The issue of the significance of the role of information technologies in the pension system was highlighted. The information and communication model of the state regulation of financial support of the pension system in the market of non-banking financial services was considered. The essence of information and communication support of the risk-oriented approach to the system of accumulative pension provision, which involves preventing the information and technological probability of risks, was explored. The issues of development of non-bank financial institutions as entities of aggregate financial potential were explored and promising directions of increasing the efficiency of their functioning with the use of information technologies were outlined. The necessity of introducing the mechanism of information and communication provision of the state regulation of accumulative system of pension provision by means of mandatory payment of contributions to individual pension accounts and their further investment as an important component of social protection of the population was considered. The algorithm of construction of the mechanism of information and communication provision of the risk-oriented approach to the accumulative pension system was proposed. The main indicators of the implementation of the accumulative component of the pension system were analyzed. The need for the interaction of the elements of the risk-oriented system of accumulative pensions was substantiated. Information technologies of investment of pension savings as a long-term investment resource in interaction of elements of the risk-oriented system of the accumulative pension provision were considered. The needs of introducing a risk-oriented approach to accumulated assets to strengthen social protection of participants in the non-banking financial services market were highlighted. The results of the redistribution between the cluster proved a close relationship of incomes of population and long-term pension savings

Keywords: risk-oriented approach, information and communication support, pension system, investment income, pension assets

UDC 369.5:336.764
DOI: 10.15587/1729-4061.2021.245384

DEVELOPMENT OF AN OPTIMIZATION PLAN FOR REDISTRIBUTION OF PENSION ASSETS USING INFORMATION TECHNOLOGIES

Svitlana Achkasova
PhD, Assosiate Professor
Department of Banking and Financial Services*
Yevheniia Malyshko
Corresponding author
PhD, Assosiate Professor
Department of Finance*
E-mail: jekiaj@ukr.net
*Simon Kuznets Kharkiv National University of Economics
Nauky ave., 9-A, Kharkiv, Ukraine, 61166

Received date 28.09.2021
Accepted date 12.11.2021
Published date 24.12.2021

How to Cite: *Achkasova, S., Malyshko, Y. (2021). Development of an optimization plan for redistribution of pension assets using information technologies. Eastern-European Journal of Enterprise Technologies, 6 (13 (114)), 72–79. doi: https://doi.org/10.15587/1729-4061.2021.245384*

1. Introduction

The development of pension provision requires a financial balance of the distribution system, which will reduce the problematic issues regarding the introduction of the accumulative component of the pension system. Information and communication support play the role of certain processes, technologies, and measures in the implementation of certain social services. The system of information support of the social policy is the basis for ensuring economic stability in the implementation of reforms. The pension system is an integrated mechanism that includes three levels, which are based on the principle of pension insurance of income of the population. Only practical implementation of redistribution programs and the accumulative component, which proves the growing needs of citizens of retirement age, remains important. This is due to the need to introduce a mechanism of state regulation of the accumulative system of pension provision by means of mandatory payment of contributions to individual pension accounts and their further investment. Currently, introduction of accumulative pension provision is the observance of the necessary conditions and priority tasks by the state, which will contribute to economic growth and the formation of financial resources. That is why information technologies for regulating the risk-oriented system are an urgent issue of choosing a reliable subject of the accumulative level of pension provision.

2. Literature review and problem statement

The results of paper [1] provide an overview of different pension systems in the EU member states. The development of pension schemes, as well as their current duration of existence, was evaluated, recommendations for their implementation in the EU were provided. It was found that the key elements of an adequate and sustainable pension system are, for example, a higher level of participation in the labor market, especially among older workers – a higher retirement age. Even though the foreign experience of the implementation of the pension system was theoretically explored, the issue of implementing the information support for social protection of active population remains.

Paper [2] describes the key components of the Chinese Pension System, highlights the progress made, and identifies weaknesses in information disclosure, management frameworks, and the standards of pension fund management. This does not reveal the importance of information technologies for the development of a sustainable pension system.

However, the authors of [3] determined the impact of pension assets on the economic growth of European post-socialist countries. This emphasizes the feasibility of finding tools to assess the impact of the pension system on the economy of countries. The research in this paper makes it possible to outline the modern model of the pension system

but does not prove the importance of long-term maintenance of the balance of the pension system. Study [4] assesses key indicators of non-banking financial services markets. Cluster analysis revealed the groups of markets of non-bank financial services. The study identified the models of progress and regression in the markets of non-banking financial services. The results of this analysis are of importance in further research into the prospects for the implementation of the accumulative system. It should be noted that this study does not take into consideration the needs of pension system entities in redistribution and accumulation of pension assets.

The desire and ability to apply the concept of social responsibility that is directly proportional to the culture formed through relevant knowledge, skills and qualifications were highlighted in paper [5]. However, the issue of the mechanisms of state regulation of the risk-oriented system of mandatory accumulative pensions remains unresolved.

