моделей, а також імітаційну актуарну модель розрахунку пенсійних внесків та виплат.

Ключові слова: актуарні розрахунки, пенсійне страхування, солідарна система, накопичувальна пенсійна система, недержавне пенсійне забезпечення

Журавлёва Н.М., Сенкевич Б.А. Использование актуарных расчётов в пенсионных схемах.

В этой статье рассмотрены актуарные расчёты для пенсионных схем на трёх уровнях пенсионного обеспечения Украины: солидарного, накопительного и негосударственного. Проанализировано украинское пенсионное законодательство для каждой системы. Представлено методику проведения актуарных расчётов. Выделено основные входные и выходные показатели, которые используются для расчёта актуарных моделей. Предоставлена сравнительная характеристика каждой с пенсионных систем. Представлены формулы для расчёта пенсий в солидарной системе, виды пенсий в накопительной системе пенсионного обеспечения, риски в негосударственных пенсионных фондов, которые актуарии фиксируют в параметрах при разработке актуарных моделей, а также имитационную актуарную модель расчёта пенсионных вкладов и выплат.

Ключевые слова: актуарные расчёты, пенсионное страхование, солидарная система, накопительная система, негосударственное пенсионное обеспечение

Zhuravlyova N.M., Senkevych B.A. Using actuarial calculations in pension schemes.

In this article is characterised actuarial calculations for pension schemes in three levels pension providing in Ukraine: PAYG, individual and private. Ukrainian pension laws for every level have been analyzed. Procedure for actuarial calculations has been demonstrated. The main indicators for building actuarial models have been introduced. A comparative characteristics every pension system have been introduced. The formulas for pension in PAYG, the types pensions in the individual pension system, risks in the private pension system which specialists fix in parameters constructed actuarial models and simulation actuarial model for calculation pension funds and pays have been introduced.

Keywords: actuarial calculations, pension insurance, PAYG system, individual system, private pension providing

I n 1991 with independence declaration in Ukraine process of transition of all public life spheres to market economy began. It affected also such sphere as insurance. Especially it concerned one of the most important kinds of social insurance – pension insurance. So, in 2003 the Verkhovna Rada adopted the Law of Ukraine "About obligatory national pension insurance" and by that guaranteed to all social groups the public assistance in an old age, on a case of a disease or incapacitation.

Today social insurance development it is simply impossible without use of knowledge of probability theory, statistical and mathematical methods together with use of modern information technologies. And especially, when the pension system of Ukraine which according to the legislation consists of three levels: solidary, accumulative and non-state, requires exact determinations of necessary sizes. Therefore application of actuarial calculations in pension system, and also development in our country of such new profession as the actuary is very important.

Analysis of recent researches and publications

The main foundation for actuarial science was laid for a long time in the European countries with the origin of insurance operations. To the present time in the world there is a continuous development of the main actuarial determinations and methods in insurance that it is possible to notice in works of foreign scientists such as A.G. Sholomitskiy, A.O. Nedosekín, A.I. Falín, G.I. Falín, A.K. Solovyov, Ch. L. Trowbridge, 1989, J. Hickman, 2004, J. Lemer, 2005, Ch. Lewin, 2007, H. Godinez-Olivares, 2016, M. del Karmen Boado-Penas, 2016, St. Khaberman 2016 etc.

Much attention was paid to research of actuarial calculations application in pension insurance by many local scientists among whom there is N.A. Telichko, V.S. Tolubyak, A.P. Koval, V.V. Voloshin, S.A. Kropelnitskaya, V.I. Uspalenko, T.V. Solodzhuk, L.V. Vremenko, N.M. Vnukova, A.D. Volchanka, etc.

Thus, it is possible to see that methods of actuarial science are constantly researched and enhanced that generally there is due to insurance development through implementation of various economic actions and quick rates of the world computerisation development.

Unsolved aspects of the problem

In spite of the fact that in our country the actuarial science also develops, nevertheless there is a complexity of its application in case of pension calculations of solidary, accumulative and non-state level. And thus, determination of each pension insurance level of actuarial calculations is very important.

The purpose of article is determination and further application of actuarial calculations in pension schemes of the national and non-state insurance.