Study [6] focuses on the system of pension fund management. The essence of responsibility for monitoring and supervision in the management of the pension fund was revealed. However, the issue of the impact of risks in the interaction of pension system entities in the cluster was not tackled.

Paper [7] determined the goals for pension supervision and protection of the interests of the pension fund, which ensure the stability of the entire pension system. Thus, regular assessment of the activities of pension funds through monitoring and analysis is crucial in analyzing its solvency. Recommendations on the adequacy of risk measurement can be used in the study of the mechanism of the risk-oriented system of mandatory accumulative pension provision. The conducted study does not make it possible to separate the main directions of implementation of mandatory accumulative pension provision.

In turn, according to the recommendations for the implementation of risk-oriented supervision in the field of pension provision, the risks in the activities of pension funds were determined, which requires stronger control over them [8]. However, the issue of information support of the risk-oriented approach to mandatory accumulative pensions remains insufficiently studied.

According to the authors of research [9], when managing pension funds, non-compliance with guidelines (related to investments or management in general) should be prevented in advance, even though the profit will be higher than expected. Considering the issue of risk management in the field of pension provision, the authors of [10] point out that the formation of an informational basis is an important condition for functioning of risk management systems. In particular, the availability of adequate and comprehensive internal financial data on compliance and external environment is a necessary condition for ensuring reliability, timeliness, accessibility and consistency in the activities of pension funds.

It was found in paper [11] that the financial monitoring system has a mechanism for improving the risk-oriented approach. It was noted that at the national level, the mechanism of the risk-oriented approach applies to accountable subjects of primary financial monitoring. Therefore, the mechanism of the risk-oriented approach is aimed at risk analysis and classification. However, the issue of information- communication and information-technological support was not sufficiently explored.

The authors of [12] determined the general features of outsourcing of information technologies and logistics services. It was proved that modern information and logistic technologies are most important in ensuring their activities. The recommendations of this study can be used in the study of the pension system. However, the issue of the risk of outsourcing of information technologies and logistic services during the implementation in the pension system was not considered.

3. The aim and objectives of the study

The aim of the research is to devise an optimization plan for redistribution of pension assets using information technologies. This will enable the implementation of the mechanism of information and communication support of the risk-oriented approach to the accumulative pension system.

The implementation of the goal of research involves setting and solving the following tasks:

– to outline information support for state regulation of the accumulative system of pension insurance;

– to construct an algorithm for the mechanism of information and communication provision of the risk-oriented approach to the system of accumulative pension provision;

– to substantiate the need and significance of the implementation of the accumulative pension provision using information technologies;

– to consider the problem of optimization of the plan in mathematical statement of the transport problem of linear programming.

4. Materials and methods of research

During the study, we used the method of analysis and synthesis to determine the information support of the state regulation of the accumulative system of pension insurance. The method of analysis and synthesis reveals the issue of information support of state regulation in the management of pension provision.

The comparison method was used to study the mechanism of information and communication support of the risk-oriented approach to the system of accumulative pension provision. The significance of the improvement of the pension system was found with the use of the comparative method.

To address the significance of the implementation of the accumulative pension, we used the method of comprehensive analysis that revealed the significance of pension savings. The application of the method of comprehensive analysis to the study of the implementation of accumulative pension will determine the profitability of assets.

The linear programming method became the basis of the study on the formation of an optimal plan depending on the specific weight of accumulation of pension assets at minimal investments for entities of the pension system.

5. Results of research into the development of an optimization plan for the redistribution of pension assets using information technologies

5. 1. Analysis of information support of state regulation of the accumulative system of pension insurance

One of the priority tasks facing the state is proper information and communication support of social guarantees of

the country's population. Information and communication support directly depend on the mechanism of implementation of the accumulative system, which will create a powerful tool for internal long-term investment resource to attract and accumulate funds of citizens.

Consideration of pension provision in different countries revealed that a combination of information technologies and social protection will ensure the quality of management and the effectiveness of the pension system mechanism when forecasting accumulative pension assets. Using the experience of other countries of the world on functioning of pension system levels, there is a need to intensify the improvement of the accumulation principles of pension contributions and their further investment. Thanks to information technologies, pension system entities will practically model the optimization and automated processes of the effectiveness of social protection of the population.

Advances of information technologies at all levels of state regulation of the pension system will create informational awareness of the population. Information support in the implementation of the accumulative component is a necessary combination of modern programs and the mechanism for pension system management.

According to information data, top 15 countries of the world with the fastest rate of population decline were established. This indicates that in the coming decades the population will decrease almost entirely at the expense of population of working age. If the current birth rate, mortality and migration indicators remain the same, according to the information data, the population is expected to decrease by 28 % by 2050, while the share of people aged 60 years and older will increase up to 32 %.

The average forecast option provides for a gradual increase in the total birth rate up to 1.8 children per woman in 2050. It will ensure an increase in life expectancy on average by 5 years. It should be noted that under such conditions the population will decrease by 18 %, and the aging level will increase up to 34 %.

The ratio between the population of retirement and working age will almost double. The demographic changes observed in the country as a whole are in line with the global trends and indicate a very rapid pace [13]. It is the introduction of the accumulative pension provision that will make it possible to increase pension payments at the expense of mandatory savings of funds of the system participants.

The reform of the pension system envisaged the adoption of a new legislative framework, normative acts, a mechanism of state regulation, control and supervision between entities and participants of the mandatory accumulative pension system. Pension provision is based only on the principles of solidarity and voluntariness of participants, which indicates the problems of information and communication management of modern technologies of the system. Thus, the use of information software in pension funds will facilitate the control of savings on personal pension accounts.

The implementation of the information and communication support of the mechanism of state regulation of pension provision is only a set of measures aimed at improving the financial stability of the pension system. However, balancing the reformed pension system is possible through the provision of financial resources for investment.

According to source [14], it is envisaged to introduce a three-level system of state pension insurance, in which solidarity level is supplemented by two levels of the accumulative system: the second – mandatory and the third – voluntary. State regulation of the pension system is based on socio-economic programs, social development strategies and interests of business entities. It is the guarantee of social protection of pensioners that is the main purpose provided by law for an insured person of retirement age.

The issue of introducing a mandatory system of accumulative pension provision will contribute to significant changes in the model of the state regulation of financial support of the pension system.

Thus, the draft law [14] stipulated the need and defined legal, economic and organizational principles of mandatory accumulative pension provision when introducing the second level of the pension system. An important task envisaged by the draft law is to create the savings fund that will accumulate insurance payments of insured persons accounted for in accumulative pension accounts due to the latest information technologies.

The draft law provides for the establishment of the Pension Treasury, which is a legal entity of public law, created and operating in the organizational and legal form of an institution that does not aim to make a profit. Money and property are transferred to the Pension Treasury to ensure its establishment and to start functioning. For information and communication support of management and control over the current activities of the Pension Treasury, the Pension Treasury Board is formed, which consists of five persons appointed by election based on the competition results [15].

The formation of a cluster between the entities of the accumulative pension system is the creation and implementation of a science intensive competitive product that will regulate relations at three levels of the pension system, that is, of an integrated mechanism [16].

State regulation of accumulative provision determines the mechanism of interrelated goals and processes in the construction of the pension provision system. Determining the possibilities of introducing the accumulative pension element as a powerful investment resource will make it possible to obtain pension payments.

5. 2. Identification of the mechanism of information and communication support of the risk-oriented approach to the system of accumulative pension provision

As stated in chapter 5. 1, accumulative pension provision is a necessary component in the effective functioning of the pension system.

Protection of interests of participants in the pension system is based on the principles of transparency and openness, which will ensure minimization of risks through information technologies. The effectiveness of information and communication support in regulating and supervising the activities of non-banking financial institutions implies the conduction of financial monitoring. The peculiarity of investing pension assets is their protection with the help of financial institutions in the securities market through placement, preservation, and management.

The essence of the risk-oriented approach to information and communication provision of the accumulative pension system is to prevent the probability of risks that may affect the achievement of the existing goals shown in Fig. 1.