The main part

Pension insurance as one of main types of social, is the system of measures guaranteed by the state for providing citizens in old age, on a case of a disease, incapacitation. The local pension legislation provides two forms of pension insurance: obligatory which plays a major role, and voluntary [1].

The structure of provision pensions system according to the Law of Ukraine "About obligatory national pension insurance" consists of three levels:

— solidary system which is based on the principles of solidarity and backing and implementation of pension payment and provision of social services at the expense of the Pension fund means;

— Defined Contribution System which is based on principles of means accumulating of insured persons in the Accumulation fund or in the relevant non-state pension funds and financing of expenses implementation on payment of insurance contracts of life pensions and one-time payments;

— system of non-state pension provision which is based on the principles of voluntary citizens participation, employers and their associations in pension accruals forming for the purpose of receipt by citizens of retirement benefits [2].

Ukraine citizens can be participants and receive retirement benefits at the same time from different levels of pension's provision system in Ukraine [2].

At the first level of this system pension is determined by a retirement benefit, make payment in cash which is received by the insured person in case of achievement by his of a stipulated by the legislation retirement age or recognition by his disabled person, or members of his family receive [2].

Abroad the state distribution pension system, of course, is financed on the pay-as-you-go system (PAYG) in which pensions for pensioners are paid for the account of fees of able-bodied population. The successful PAYG system requires balance between expenses on pensions and the income from the contributions made by an active part of able-bodied population for the period of time. This system is usually determined as solidarity between generations [3].

In distribution solidary system of pensions provision in Ukraine forecasting its functioning and development in various situations and conditions is very important. For this purpose by means of actuarial calculations the financial analysis of functioning system consequences in short-term and long-term prospects is carried out.

There is a special technique of carrying out actuarial calculations for the pension system of Ukraine.

This technique considers system of actuarial calculations as a complex of the organisational, program and technological actions, which performed for the purpose of obtaining short, medium- and long-term forecasts of pension system financial condition [4].

According to this technique actuarial calculations for determination of financial condition of the pension system are:

— short-term if calculation is made for every year and next 5 years;

— medium-term if calculation is carried out each 10 years;

— long-term – for each next 75 years.

The created database which includes demographic, macroeconomic, general indicators, and also the income and expenses data of accumulative system, the carried-out actuarial calculations and representation to Cabinet council of Ukraine the report on results of carrying out actuarial calculations is system part of actuarial calculations [4].

Experts of actuarial calculations according to [4] in solidary system of pensions provision in Ukraine to carrying out the analysis apply various entrance and output indicators (fig. 1) and also their list can be supplemented in the future with other indicators.

For carrying out actuarial calculations of state pension schemes the following kinds of models are used:

— forecasting model of financial condition of the solidary pension system;

— forecasting model of financial condition of Defined Contribution pension systems;

— the integrated forecasting model of a financial condition of the pension system [4].

Actuaries of the Pension fund give to the central executive body the carried-out calculations with offered into next year next year size of insurance premiums, the funds of a single fee for obligatory national social insurance which goes for obligatory national pension insurance including the part of insurance premiums sent to the Accumulation fund [2].

The main methods which are used by the actuarial calculations expert for carrying out a financial analysis of short-term and long-term prospects of functioning and development of the solidary pension system are the following methods:

— theories of compound interests;

— probability theory;

— mathematical analysis;

— mathematical statistics;

— theories of the stochastic analysis;