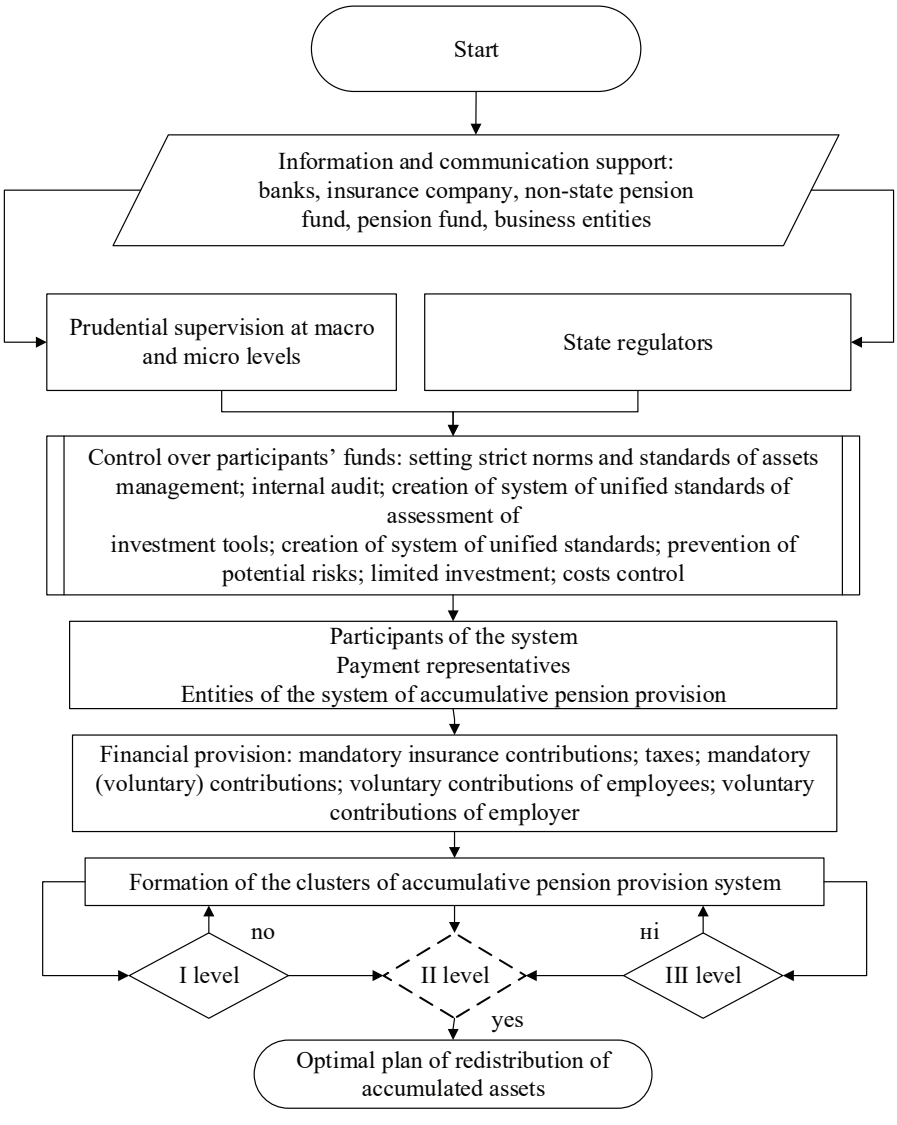

Fig. 1. Algorithm for construction of a mechanism of information and communication support of the risk-oriented approach to the accumulative pension system

As it can be seen from Fig. 1, the mechanism of information and communication support of the state regulation of the accumulative pension system is based on the construction of optimal accumulation of funds and payment of pensions, a strict regulatory framework for managing investments in reliable investment instruments. Information technologies of prudential supervision of pension system entities when investing pension assets will meet the requirements of legislative norms and international standards.

State regulation in the context of a unified and effective state policy provides for the improvement of information technologies on control, supervision, transparency and openness of the pension system. The constructed mechanism of information and communication support of the risk-oriented approach to the accumulative pension system will help protect the interests of participants in the financial services market.

Information technologies will directly form a set of measures to protect invested pension assets and, accordingly, create a reliable mechanism for pension provision. The National Securities and Stock Market Commission will regulate and prudentially supervise the investment of pension assets and receive investment income.

Thus, the constructed mechanism of information and communication support for state regulation of the accumulative pension system makes it possible to develop the ways to improve the pension system and guarantee the distribution of long-term pension savings.

5. 3. Determining the need and significance of the implementation of accumulative pension provision using information technologies

As specified in chapters 5. 1, 5. 2, effective functioning of the pension system is based on the implementation of the mechanism of information and communication support of the risk-oriented approach to the accumulative pension system. The introduction of pensions will contribute to the formation of mandatory pension savings.

When considering the reform in the financial sector, we should point out an increasing financial stability and transparency in the activities of banks. Thus, on July 1, 2020, the law outlining the transition of the regulator of the non-banking sector [17] was passed, which will ensure more comprehensive and effective regulation of both the banking and non-banking sectors.

The source [18] indicates the main data on the development of non-state pension funds, indicating the investment of pension assets in bank bonds and government bonds, which proves their dependence on banks. That is why the activity of financial institutions in the market of non-banking financial services is characterized by the increased influence of risk factors of the external and internal environment. It is the investment of pension assets in the securities of international exchanges that will significantly increase the guarantees of savings on pension accounts, which will provide protection against inflation of payments.

The insurance market is the second largest among other non-banking financial markets. However, in early 2021, their number decreased significantly.

The data for analysis of the results of activities were presented according to the rate of USD 1 to UAH 26.32. Thus, the share of insurance premiums received from individuals for 9 months of 2020 amounted to 49.6 %, from legal entities to 40.9 %, from reinsurers to 9.5 %. Insurance premiums in the amount of UAH 6.4 billion (USD 0.24 billion or 19.5 %) was transferred to re-insurance, of which UAH 2.7 billion (or USD 0.10 billion) was transferred to non-resident insurers [19]. It is the regulation and supervision of insurance companies that ensures the fulfillment of requirements for a sufficient reserve of solvency.

In January-May 2021, the Pension Fund ensured the payment of pensions and monetary assistance in full amount

in all regions. According to operative data, the total amount of expenditures on pension and other planned payments amounted up to UAH 211.1 billion (or USD 8.02 billion), versus UAH 196.6 billion (or USD 7.47 billion) of the corresponding period last year [20]. At present, in order to optimize financial resources and balance the budget of the Pension Fund, it is necessary to ensure financial stability and solvency.

The intensification of information technologies for supervision over the activities of entities of financial services market serves as an impetus for the consideration of forecast indicators in the implementation of mandatory accumulative pensions. Thus, the introduction of the accumulative component of the pension system in accordance with the draft law requires additional costs from the State Budget. Table 1 gives the main forecast indicators of the activities of the accumulative fund. Despite the initial costs when creating the accumulative component of the pension system, the growth of the long-term investment resource – the accumulative assets of employees – was also analyzed.

As Table 1 shows, the estimated value of indicators in the implementation of the accumulative component of the pension system indicates cost-recovery. Thus, according to forecasts, there will be a decrease in the number of contribution payers based on the demographic situation in the country. Then, as the accumulative assets of employees will increase at the expense of participants up to the age of 35, since mandatory insurance payments are regulated by tax legislation. In order to ensure control over the directions of invested pension funds, the mechanism for personalized accounting of pension system participants will be introduced.

Thus, it remains relevant to determine the possibilities for improving the conditions for redistribution of savings by entities of the pension system. The combination of distributive and accumulative systems of pension provision will make it possible to invest the costs of pension funds.

Table 1

Indicators of implementation of the accumulative component of the pension system

Indicator	2023, UAH/USD	2025, UAH/USD
Net cash flow of activity of Accumulative Fund	75,957,474.28/2,886,266.29	631,538,674.63/23,997,490.75
Net profit of activity of Accumulative Fund	116,023,511.65/4,408,713.61	341,108,694.76/12,961,601.68
Number of payers, thousand people	11.065	10.906
Insurance payments, mln	78.879/3.00	127.792/4.86
Accumulative assets of employees, mln	217.916/8.28	474.790/18.04
Total investments of large and medium-sized business entities to bring the activities in line with the requirements of authorization of second-level entities will be, million	8,376,070.00/318,277.68	×
Total average annual expenditures of large and medium-sized business entities to bring the activities in line with the requirements of authorization of second-level entities, million	71,687,440.00/2,724,011.60	×

Source: based on analysis of the impact of the regulatory act on the draft law On Mandatory Accumulative Pension Provision [21] and calculations of the Institute of Demography and Social Research [22]

5. 4. Using the problem of optimization of the plan in the mathematical statement of the transport problem of linear programming

As specified in chapters 5. 2, 5. 3, the use of NEOS (Network-Enabled Optimization System) software with some optimization criteria will enable the development of a mechanism for the distribution of pension savings.

At interacting of the elements of the risk-oriented system of accumulative pension provision, the possibility of investing pension savings as a long-term investment resource was considered. To achieve this goal, it is necessary: to form the conditions of the optimal plan of long-term investment at all levels of the pension system; to establish depositing of accumulative assets of employees in a cluster of pension provision entities.

The optimal plan for accumulation of pension deposits between the levels of the pension system at minimal investments was designed with the solution of the transportation problem of linear programming [23].

It is noted that $(m-3)$ points of the pension system (A_1, A_2, A_3), in which accumulative pension investments (a_1, a_2, a_3) are deposited. These pension investments are interconnected in the system from n points (B_1, B_2, B_3) with the volume of demand, respectively (b_1, b_2, b_3). It is supposed that the transportation from each point of supply to each point of consumption, that is, from an investor to the levels of the pension system, is possible. At the same time, the condition that the total amount of accumulative assets of a depositor is equal to the total demand for pension deposits of the pension system levels is satisfied. The costs of C_{ij} pension savings from each A_i-th depositor to B_j-th levels of the pension system $(i=1, m; j=1, n)$ are known. Using the requirements for the statement of the transport problem of linear programming [23], a cost matrix that has the form was proposed:

$$C_{ij} = \begin{pmatrix} 1 & 3 & 2 \\ 2 & 1 & 3 \\ 3 & 2 & 1 \end{pmatrix}.$$

To achieve the goal, we determined the plan, in which all pension savings amounting to UAH 474,790 million (or USD 18.04 million) are distributed among all levels of the pension system that is cluster of pension entities to ensure satisfaction of financial interests of depositors, as well as all entities of accumulative pension provision:

$$\sum_{i=1}^{m} a = \sum_{j=1}^{n} b.$$

The mathematical statement of the problem must correspond to the following values of objective function [23]:

$$Z = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} \cdot X_{ij} \to \min . \qquad (1)$$

At the constraints:

– by the volume of accumulated assets of employees:

$$\sum_{j}^{n} x_{ij} = a_i; \quad i = 1, m, \quad (2)$$

– by the volume of depositing to the level of the pension system:

$$\sum_{i}^{m} x_{ij} = b_j; \quad j = 1, n; \quad (3)$$

– non-negative variables: $x_{ij} \geq 0$; $i=1, m$; $j=1, n$.

The model of distribution of accumulated assets of employees among all participants of the pension system is as follows:

Existence of accumulated assets of employees, UAH million/USD million.