— differential equations;
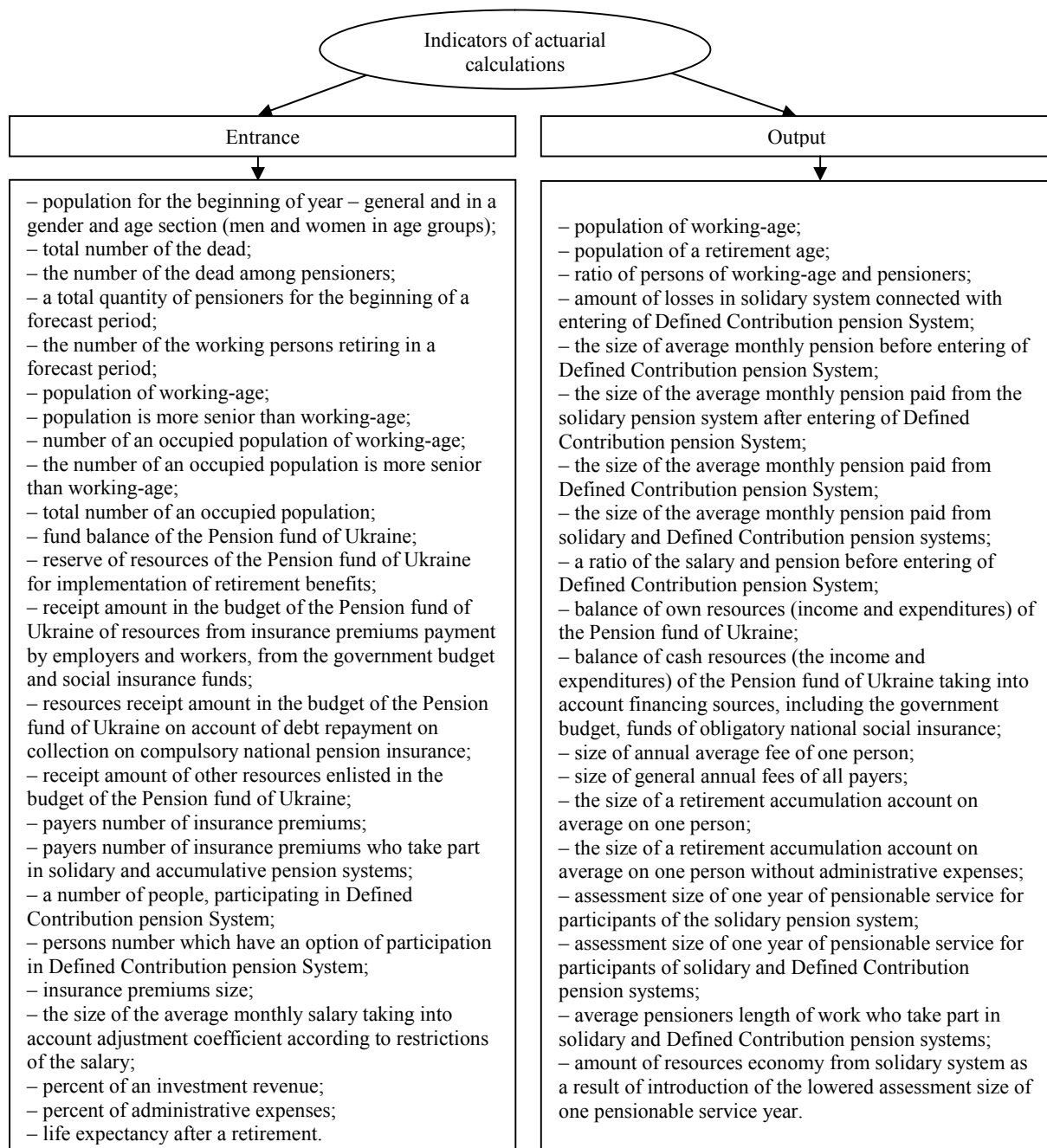
— optimisation methods [4].

Fig. 1. Entrance and output indicators of actuarial calculations
Source: Compiled by the author according to the material [4]

For determination of old-age pensions in hryvnias in solidary system of pension provision the following formula is used:

$$P = S \cdot Cps, \qquad (1)$$

where P – old-age pension;

S – the salary which is used for a pension calculation;

Cps – coefficient of pensionable service [2].

For calculation of an old-age pension the salary for the entire period of pensionable service since July 1, 2000 is considered. The salary for the period of pensionable service till July 1, 2000 is considered for calculation of pension based on documents on Accrued Wages [2].

Thus, the salary in hryvnias which is used for a pension calculation on age is determined by formula (2):

$$P = As \cdot \frac{Tc}{Ps}, \qquad (2)$$

where As – the average salary from which insurance premiums, in 3 calendar years preceding year of the request for award of pension on age are paid;

Tc – the total of coefficients of the salary for every month (Cs1 + Cs2 + Cs3 +... + Csn);

Ps – pensionable service in months which are considered for calculation of coefficient of the salary of the insured person.