$x_{11}+x_{12}+x_{13} \leq 128.1933$ (or 4.87),

$x_{21}+x_{22}+x_{23} \leq 218.4034$ (or 8.30),

$x_{31}+x_{32}+x_{33} \leq 128.1933$ (or 4.87).

The need for accumulation of assets of employees, UAH million/USD million.

$x_{11}+x_{12}+x_{13} \leq 113.9496$ (or 4.33),

$x_{21}+x_{22}+x_{23} \leq 199.4118$ (or 7.58),

$x_{31}+x_{32}+x_{33} \leq 161.4286$ (or 6.13).

To state the dual problem, variable x_{ij} in condition (2) will be substituted with u_1, u_2, u_i, ..., u_m and variables xij in condition (3) – with v_1, v_2, v_j, ..., v_n. Objective function will have the form of:

$F=113.9496u_1+119.4118u_2+161.4286u_3+128.1933v_1+$
$+218.4034v_2+128.1933v_3 \rightarrow \min$.

The optimality of the baseline plan was tested. Previous potentials u_i, v_j in occupied cells of the table, in which $u_i+v_j=c_{ij}$, considering that $u_1=0$, was found. Then

$u_1+v_2=3$; $0+v_2=3$; $v_2=3$,

$u_2+v_2=1$; $3+u_2=1$; $u_2=-2$,

$u_2+v_3=3$; $-2+v_3=3$; $v_3=5$,

$u_3+v_2=2$; $3+u_3=2$; $u_3=-1$,

$u_3+v_1=3$; $-1+v_1=3$; $v_1=4$.

The baseline plan is optimal, since all evaluations of free cells satisfy the condition $u_i+v_j \leq c_{ij}$, which is given in Table 2.

As Table 2 shows, the proposed accumulation of pension deposits proves the balance between the availability and need for pension savings among the entities of the pension system.

Table 2

Optimal plan for depositing accumulating assets of employees

Entities of pension system	Variability of depositing			Existence of accumulated assets of employees, UAH million/USD million
	Level I	Level II	Level III	
Level I	1 –	3 128.1933	2 –	128.1933/4.87
Level II	2 –	1 56.9748	3 161.4286	218.4034/8.30
Level III	3 113.9496	2 14.2437	1 –	128.1933/4.78
The need for accumulation of assets of employees, UAH million/USD million	113.9496/4.33	199.4118/7.58	161.4286/6.13	474.790/18.04

Source: developed by Authors

It was established that with this optimal plan, in all these three options, the total income from pension savings will be:

$(F)=3\times128.1933+1\times56.9748+3\times161.4286+3\times113.9496+$
$+2\times14.2437=1296.1767$ UAH mln (USD 49.25 mln)$\rightarrow$min.

The results of the redistribution between the cluster of pension system entities proved the close relationship of the incomes of population from long-term pension savings. It is the optimal plan for the redistribution of pension assets that will ensure the diversification of financial resources, which will help minimize the onset of risks in the implementation of the mechanism of information and communication support of the risk-oriented approach to the accumulative pension system.

The practical use of the proposed optimal plan for depositing accumulated assets of employees provides the prospects for management decisions when introducing the accumulative component of the pension system. It was found that depending on the share of pension savings, the total income from pension savings will be UAH 1,296.1767 million (or USD 49.25 million) This will create conditions for the proper protection of pension system entities from the influence of both external and internal risks. A positive factor from the proposed optimization plan for the redistribution of pension assets is the allocation of financial resources to support pension provision.

6. Discussion of results on devising an optimization plan for the redistribution of pension assets using information technologies

After analyzing the information support of the existing pension system, the need to create a powerful investment resource, namely, mandatory accumulative pension provision was identified. Studies [1–12] on the pension system included the research to justify the need to implement the accumulative component through redistribution of pension savings.

To solve this problem, a mechanism for information and communication support of a risk-oriented approach to the accumulative pension system was constructed to protect the interests of participants in the financial services market, which is proved in Fig. 1. The implementation of the constructed algorithm in respect to the accumulative pension system is based on an optimal plan for redistribution of accumulated assets, which, unlike others, depends on the share of pension savings.

The estimated indicators of the implementation of mandatory accumulative pension provision were proposed. The increase in the indicator of accumulative assets of employees

proved the need to put into effect the accumulative pension provision, which will ensure personalized accounting of participants in the pension system (Table 1).

The proposed optimization plan for redistribution of accumulated assets of employees implies diversification of directions of funds allocation, which is the source of the investment resource shown in Table 2. The implementation of the optimal plan for redistribution of pension savings is possible if depositing pension assets of employees in the cluster of pension provision entities will amount to UAH 1,296.1767 million (or USD 49.25 million).