The coefficient of the salary of the insured person in solidary system for every month of pensionable service which is considered in case of a pension calculation on age is determined by the following formula:

$$Cs = \frac{Sm}{As}, \qquad (3)$$

where Cs – coefficient of the salary of the insured person;

Sm – the salary of the insured person, in a month;

As – the average salary in Ukraine [2].

Pensionable service – the period during which the insured person pays every month insurance premiums which size can't be less, than the minimum insurance premium. It is estimated in months by employees of the local Pension funds with use of information system data of persons accounting which pay insurance premiums, and also agrees the documents provided by the person for the period of time when this information system was absent. For a retirement on age the pensionable service of the person which addresses to the Pension fund for its registration shall constitute at least 15 years [2].

The coefficient of pensionable service for the person registered in solidary system of pensions provision is calculated on a formula (4):

$$Cps = \frac{Am \cdot Sa}{100\% \cdot 12}. \qquad (4)$$

where Cps – coefficient of pensionable service;

Am – months amount of pensionable service;

Sa – assessment size of one year of pensionable service, % [2].

If the person was a participant of solidary and Defined Contribution pension systems, then the above-mentioned coefficient will be calculated as the amount of pensionable service coefficient only in solidary system and pensionable service coefficient which is determined for the period participations in solidary and Defined Contribution pension systems.

Assessment size of one year of pensionable service of the person insured in solidary system, is according to 1.35% [2]. If the person is a participant also Defined Contribution pension system of pensions provision in Ukraine, then this size is 1.08%.

So, for actuarial calculation of an old-age pension in solidary system of pensions provision which is now used in Ukraine, necessary components is salary size of insured person and coefficient of pensionable service which depends on payment period of insurance premiums

Today in our state and in general in the world, reforming process of pension insurance takes place. Assignments on social insurance are purchasing market nature more and more, that is there is a gradual transition to Defined Contribution pension system where a considerable part of expenses on pension insurance is financed from insurance premiums of employers for benefit of specific workers (for example, an insurance part of a work pension). Not long ago the unified social tax (UST)

was entered, and it is already necessary to adjust it. It is probable that already in the nearest future it will be necessary to change the UST size again, or to redistribute its components between assureds and assurors. Among the reasons of change of a rate there can be also a discrepancy of fees and payments sizes which can cause insufficiency of the exact economic-mathematical (actuarial) model, used when calculating rates [5].

It is supposed that since July 1, 2017 in Ukraine the funded pension system of social insurance will begin to work.

At the second level, that is in Defined Contribution pension system of the Ukrainian pensions provision, person insurance and the retirement benefit is performed by the insurance company chosen by it. According to the legislation of Ukraine the insurance company, unlike other types of insurance, can't require the health declaration of participant of this pensions system.

In a forecasting financial condition model of Defined Contribution Pension System are applied the assumption relatively:
— terms of its introduction;
— the expected number of persons which participate in Defined Contribution Pension System on creation date of the Accumulation pension fund and during all forecast period;
— investment revenue level;
— level of administrative expenses [4].

Representatives of the insurance company, which chosen by the person, shall offer to future participant of Defined Contribution Pension System three types of pension:
— a cradle-to-grave pension with the established period which provides payment every month during life of the pensioner, on condition of payment at least 10 years from the moment of its appointment;
— for cradle-to-grave the caused which provides payment every month during life of the pensioner;
— a cradle-to-grave pension of couple which provides monthly payment to the pensioner and after his death – to his husband (or the wife) who reached a retirement age during life.

Within three working days from election date of type pension and reimbursement under the signed agreement representatives of insurance company actuarially calculate the size of a retirement benefit. During actuarial calculation of pension, the payment amount of the agreement of pension insurance, future investment revenue, expenses which are connected with the subsequent investment of the above-stated amounts, and also statistical average life expectancy of men and women in Ukraine is considered [2].

Thus, in Defined Contribution Pension System of pensions provision of Ukraine the main sizes for actuarial calculation is the specified amount in the agreement of pension insurance, the size of the calculated investment amount and expenses which are connected with investments, and also statistical data of demographic nature.

The third level provides monthly pensions payment by non-state funds of pensions provision of Ukraine. Such funds in Ukraine began to work after January 1, 2004, that is from coming into force of the Law of Ukraine "About non-state pension provision".

In the USA insurance of pensions or annuities is rather developed. Insurance of pensions differs from other types of personal insurance in the fact that the assured grants directly the considerable capital sum that during the certain period or until the end of the life to receive payments series from the insurance company. Annuities cost is determined by a payment amount, which the company shall pay to the insurance policy owner, his age and sexual identity [6]. Thus, in case of actuarial calculation of annuities it is important to consider statistical data.

In Ukraine non-state pension funds are divided into three types (fig. 2).

Actuarial calculations in non-state pension funds are carried out by specialists who on the basis of these calculations, build models of development of system in time, arrange everything documentary and submit the analysed information to the top-tier people of the company. As well as at other levels of Ukrainian pension system, for actuarial calculations, statistical information on population, average life expectancy of women and men, indicators of GDP, inflation is used.
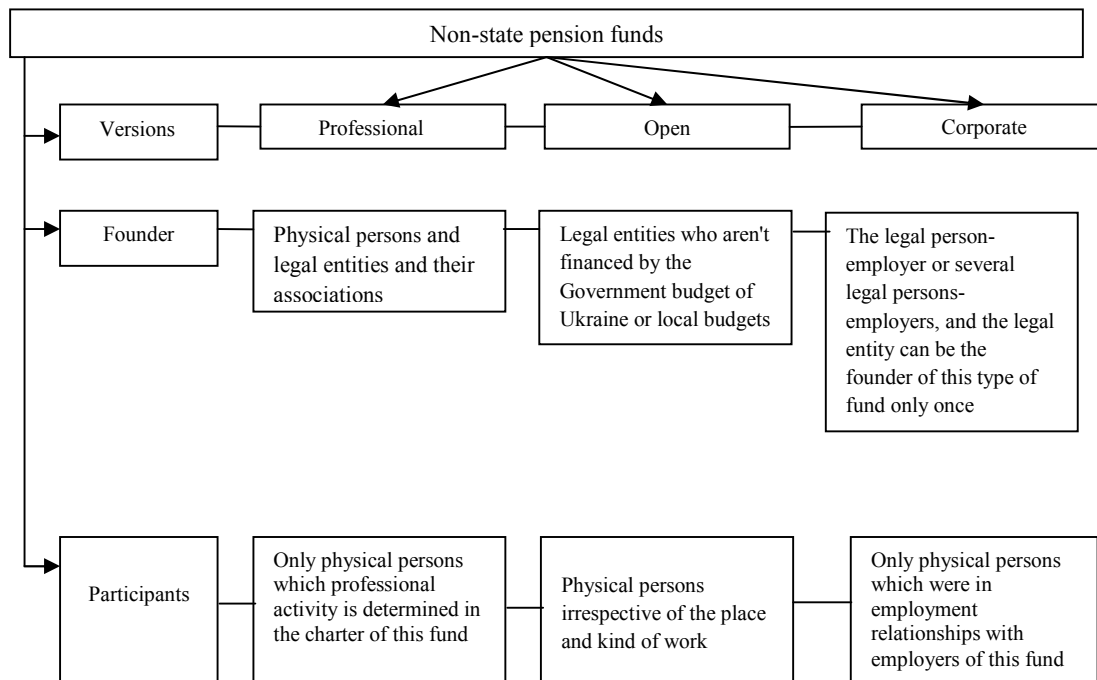

Fig. 2. Types of non-state pension funds
Source: Own elaboration

In work [7] the actuarial model of cash flows for the non-state corporate pension plan is considered. Calculation of size of pension, and also size of rates of pension assignments (or aggregate premiums) is result of carrying out actuarial calculation in time. It is important to note that this model of actuarial calculation is applied, as for pension schemes with the established fees, and for pension schemes with defined benefits.

The major role in pension schemes creation of non-state funds is played by the actuary. Its activities can be presented in the form of an actuarial simulation model. The actuary, as well as the financial manager of non-state pension fund or insurance company [8], can make the analysis of financial investments.

The actuarial calculations expert performs them once a year, at the same time includes some future indicators in the fixed parameters. And complex of these parameters composes actuarial basis. This actuarial simulation model is a general and simulation model with feedback (fig. 3) [7].

In actuarial model which is provided in fig. 3 fluctuations of inflation, investments, the size of the salary and the number of participants on age of the non-state pension plan are sources of actuarial risk (uncertainty) [7].