When solving the transportation problem of linear programming, the restrictions on the amount of accumulated assets of employees a1 and the amount of depositing to the levels of the pension system b1 were set. Thus, all savings in the amount of UAH 474,790 million (or USD 18.04 million) (distributed among a cluster of pension system entities) Redistribution of pension assets is the optimal accumulation plan *F(x)* for the proposed options of pension system entities, which was proved by the condition of the problem $u_i+v_j \leq c_{ij}$.

It can be considered that the drawback of the study is estimated indicators at solving this model of the optimal redistribution plan taken as the basis, which in further studies may have other constraints.

Practical recommendations on promising directions of effective functioning of the elements of information technologies of the risk-oriented system of accumulative pension provision were given, specifically:

1) increasing public trust;

2) investing in reliable financial instruments;

3) formation of the optimal investment portfolio;

4) protection of pension savings from inflationary processes;

5) increase in financial instruments available in the domestic market;

6) redistribution of functions between financial sector regulators;

7) guarantees of preservation of pension assets.

The relevance of the study is the use of the proposed redistribution of pension savings by pension system entities. This will contribute to minimization of the onset of risks in the implementation of the pension reform. The potential merits of information technologies will increase the quality of activities of pension provision, and therefore will make it possible to model the need and significance of pension savings.

7. Conclusions

1. It was found that information support plays an important role in improving the current pension system. Socio-economic policy of the state should be aimed at improving the quality of management systems. Information and communication technologies implement the functions of the accumulative component of pension provision through distribution of income of working population in their personal accounts. Information technologies help to track the data on reducing the number of payers of social contribution, which negatively affects the formation of pension institutions. The introduction of proper information and communication support on prudential supervision over the activities of pension insurance entities will minimize the risks depending on their level, and therefore, will create conditions for their effective use.

2. The algorithm of the constructed mechanism of information and communication support of the state regulation of the accumulative pension system reflects the practical model of an effective automated system for entities of the accumulative component. The implementation of the constructed mechanism is based on the optimal redistribution of accumulated assets in the cluster of pension system entities with the use of information technologies. The obtained mechanism of information and communication support reflects the implementation of the state regulation of the accumulative pension system, which will reduce the onset of risks when investing pension assets, and thus increase the confidence of participants.

3. Practical implementation of the accumulative pension will contribute to accumulation of the part of mandatory contributions in the fund and be accounted for in personal accounts. Information technologies of calculations proved an increase in the indicator of accumulative assets of employees in the amount of UAH 256,874 million (or USD 9.76 million). In turn, pension savings will be invested in the country's economy. The accumulative pension provision will improve the effectiveness of management and proper state regulation in the area of pension provision.

4. Expediency of the proposed optimization plan for redistribution of accumulated assets of employees in the amount of UAH 474,790 million (or USD 18.04 million) implies meeting the need to implement the accumulative component, taking into consideration the method of risk-oriented approach. The results of the problem of optimization of the plan in the mathematical statement of the transport problem of linear programming received the income from pension savings, which is UAH 1,296.1767 million (or USD 49.25 million), thereby proving the effectiveness of the introduction of mandatory pension insurance. Information and communication support for the implementation of the mechanism of increasing pension contributions requires state control and normative regulation.

Acknowledgements

The paper was prepared and financed within the framework of the state budget scientific work No. 45/2020-2021 Formation of a risk-oriented system of accumulative pension provision (DR No. 0120U101508).

References

1. Eichhorst, W., Gerard, M., Kendzia, C. M. J., Mayrhuber, C., Nielsen, C., Rünstler, G., Url, T. (2011). Pension Systems in the EU – Contingent Liabilities and Assets in the Public and Private Sector. Research Report No. 42. Available at: http://ftp.iza.org/report_pdfs/iza_report_42.pdf
2. Impavido, G., Hu, Y.-W., Li, X. (2009). Governance and Fund Management in the Chinese Pension System. WP/09/246. Available at: https://www.imf.org/external/pubs/ft/wp/2009/wp09246.pdf
3. Kolodiziev, O., Telnova, H., Krupka, I., Kulchytskyy, M., Sochynska-Sybirtseva, I. (2021). Pension assets as an investment in economic growth: The case of post-socialist countries and Ukraine. Investment Management and Financial Innovations, 18 (3), 166–174. doi: http://doi.org/10.21511/imfi.18(3).2021.15