The actuarial risks connected with conditions and situations which can happen in the future and lead to negative consequences in the non-state pension system. The main risks which are determined in work [7] are the losses connected with an investment risk which provides a deviation of real investment revenue from forecast, and risk of fluctuations of participants number of non-state pension insurance program, that is a deviation of real regulations of death rate from forecast. At the same time participants of the program can be exposed to social risk and need social services from social insurance [9].

So, actuarial calculations which are carried out for system of non-state pension provision include statistical data, the size of investments, and also the available actuarial risks are recognized.
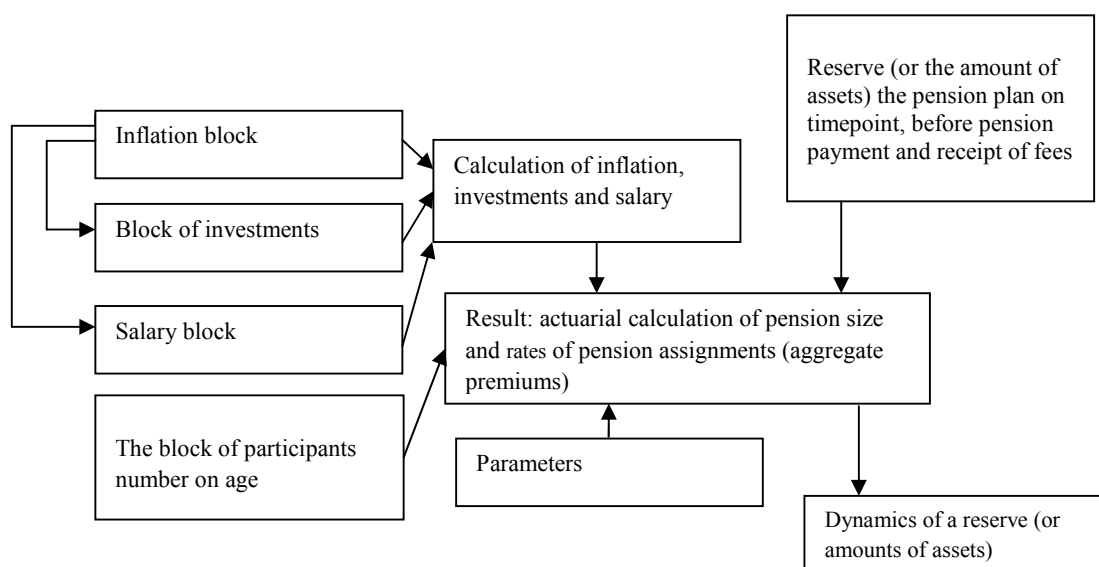
Fig. 3. Scheme of a simulation model of the pension plan
Source: Compiled by the author according to the material [7]

Conclusions

Actuarial calculations are the main creation instrument of actuarial models in pension schemes of the state and non-state insurance. With their use it is possible to determine correctly insurance pension fees and retirement benefits that will allow to carry out the analysis and to predict development of pension systems for several years ahead. It should be noted that actuaries of all three levels of pensions provision in Ukraine, developing dynamic models, use in the activities probability theory, statistical methods, high-quality and quantitative methods of management, optimisation methods, etc.

Further enhancement and use of actuarial calculations in pension schemes for solidary, in Defined Contribution and non-state levels of pensions provision in Ukraine is perspective.

Abstract

Today development social insurance is possibility with using knowledge of theory of probability, statistics and mathematical methods together are using modern information technologies. In Ukraine system pension insurance is PAYG ("pay-as-you-go"), individual and private pension levels. So it is important using actuarial calculations in pension schemes and development in our country this profession.

A main goal this article is determined and used in the future actuarial calculations in pension schemes public and private insurance. The tasks are determined actuarial calculations for three levels pension system in Ukraine. A main method is analysis the characteristics actuarial calculations for Ukraine pension system.

In Ukraine special procedure for actuarial calculations exists. In three levels pension Ukraine system the statistics demography information, investments, risks, insurance seniority, pension age, wages and etc. are taken into account in actuarial calculations.

Thus, actuarial calculations are main instrument constructed actuarial models in pension schemes public and private insurance.

JEL Classification: G2, G22.

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