4. Vnukova, N., Kavun, S., Kolodiziev, O., Achkasova, S., Hontar, D. (2020) Indicators-markers for assessment of probability of insurance companies relatedness in implementation of riskoriented approach. Economic Studies journal, 1, 151–173.
5. Trynchuk, V., Khovrak, I., Dankiewicz, R., Ostrowska-Dankiewicz, A., Chushak-Holoborodko, A. (2019). The role of universities in disseminating the social responsibility practices of insurance companies. Problems and Perspectives in Management, 17 (2), 449–461. doi: http://doi.org/10.21511/ppm.17(2).2019.35
6. Guidelines for Pension Fund Governance (2009). OECD. Available at: https://www.oecd.org/finance/private-pensions/34799965.pdf
7. Guidelines for the Supervisory Assessment of Pension Funds (2008). IOPS. Available at: http://www.iopsweb.org/principlesguidelines/
8. IOPS Toolkit for Risk-Based Pensions Supervision (2012). IOPS. Available at: http://www.iopsweb.org/rbstoolkit/Module3identifyingrisks.pdf
9. Musalem, A. R., Palacios, R. J. (2004). Public Pension Fund Management. Governance, Accountability, and Investment Policies. Proceedings of the Second Public Pension Fund Management Conference. doi: https://doi.org/10.1596/0-8213-5998-3
10. Stewart, F. (2010). Pension Funds' Risk-Management Framework: Regulation and Supervisory Oversight. OECD Working Papers on Insurance and Private Pensions, No. 40, OECD publishing, OECD. doi: http://doi.org/10.1787/5kmlcz7qq3zx-en
11. Achkasova, S. A., Pritula, N. I.; Marchuk, V. V., Soltanovich, A. V. (Eds.) (2019). Risk-orientirovannyi podkhod v sisteme finansovogo monitoringa dlya protivodeistviya korruptsionnym riskam. Problemy ukrepleniya zakonnosti i pravoporyadka: nauka, praktika, tendentsii. Minsk: Izd. tsentrBGU, 12, 30–35.
12. Pererva, P., Kuchynskyi, V., Kobielieva, T., Kosenko, A., Maslak, O. (2021). Economic substantiation of outsourcing the information technologies and logistic services in the intellectual and innovative activities of an enterprise. Eastern-European Journal of Enterprise Technologies, 4 (13 (112)), 6–14. doi: http://doi.org/10.15587/1729-4061.2021.239164
13. Babenko-Levada, V., Morozova, A. (2020). The process of implementation of accumulative insurance system in Ukraine. Efektyvna Ekonomika, 12. doi: http://doi.org/10.32702/2307-2105-2020.12.70
14. Pro zahalnooboviazkove derzhavne pensiine strakhuvannia (2003). Zakon Ukrainy No. 1058–IV. 09.06.2003. Available at: https://zakon.rada.gov.ua/laws/show/1058-15#Text
15. Pro zahalnooboviazkove nakopychuvalne pensiine zabezpechennia (2019). Proekt Zakonu Ukrainy No. 2683. 27.12.2019. Available at: https://ips.ligazakon.net/document/GI01073A?an=2
16. Malyshko, Y. O. (2020). The Ways to Improve the Mechanism of the State Regulation of the Compulsory Accumulative Pension Provision. Business Inform, 12 (515), 347–354. doi: http://doi.org/10.32983/2222-4459-2020-12-347-354
17. Natsionalnyi bank pryiniav povnovazhennia z rehuliuvannia rynkiv nebankivskykh finansovykh posluh (2020). Ofitsiine Internet-predstavnytstvo Natsionalnoho banku Ukrainy. Available at: https://bank.gov.ua/ua/news/all/natsionalniy-bankpriynyav-povnovajennya-z-regulyuvannya-rinkiv-nebankivskih-finansovih-poslug
18. Informatsiia shchodo pidsumkiv rozvytku systemy nederzhavnoho pensiinoho zabezpechennia stanom na 31 hrudnia 2020 roku (2020). Available at:https://www.nssmc.gov.ua/wp-content/uploads/2021/04/npf_4_kv-2020.doc
19. Pidsumky strakhovoho rynku Ukrainy za 9 misiatsiv 2020 roku (2020). Available at: https://www.bsg.ua/ru/news/підсумки-страхового-ринку-України-за-9-місяців-2020-року
20. Ohliad osnovnykh pidsumkiv roboty Pensiinoho fondu Ukrainy za sichen-traven 2021 roku (2021). Available at: https://www.pfu.gov.ua/2137083-oglyad-osnovnyh-pidsumkiv-roboty-pensijnogo-fondu-ukrayiny-za-sichen-traven-2021-roku/
21. Analiz vplyvu rehuliatornoho akta do proektu Zakonu Ukrainy «Pro vnesennia zmin do Podatkovoho kodeksu Ukrainy shchodo zahalnooboviazkovoho nakopychuvalnoho pensiinoho zabezpechennia» (2018). Available at: https://www.nssmc.gov.ua/documents/analz-vplivu-regulyatornogo-akta-do-proektu-zakonu-ukrani-pro-vnesennya-zmn-do-podatkovogo-kodeksu-ukrani-shtodo-zagalynoobovvyazkovogo-nakopitchuvalynogo-pensynogo-zabezpetchennya/
22. Ptoukha Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine. Available at: https://idss.org.ua/index
23. Shi, Y. (1995). A Transportation model with multiple criteria and multiple constraint levels. Mathematical and Computer Modelling, 21 (4), 13–28. doi: http://doi.org/10.1016/0895-7177(95)00002-j